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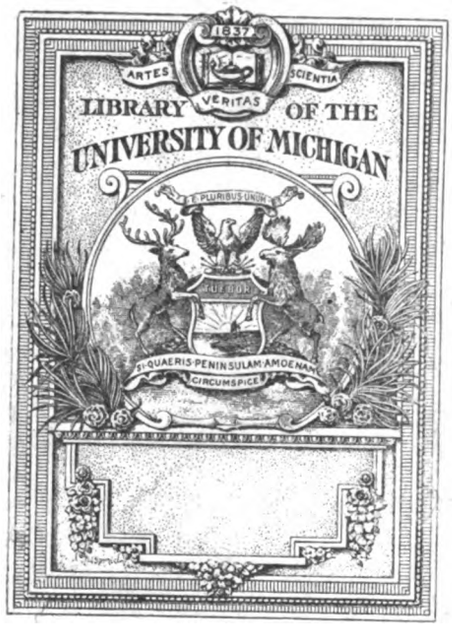

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THE

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NOTES.

New Measuring Instrument.—A French engineer, M. Mesnager, has invented an apparatus for measuring with great precision the elastic deformation of metals under strain.

Junior Institution of Engineers.—A visit is to be paid to Dover on Saturday, the 9th inst., when the South-Eastern and Chatham Railway turbine steamer "The Queen," the Admiralty Harbour Works, and the works of the Dover Harbour Board will be inspected. There will be a reception by the Mayor and Mayoress at the town hall in the afternoon. Train leaves Victoria at 9.55 a.m.

Huddersfield Sewerage Extension. — At the enquiry conducted by the Local Government Board last week into the application of the Huddersfield Corporation for sanction to borrow £135,000 for extensions of the sewerage works, Mr. K. F. Campbell, the borough engineer, explained that the new plant necessitated by the peculiar circumstances of the town will be operated electrically, by which a substantial saving would be effected on the present annual charges.

Electric Launch.—A new attraction on Derwentwater this year will be an electric launch, which will be worked from the Lodore Hotels. The vessel, which is named the "Iris," is 45ft. long, with an 8ft. beam and a draught of 16in. She is propelled by a screw making 650 revolutions per minute. The storage batteries will be charged at Lodore, where there is a generating station, with turbine power gained from the water of Lodore Falls. The boat will be sailed under Board of Trade regulations, and is constructed to accommodate 52 passengers. This combination of a water-power plant to charge an electric launch is excellent.

Society of Arts Conversazione.—On Monday a large gathering, representative of the arts and science section of the community, testified to their appreciation of the Society of Arts plan of holding the annual conversazione in the open air. Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., chairman, and other members of the council, held a reception at the entrance to the conservatory from 9 to 10 p.m. The tropical house, containing the Victoria Regia (the giant water lily) and other interesting tropical plants, was thrown open to visitors. There was also a remarkably fine collection of growing and cut roses and other flowers by Messrs. William Paul and Son, of Waltham Cross. The gardens and conservatory were transformed into fairyland by festoons of coloured lamps, huge Christmas trees, and other charming devices. The programme further contained selections by the string band of the Royal Artillery, the band of H.M. Irish Guards, and a vocal and instrumental entertainment under the direction of Mr. H. Tipper.

The Thermo-Galvanometer.—This is the designation of the instrument just invented by Mr. W. Duddell for measuring very weak alternating currents, which has lately been the subject of some experiments in Bushey Park by Sir William Preece, Mr. John Gavey, and Mr. R. T. Glazebrook, on behalf of the Post Office, the object being to test the strength with which wireless messages arrive at the receiving station. An extremely fine strip of gold leaf or platinum, stuck on to a piece of glass, is employed, and this, being subjected to the electric waves caught in the receiver, becomes slightly warmed. The degree of heat can be ascertained by means of Prof. Boys's radio-micrometer, and so the strength of the current is gauged. Thus the invention may be of great service in the development of inland wireless telegraphy by demonstrating whether intermediate objects, such as electric railways, metallic deposits, or mountains, exercise any effect upon the waves; and it also provides a means of comparing different systems. The results of the experiments have not yet appeared in detail, but they are stated to be of an enlightening character.

"The Central."—We have received No. 3 of the first volume of this journal, which is the official organ of the Old Students' Association of the Central Technical College. It is quite up to its predecessors, both in the matter and in method of production. It commences with a reference to the retirement of Prof. Unwin, who for so many years has been head of the civil and mechanical engineering department. Besides organising the college, he has held the position of professor since 1884. The other articles consist of "Popular Motorcars," by M. O'Gorman; "The Mechanism of Combustion," by Prof. H. E. Armstrong; "The Manufacture of Wood Pulp," by R. W. Sindall; "The Elongation Equation for Ductile Test Bars," by J. W. Hayward; and some editorial comments on the Mosely Educational Commission, special reference being made to the views of Profs. H. E. Armstrong and W. E. Ayrton. Prof. Armstrong's opinions on the education of girls are, of course, hostile, and the professor will see that there is an atmosphere about them not unlike that in Section L of the British Association when he is expressing his opinions on this critical subject.

The Compensation Limit. — The action of the Sheffield Corporation in seeking to limit its liability for accidents occurring on the municipal tramways to £25 by publishing a notice on the cars and the backs of the tickets has given rise to considerable discussion, some of the members of the Corporation itself dissenting from the step. The contention of the Corporation is that, having reduced the fares, they are entitled to limit their liability, but there is no precedent to support this view, and the idea that the mere passing of a by-law, even when it has received the approval of a Government department, relieves a public undertaking from the responsibilities imposed by the Statute-book has, of course, already been proved a fallacy.

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At a recent meeting of representatives from the various municipalities on the inter-running question the subject was alluded to, the general opinion being that the attitude adopted by the Sheffield Corporation was untenable, and indeed, we think that there can scarcely be room for doubt. The point will, however, be contested shortly, a local councillor having carried out his threat of refusing to accept a ticket, and being consequently unable to produce one when called upon to do so by the inspector. The Corporation have served a summons upon him. If a claim just made by a passenger of £50 as compensation is made the subject of an action, the question will be raised in a specific form.

Royal Meteorological Society.—The Prince of Wales has consented to become a patron of this institution. At the last meeting of the society, Captain D. Wilson Barker, president, in the chair, the Rev. C. F. Box gave an account of some curious "Effects of a Lightning Stroke at Earl's Fee, Bowers Gifford, Essex, April 13, 1904." A thunderstorm occurred during the early morning hours, and about 3 a.m. there was a blinding flash, lighting up the whole neighbourhood for miles around, followed immediately by a crashing explosion. One person stated that he saw what appeared to be a cylinder, and another person a ball of fire, descend, and then explode, "casting darts" in all directions. On careful examination in daylight, it was found that in an oatfield, which had recently been dredged, there were three distinct sets of holes, ranging from 9in. down to about 1in. in diameter. The holes, which were perfectly circular, diminished in size as they went downwards, and remained so on to the perfectly rounded ends at the bottom. Upon digging sectionally into the soil, which is stiff yellow clay, it was found that the holes were "as clean cut as though bored with an auger." An interesting discussion followed the reading of this paper. A paper by Mr. A. Laurence Rotch, of the Blue Hill Observatory, U.S.A., describing "An Instrument for Determining the True Direction and Velocity of the Wind at Sea," was, in the absence of the author, read by the Secretary.

The Inter-Running Question.—Undeterred by their reverses before the two parliamentary committees, the Newcastle Corporation have been in further conference with the representatives of the chief municipal authorities, with a view to securing the elimination of the inter-running clause in the Tyneside Tramway Company's Bill, which came before the House of Commons last night for third reading. Meantime, the promoters have issued a statement defining their position very succinctly. They refer to the desire of the councils of the intermediate districts that there should be a through service, and state that manfacturers employing thousands of hands in such localities have petitioned in favour of the Bill. Another point to which they call attention is that when the Corporation obtained sanction to laying their line through Walker, the chairman of the House of Commons committee remarked, "Of course, the idea is that there shall be a through service ultimately." The terms of user are left by the Bill to the Board of Trade, failing agreement; and the company offered in committee to insert a provision that each party should take the net profits earned on its own lines. In conclusion, the company refer to the precedents for inter-running afforded by other large cities. It is obvious, however, that the Corporation intend to contest the question to the very end, so that there will be an opportunity for Parliament to pronounce its verdict on this vexed subject.

Birthday Honours.—The list of appointments made to celebrate the birthday of King Edward VII. this year include a number of names which are interesting to engineers. The first on the list of new members of his Majesty's Most Honourable Privy Council is Charles Booth, Esq. This successful shipowner of Liverpool is known all over the world as the author of a series of volumes dealing with the problems of life incidental to the poor quarters of London. His statistical works are most valuable, and his views on the housing of the working classes have much to commend them. In this branch of his work he deals largely with the improved means of transport provided by electricity. Amongst the new knights appear the names of Prof. James Dewar, F.R.S, Mr. G. S. Gibb, and Mr. W. Lloyd Wise. Prof. Dewar is so well known in the scientific world that it seems redundant to mention the many discoveries of which he has been the author. He was the co-inventor with Sir Frederick Abel of cordite, and the experiments which he conducted on materials at extremely low temperatures are historic. Mr. George Gibb has been general manager of the North-Eastern Railway for the past 13 years. It is largely due to his initiative that the suburban lines around Newcastle have been electrified. This forms an excellent example of the untiring energy shown by Mr. Gibb in the management of the railway, and of his readiness to make use of the inventions of science to improve the public service. Mr. Lloyd Wise is a patent expert, and has assisted innumerable inventors, including a large number of electrical engineers. He was the first president of the Chartered Institute of Patent Agents, and his opinion on scientific questions is often called for in the courts.

Institution Conversazione.—At the conversazione of the Institution of Electrical Engineers on Tuesday, held as usual at the Natural History Museum, Cromwell-road, South Kensington, about 1,500 persons were present. The guests were received by Mr. R. K. Grey (president) and Mrs. B. Hopkinson, Mr. Alexander Siemens (president-elect) and Mrs. Siemens, and the following members of the council: Major-General C. E Webber, C.B., R.E., and Sir Henry Mance, C.I.E. (past presidents), Mr. W. H. Patchell, Mr. J. E. Kingsbury and Mr. W. M. Mordey (vice-presidents), and Mr. R. Hammond (hon. treasurer). Among those present were Prof. H. E. Armstrong, F.R.S., Mr. A. Acland Hunt, Prof. W. E. Ayrton, F.R.S., Mr. T. O. Callender, Prof. H. L. Callendar, F.R.S., Mr. W. R. Cooper, Mr. W. G. Cavendish Bentinck, Colonel R. E. Crompton, C.B., Sir J. H. Bergne, K.C.M.G., Mr. S. Dobson, Mr. W. Duddell, Prof. J. D. Everett, F.R.S., Mr. Frank Gill, Mr. J. Gavey, C.B., Dr. R. T. Glazebrook, F.R S., Mr. H. E. Harrison, Mr. H. Hirst, Mr. J. S. Highfield, Mr. C. Hawksley, P.P.I.C.E., the Hon. Sir A. R. Jelf, Lord Kelvin, O.M, G.C.V.O., Prof. A. B. W. Kennedy, F.R.S, Mr. G. C. Lloyd (secretary), Lady Maxim, the Mayor and Mayoress of Colchester, Mr. P. V. Luke, C.I.E, Mr. C. O. Mailloux, Sir W. H. Preece, K.C.B, F.R S., the Hon. C. A. Parsons, F.R.S., Sir W. Ramsay, K.C.B., Prof. H Robinson, Colonel Sir B. Scott, K.C.I.E., Mr. C. P. Sparks, Mr. J. W. Swan, F.R.S., Mr. James Swinburne, Mr. A. A. C. Swinton, Dr. W. E. Sumpner, Mr. C. F. Von Siemens, Mr. C. E. Spagnoletti, Prof. S. P. Thompson, F.R S., Sir J. I. Thornycroft, LL.D., F.R.S., Colonel J. K. Trotter, C.B., C.M.G., Sir C. Tupper, G.C.M.G., C.B., Mr. G. G. Ward, Major-General R. Wace, C.B, R.A., Mr. C. H. Wordingham, Mr. E. O. Walker, C.I.E., Colonel Sir H. A. Yorke, R.E. During the evening the string band of the Royal Engineers, by permission of Major-General Sir Reginald Hart, played in the central hall, and the Westminster Abbey Quartette, consisting of Mr. J. A. Brown, Mr. E. Dalzell, Mr. F. Norcup, and Mr.

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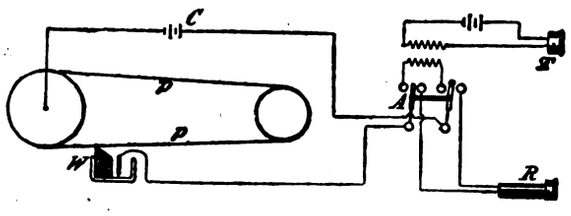
B. Mills, performed a programme of glees and part-songs in the bird gallery.

Electro-chemical Phonograph.—We take from the columns of the *Scientific American* the following description of an interesting electro-chemical phonograph devised independently by Messrs. Nernst and Lieben. Instead of using magnetic action on a continuous band, as in the Poulsen phonograph, the inventors use electro-chemical action. As will be seen in the diagram, a platinum band, *p*, passes over two pulleys which are operated by a motor.



Against the band presses a wedge of wood, W, partly immersed in an electrolyte contained in the glass vessel. Near it is an electrode which is connected to one of the contact points of the switch, A. At T is a telephone transmitter which may be connected in the circuit through a battery and an induction coil, and at R a receiver which may be thrown in. To produce the record the transmitter is connected in; then the band is passed again, and the reproduction may be heard in the receiver. A supplementary battery, C, is also used. Under the influence of the telephone currents an electrolytic action is produced, and the platinum band becomes polarised successively, the action being analogous to the magnetic band of the Poulsen phonograph. Upon passing the band a second time and connecting the receiver, the reproduction is heard, and its sharpness and durability depend on the kind of electrolyte used. But it is remarkable that for reproducing the record an additional E M.F. is necessary in the telephone circuit, supplied by the battery, C, and that within certain limits the audition is better as the battery is stronger. This phenomenon is difficult to explain, as it would be supposed that the currents are produced by the discharge of the polarised electrode, and in this case the addition of a constant E.M.F. should have no action, since it is only the variation of current which produces the effect. It may also be explained by a simple variation of resistance in the circuit, but it is difficult to suppose that such a variation in resistance could be caused by the polarisation of oxygen or hydrogen on the platinum. Besides, M. Lieben has found that the same effect is produced, when the resistance is not varied, in the case of a silver band and a solution of double cyanide of silver and potassium. He has made a number of researches with different forms of the apparatus, and concludes that the phenomenon cannot be explained by polarisation alone. On the other hand, the idea of a resistance variation will not account for all the effects. A third hypothesis is based on the variation of the friction of polarised electrodes observed by Edison. To efface the record, a compress wet with acid is pressed against the band. It is still better to connect it with a pole of the battery, when a continuous electrolytic action is produced, which acts like a brush to efface the record.

The Detection of Arsenic Electrolytically.—The *Lancet* of June 25 contains an abstract of a paper contributed by Mr. W. Thompson to the *Proceedings* of the Manchester Literary and Philosophical Society on the electrolytic method of detecting and estimating minute quantities of arsenic. In consequence of the difficulty of obtaining zinc absolutely free from arsenic for use in the hydrogen generator in the Marsh-Berzelius method, it was suggested some time ago by Lord Kelvin that an electrolytic method of liberating hydrogen might be devised. Mr. Thompson's paper gives the results of a series of tests made with the apparatus designed to carry out Lord Kelvin's idea. It was found to be impossible to get arsenical mirrors by this apparatus when using arsenic in less quantities than one three-hundredth of a grain of arsenious acid per gallon, employing about 20 cubic inches of liquid in the apparatus. Except for pure granulated zinc the use of metals other than platinum as the cathode proved unsatisfactory. With a piece of granulated zinc as the cathode stronger mirrors were obtained than were given by the platinum cathode apparatus, but when the quantity of arsenic came down to a thousandth of a grain the result was not equal to the standard produced by the Marsh-Berzelius method. On employing a rod of pure zinc as cathode, however, it was found that the electrolytic method was as delicate as the Marsh-Berzelius process for the detection and estimation of most minute quantities of arsenic. A suggestion was made that frothing could be prevented in the case of experiments with beer by the addition of amyl alcohol without interfering with the test, but Mr. Thompson's investigations show that the delicacy of the test is considerably impaired thereby, though small quantities of invert sugar do not appear to make any serious difference. In conclusion, Mr. Thompson finds that by using 25 cubic centimetres of beer, as recommended by the committee appointed by the Inland Revenue Commissioners in connection with the matter, and completely destroying the organic matter, a very faint mirror is produced when a one-hundredth of a grain of arsenic per gallon is present, but when the beer is used direct with amyl alcohol no mirror at all is produced. It would appear, therefore, that this direct method fails to detect an amount decidedly greater than that which the committee consider sufficient to condemn the sample. The results, taken all round, suggest that the electrolytic method may prove of some value, though for extreme delicacy it has apparently not yet given results equal to those of the older process.

Electrical Engineers (R.V.).—The camps of this corps begin this month, and are to be held each week until the end of August. The corps is unique in its arrangements for the yearly camps. Each man selects the most convenient date for his training, and, as far as possible, is allowed to exercise a choice of place. The plan has many advantages. Owing to the number of camps each year—some 17 or 18—the number of men at any station at once is comparatively small, and each member secures a most efficient training, and at the same time has a very enjoyable outing. Thus, the highest efficiency is maintained without interfering with the convenience of the men. The work consists of coast-defence work, including searchlights and submarine mining. Camps are held at most of the southern coast Royal Engineer stations—this year at the Isle of Wight, Weymouth, Falmouth, Plymouth, Portsmouth, Sheerness, Felixstowe, Gravesend, and, it is hoped, Dover and the Scilly Isles. Some of these are mobilisation camps. An Easter camp was also held this year at Weymouth to meet the convenience of men unable to get away in the summer. In addition, the corps sends a big detachment of men annually to assist in the naval manœuvres, and it is hoped they will also attend the military manœuvres this year in order to work the field searchlights. Between camps instruction goes on at headquarters, the corps being well equipped with service pattern oil-engines (stationary and portable), dynamos, searchlights, and complete submarine mining outfit. The members show extreme

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keenness over their technical work, its character and instructive nature appealing greatly to them. The corps is recruited largely from students of Cambridge University, Royal School of Mines, the Central Technical College, and engineering colleges; also from men actually employed in electrical works. The corps has several sub-stations in different parts of the country, at which members can receive technical instruction. Week-end classes are held at headquarters, for which the country members come up to town. The chief outlying stations are at Cambridge, Winchester, Chelmsford, Loughborough, and Woolwich. Mr. Horneby has just presented the corps with a 1-h.p. engine, which it is intended the men shall take apart and build up for themselves, so that they may know all the inner workings of an oil-engine. This year very successful night manœuvres were held at Wimbledon Common and Hampstead Heath, the portable search-light projectors used by the corps at the front being called into service. Under the command of Colonel Crompton, C.B., the future of the Electrical Engineers looks very promising.

Turbine Test.—The *Electrical World* of New York gives some particulars of an elaborate test of a Westinghouse-Parsons 400-kw. steam turbine at the works of the Westinghouse Machine Company, East Pittsburg. The condensed water was measured at intervals of 10 minutes, and the brake horse power was determined by means of a water dynamometer of the Froude type. The duration of the tests was two hours for the full load test with 100deg. superheat, and one hour for most of the other tests, a few being of shorter duration. The accompany table gives the results of the principal test.

Dry Saturated Steam.	Over-load.	Full load.	Medium load.	Low load.
Revolutions per minute.....	3,481	3,545	3,583	3,602
Throttle gauge pressure ...	153	154	156	156
Vacuum	26·87	26·84	26·80	26·90
Ratio of rated load	1·26	1·02	0·77	0·42
Steam per brake h.p. hour...	13·63	13·91	14·48	16·06
Superheat, 100deg. F.				
Revolutions per minute.....	3,457	3,546	3,580	3,588
Throttle gauge pressure ...	150	156	154	153
Vacuum	27·10	27·06	27·10	27·10
Ratio of rated load	1·31	1·02	0 77	0 41
Steam per brake h.p. hour...	12·07	12 41	12·88	14·62
Superheat, 180deg.				
Revolutions per minute.....	3,477	3,542	—	—
Throttle gauge pressure ...	151	154	—	—
Vacuum	27	27·10	—	—
Ratio of rated load	1·32	1·02	—	—
Steam per brake h.p. hour...	11·17	11·45	—	—

Tests were also made to determine the variation of the speed of the turbine at different loads. This variation in the test with steam superheated to 100deg. F. was 2·5 per cent. below speed at rated load, for 31 per cent. overload, the figures for 77 per cent. load and 41 per cent. load being ·9 and 1·2 per cent. below rated speed respectively. In the test with dry steam the variations were 1·8 below normal for 20 per cent. overload; 1·60 per cent. above for 42 per cent. load, and 3·4 per cent. above for friction load. An economy of 1 per cent. for every 10deg. of superheat between the limits employed in the tests is shown by some curves contained in the report. The report calculates the thermal efficiency of the turbine tested for the several different conditions of operation. Since the thermal efficiency of a reciprocating steam-engine is usually referred to indicated horse-power, and as the tests of the turbine were in terms of brake horse-power, in order to have a common basis for comparison it was assumed that the friction of a reciprocating engine is 6 per cent. On this basis of internal steam horse-power, the thermal efficiency for dry steam is given as 17·22 per cent., for 100deg. superheat 18·43 per cent., and for 180deg. superheat 19·43 per cent.

New South Wales Electrical Association.—We have received a copy of the *Proceedings* of the above association, in which the presidential address delivered by Mr. J. R. Woodruffe-Gardam appears. This was read in Sydney on April 8. In it the practice of other presidents is followed in that a general review of electrical engineering progress is given; but the points which most interest us are those which relate to local matters. For instance, the president says that the City Council's electric lighting supply will be commenced in August or September next. It will be remembered that the Sydney municipal system will compete with those of the electric lighting companies, which already have five stations in the city with an aggregate plant capacity of 1,985 kw. The president prophesied in his address last year that the plant then being laid down by the City Council would be inadequate to meet the demands of the inhabitants. This prophesy has been justified by the demand for supply, and more plant has been ordered. The supply is offered to consumers in five different forms, and, as the president says, he will be a hard customer to please who cannot find one to suit his tastes—he may have 240 or 480 volts continuous-current, 240 or 415 volts single-phase, and 415 volts three-phase. The president laments that the voltages selected by the council for the continuous-current supply were not 230 and 460 volts, as used in Melbourne, and in the majority of cases in England, so that the confusing number of voltages for which apparatus must be stocked in the Commonwealth might have been avoided. Some amusing remarks are made on the maximum demand system of supply, and the opinion is expressed that it will not be profitable until the plant is well loaded. This shows that the Sydney authorities are well advised, and that they are not hampered by the Bermondsey clause, now on its death-bed. Amongst the comments is a quotation that the advantage of the maximum demand system is that "it is better for a customer to complain of what he does not understand than of what he does understand." Turning to the tramways, the statement is made that they are now practically all converted from steam to electric traction, only 15 miles remaining to be electrified. The increase in popularity of the system during conversion has been remarkable. In order to supply the increased amount of energy required in consequence of the larger traffic, a steam turbo-alternator set of 1,875-kw. capacity has been ordered, which will bring the total capacity of the plant at Ultimo up to nearly 10,000 kw. In another part of the address the success of electric lifts in Sydney is commented upon. The results show that with electricity at 4d. per unit, they are from 60 to 80 per cent. cheaper that hydraulic lifts, so that when energy is obtainable from the Corporation mains at 2d. per unit, as will be the case in August or September, hydraulic power will be hopelessly handicapped. The president was accorded a hearty vote of thanks for his excellent address.

Books Received.—The Gresham Publishing Company, of 34, Southampton-street, Strand, W.C., have forwarded to us vol. iii. of "Modern Electrice Practice," edited by Prof. Magnus Maclean. This, as our readers know from previous issues, is a joint production in which no less than 36 different expert authors collaborate. Thus, in the present volume there are two sections, the first deals with electric lighting and power distribution, which is again divided into five sub-sections. These are respectively, "Distribution and Transmission of Electric Energy," by W. B. Esson; "Electric Lighting and Wiring," by W. W. Lackie;

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"Electric Fittings," by G. Byng and V. Zingler; "Arc Lamps," by F. Biliotti; and "Incandescent Lamps," by C. J. Robertson. The other section, No. 3, deals with electric tramways, but only contains information on "Rails," by John R. Wignall, and "Rail Bonding," by Victor Watlington. This subject will be continued in the next volume. The information contained on the distribution and transmission of electrical energy is exceedingly clear, as is to be expected from the pen of its author. It gives a large amount of information on extra high-tension transmission, which is quite new in this country. The author also goes into the cost both of generating and supply, and with the saving to be expected from the adoption of electrical power under various situations. The whole volume is quite up to the high standard set by the two previous volumes, and this publication should find its place on the bookshelf of every electrical engineer. We have received from Messrs. Charles Griffin and Co., of Exeter-street, Strand, the tenth revised edition of the "Elementary Manual on Steam and the Steam-Engine," by Prof. Andrew Jamieson. The book in its previous editions has been a great success, and the additions now made bring it up to date. Amongst these are descriptions of thermo-electric pyrometers; the latest type of steam-engine indicator; the 1902 piston and connecting rods for the London County Council tramway power station engines; the condensing plant for the Glasgow tramway power station; and the latest steam-turbines, which are now vieing with reciprocating engines for a first place as prime movers, not only for the fastest vessels, but also for large electrical generators. The *Transactions* of the American Institute of Electrical Engineers, issued in May this year, has just reached us. In this valuable discussions on various high-pressure transmission papers are contained, which discussions have been previously summarised in our columns. The American Institute continues the excellent practice of publishing papers well in advance. Thus, this volume reached us with advance copies of papers read at the Chicago Congress on the 21st and 22nd inst., three days before the commencement of that meeting. We are sure that this practice is of great assistance in promoting discussion. "Electric Motors," by H. M. Hobart. (London: Whittaker and Co. 12s. 6d.) Mr. Hobart's treatise on the theory and construction of electric motors, which we stated a few weeks ago would be characterised by considerable departure from conventional methods, has just made its appearance. We hope to deal more fully with this interesting volume in a future issue. "Electric Flashes," by A. T. M. Johnson. (London: Everett and Co. 2s. 6d.) This volume contains a highly-interesting exposition of various wireless telegraphy and telephony systems. We have received a copy of the "Special Bulletin" of the Cape Town (International) Industrial Exhibition, which commences in November. This brochure contains some instructive details relative to the commercial progress of South Africa, besides a description of the scope of the exhibition, and is excellently illustrated. By way of a souvenir of the opening of the Neepsend generating station, the Sheffield Corporation electric supply department has issued a beautifully-illustrated volume containing a complete description of the Corporation works.

The Electrical Congress.—The number of papers which have now been promised for the International Congress at St. Louis exceeds 160. Efforts are being made to secure the manuscripts of as many of the papers as possible in advance, so that copies may be printed for distribution at the congress. We have already published the programmes for Sections A, B, and C, and we now give those for Sections D and E. Of the former, which deals with power transmission, Mr. C. F. Scott is the chairman and Dr. Louis Bell is the secretary. The papers, with their authors, are as follows: "Electrical Transmission Plants in Switzerland," by Sig. E. Bignami; "Conditions Conducive to Economy in Motor Design," by H. M. Hobart; "Transmission of Alternating-Currents over Lines Possessing Capacity," by Mons. Maurice Leblanc; "Utilisation of Hydraulic Powers in Italy," by Prof. G. Mengarini; "High-Potential Long-Distance Transmission and Control," by F. G. Baum; "The Tower System of Line Construction," by F. O. Blackwell; "The Use of Aluminium as an Electrical Conductor," by H. W. Buck; "High-Tension Insulators," by V. G. Converse; "Line Construction and Insulation for High Tensions," by M. H. Gerry, jun.; "Bay Counties Transmission System," by L. M. Hancock; "Some Practical Experiences in the Operation of many Power Houses in Parallel," by R. L. Hayward; "Long Distance Power Transmission," by J. F. Kelly and A. C. Bunker; "Transmission and Distribution Problems Peculiar to the Single-Phase Railway System," by P. M. Lincoln; "The Maximum Distance to which Power can be Economically Transmitted," by R. D. Mershon; "Pioneer Work of the Telluride Power Company," by P. N. Nunn; "The High-Tension Transformer in Long-Distance Power Transmission," by J. S. Peck; "American Practice in High-Tension," by Dr. F. A. C. Perrine (representing National Electric Light Association); and "Theory of Single-Phase Motors," by Dr. C. P. Steinmetz (representing American Institution of Electrical Engineers). Section E, which deals with electric light and distribution, will be presided over by Mr. J. W. Lieb, jun., the secretary being Mr. G. S. Dunn. The papers and authors are as follows: "Impregnated Arc Light Carbons," by Prof. André Blondel; "Single-Phase Motors," by Herr Max Déri; "Rates for Electricity Supply," by Herr E. de Fodor; "Insulating Materials in High-Tension Cables," by Sig. Ing. E. Jona; "Upon a Means for Compensating the Series Connection of Induction Motors," by Prof. W. Kübler; "Storage Batteries," by Herr Karl Roderbourg; "Commercial Limits of Electric Transmission, with Special Reference to Lighting Service," by Sig. Ing. Guido Semenza; "The Superiority of the Alternating Current for Distribution in Large Cities," by Dr. G. Stern; "Measurements of the Energy of Light and Heat Radiation from Electric Light Sources," by Dr. W. Wedding; "Recent Improvements in Electrolytic Meters," by Arthur Wright; "The Testing of Alternating-Current Generators," by B. A. Behrend; "Protection and Control of Large Light-Tension Distribution Systems," by George Eastman (representing Nat. Elec. Light Assoc.); "Rotary Converters and Motor-Generators in Connection with the Transformation of High-Tension Alternating to Low-Tension Street Current," by W. C. L. Eglin (representing Assoc. Edison Illum. Cos.); "The Effect of Steam-Turbines on Central Station Practice," by W. L. R. Emmet; "Underground Electrical Construction," by Louis A. Ferguson (representing Assoc. Edison Illum. Cos.); "Storage Batteries as an Adjunct to Central Station Equipment," by Gerhard Goettling (representing Assoc. Edison Illum. Cos.); "American Meter Practice," by G. Ross Green (representing Nat. Elec. Light Assoc.); "Metering Efficiency on Customers' Premises," by Caryl D. Haskins; "Steam-Turbines," by Francis Hodgkinson; "Incandescent Lamps," by John W. Howell; "Distributing Systems from the Standpoint of Theory and Practice," by Philip Torchio; and "The Selection of a Distributing System for a Large City," by W. F. White. The subject to be dealt with by Prof. S P. Thompson will be announced later.

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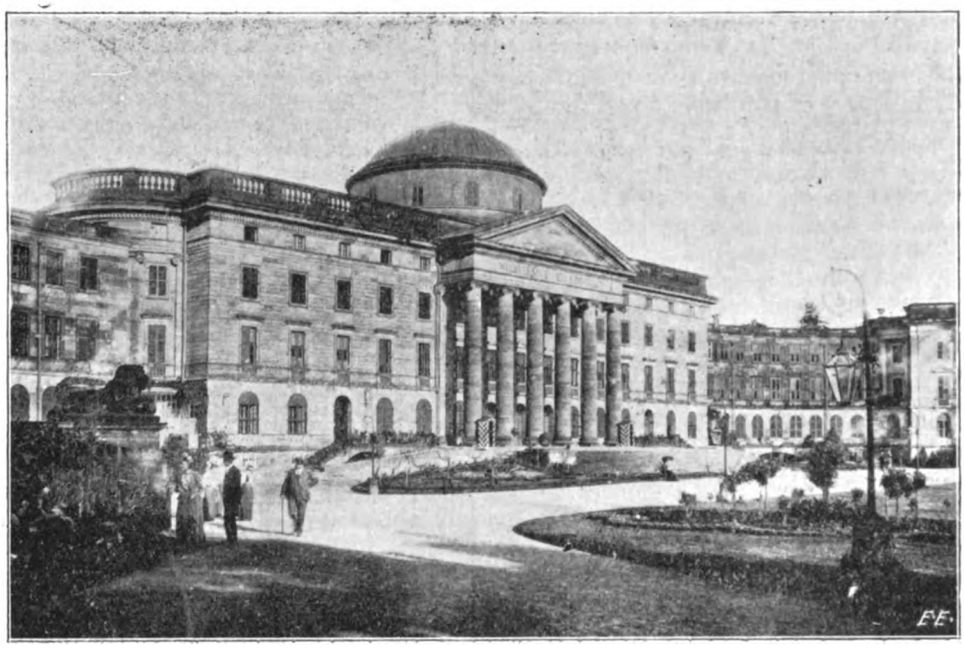
THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

Twelfth Annual Meeting. — Cassel.

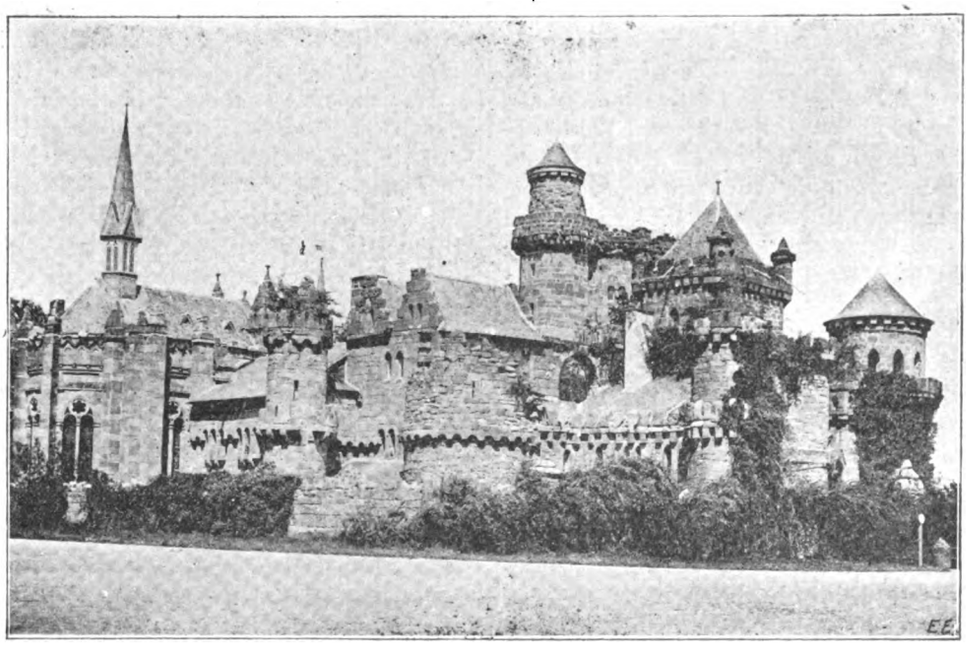
[FROM OUR SPECIAL CORRESPONDENT.]

Providence seems to have marked the annual meeting of the Verband Deutscher Elektrotechniker for special favour. Certainly not within my recollection has there occurred aught to prove the contrary, and having made common lot with the Verband at such times for years past, I may claim to speak with some authority. It is now my pleasure to record the success of the Cassel meeting, which commenced on Thursday, June 23, and was concluded on the following Sunday.

Cassel is a midland town, possessing some 100,000 inhabitants. It is situated on the Fulda—a tributary of the better-known Weser—being the southernmost point open to navigation by ships from Bremen. Further, it is a junction point for no less than six railway lines. I cannot claim an intimate acquaintance with the town itself, not having visited it prior to the occasion in question. Like in most German towns, the contrast between the old and modern parts is very striking. Some of the houses by the river struck me as being especially quaint, and the streets narrow and tortuous, while recent extensions, on the other hand, pay tribute to German progress in municipal organisation. For its size Cassel is rich in works of art and antiquities, some notable collections being contained in its several galleries and museums. Moreover, it enjoys close proximity to the Royal Palace, Wilhelmshöhe, being, for that reason, what is locally termed a Königliche Residenzstadt, a distinction, it is true, not at all uncommon in Germany. Of some historical interest is the fact that Napoleon III. was held prisoner in the palace from Sept. 5, 1870, to March 19, 1871. Far more noteworthy, however, than the palace itself are its unique surroundings. A fantastic building surmounted with a gigantic statue of Hercules stands at a commanding elevation in the background. Cascades from the front of this building to the lower level make the whole an imposing spectacle. Besides these cascades Wilhelmshöhe can boast some magnificent waterfalls, in whose development art has assisted nature. The beauty of the waterfalls and general charm of the park surrounding the palace defy adequate description. Suffice it to say that the present development of the estate dates from its possession by Landgrafen Karl, 1670-1730. A visit to Wilhelmshöhe and the associated attractions was, of course,



Royal Palace, Wilhelmshohe.



Lowenburg, Wilhelmshohe.

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included in the programme arranged for the meeting. The Germans are adepts at combining business with pleasure without detracting from either. But since I have so often dwelt upon their methods of distraction, details of this visit may well be omitted here, as also of the "Begrüszung der Festteilnehmer" on the opening day, and the "Gartenfest im Wilhelmshöhe" on Saturday evening.

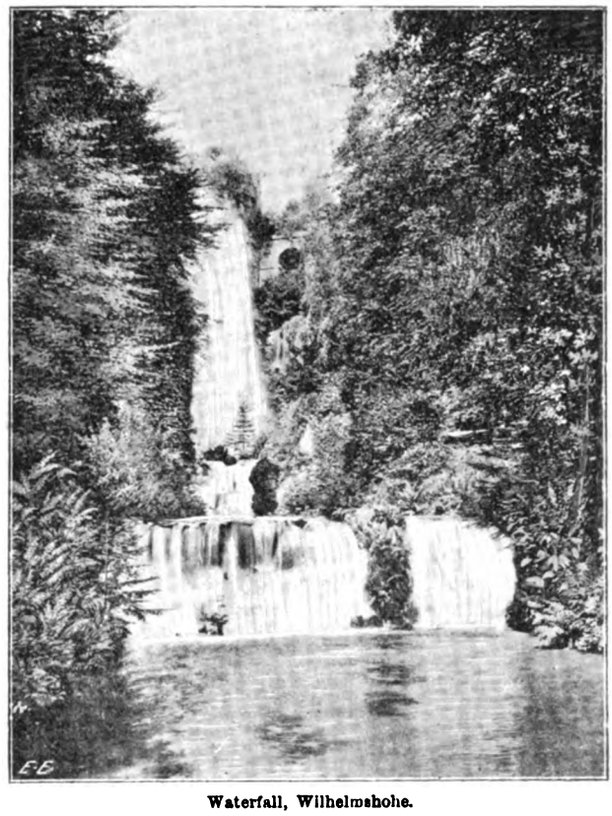
Business proper was commenced on Friday morning, but having regard to the central situation of Cassel the meeting was, perhaps, not so large as might have been expected, under 200 members reporting themselves. The President, Herr Geh. Baurat Dr. Ulbricht, of Dresden, opened the proceedings with a brief address. Assurance of the hearty welcome of the meeting in Cassel having been expressed by the Government deputy, Se Exzellenz Herr Ober präsident von Windheim, Herr Oberbürgermeister Müller, and others, Mr. Gisbert Kapp, in his capacity of general secretary to the Verband, then presented his annual report, which was of unusual length and interest, mentioning among other things that the committee entrusted with the question of standardising system and voltage on board ship had carried out the wishes of the Verband in regard to consulting with the English Engineer-

Cascades, Wilhelmshohe.

ing Standards Committee, with a view to obtaining uniform practice. As deputed by their committee, he (Mr. Kapp) had attended a meeting of the English committee and submitted their proposals. He found English engineers, representing commercial interests, were ready to adopt these proposals, but the Royal Navy Department had decided, for the present, to adhere to the direct-current system of generation at 100 volts (against the Verband's proposal of 110 volts), and possibly later to adopt a pressure of 220 or 230 volts. German experts on the installation of electrical plant on board ship regarded the higher voltages as dangerous; but as the Royal Navy did not contemplate any immediate change they were concerned for the time being, at any rate, with only the two pressures—viz., 100 volts and 110 volts. Their committee had decided in favour of the latter, and a motion to adopt this pressure as the standard for ship installations would be submitted to the meeting by Herr Schulthes.

The committee on hysterisis had given their attention to the question of ageing, which at one time excited so much concern in scientific circles. He thought, however, that the meeting would be convinced by the report to be presented by the chairman of the committee that the method now adopted in manufacturing iron plates for electrical purposes left no cause for further anxiety on this account. The question of the systematic inspection of electrical installations was discussed at a council meeting of the Verband in Kiel so far back as 1900, the view then obtaining being that it lay in the interests of the German electrical industry to establish such control as would ensure the general observance of the practice prescribed by the Verband. At that time, however, the Government were not forthcoming with any definite proposals, and the discussion was of a purely academic character. But the question had been invested with fresh importance by the introduction of a Government Bill dealing with the cost of testing and supervising electrical installations. The council had therefore deputed the chairman of the Safety Rules Committee and himself (Mr. Kapp) to submit a petition to the XII. Committee of the Abgeordnetenhauses, in which petition it was requested that (1) the Safety Rules should be adopted as basis for the proposed supervision, and (2) that the supervision itself should not be by police officials, but by practical electrical engineers.

The Council had requested him (Mr. Kapp) to obtain statistics relating to accidents through electricity. Applications had been made to 16 unions and 35 firms for full



Waterfall, Wilhelmshohe.

information concerning any accidents through electricity which had come to their knowledge. The purpose of these enquiries was, in the first place, to ascertain what alterations, if any, could be made in the Safety Rules, so as to ensure better protection to persons. So far only 13 replies had been received, so that the statistics were far from being complete. Nevertheless, the figures obtained justified the conclusion that in comparison with the enormous use of electrical energy for power purposes in Germany, the number of accidents was extremely low. The 13 reports gave particulars of 45 cases of personal injury in all, dating from 1892 to the present time. Of these cases 9 were fatal, 12 resulted in serious injuries, while about half (24) were slight. In five instances the cause was attributed to faulty installation, the injured workmen's own negligence being given in regard to the majority. From the official statistics for Westphalia, placed at the disposal of the Verband by Prof. Dr. Rasch, it appeared that between 1895 and 1900 the cases of personal injuries directly attributable to electricity were as follows: slight injuries, 25; serious injuries, 5; killed, 23—total, 53. Defective installation was given as the cause in 10 instances.

Some doubt had been raised in medical circles as to the suitableness of the directions published by the Verband

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some five years ago for first aid in the case of electric shock. The Council had consequently decided to entrust some members of the medical profession with the examination of these directions with the object in view of determining whether they still satisfied requirements in the light of present knowledge, and if not, what alterations should be introduced.

The report incidentally stated that the membership of the Verband had increased by 163 members during the past year, numbering now a total of 3,521, while the finances were in an equally healthy condition; also that the official organ of the Verband—*i.e.*, the *Elektrotechnische Zeitschrift*, had a weekly circulation of 8,400 copies at the end of 1903.

I have purposely omitted to mention some portions of Mr. Kapp's interesting report, since it is my intention to deal in greater detail with certain of the items mentioned later on. Enough has already been said, however, to indicate the thoroughness with which the Verband are pursuing their policy in the general interest of the electrical industry in Germany.

STANDARDS FOR THE USE OF ELECTRICITY ON SHIPS.

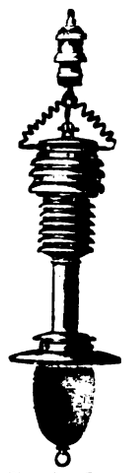
In due course Herr Schulthes submitted the proposals regarding the use of electricity on ships, which had been referred to by Mr. Kapp in his report. The chief recommendation, as already explained, was to adopt direct current at a line pressure of 110 volts as the standard for use on shipboard, while at the same time employing the two-wire system of distribution. Several pertinent reasons had guided the committee in their choice of direct current. Direct-current motors were at present the most suitable for use on board ships by reason of the better control which they enabled as compared with other types. In regard to danger from shocks, direct current was less to be feared than alternating current of the same effective potential. The navy was already dependent on direct current for its search-lights. A uniform system for warships and the mercantile marine was not only in the interest of navigation, but also in that of the electrical industry. The distributing cables for polyphase currents, which at present only came into question for power purposes, were less accessible to inspection, and since the three conductors must be made into a cable in order to reduce the self-induction, it became a difficult matter to lay it to large motors due to its section. Moreover, branch circuits were difficult to connect. The demand for electricity in the mercantile marine was principally for lighting. The advantages hitherto claimed for alternating current in that the compass was not affected thereby had little weight, since this trouble could be avoided with direct current by giving proper attention to the laying of the cables and to the construction and erection of the motors.

As regarded the adoption of 110 volts, this pressure was also usual on land, lamps, motors, and apparatus for this tension being, therefore, available. Moreover, this voltage represented a value up to which experience had shown it was safe to go without hesitation, bearing in mind the difficulty of efficiently insulating conductors on board ships.

It remains to add in connection with these standards that the recommendations of the committee were unanimously approved by the meeting.

EXHIBITION OF NOVELTIES.

An exhibition of electrical novelties is generally to be found within the immediate neighbourhood of the Verband's place of meeting. This occasion proved no exception to the rule, although the number of exhibits was far less than usual. Deserving of special mention is the Siva arc lamp, which may be described as the midget of midgets. A feature of the lamp which is likely to greatly assist its sale consists in that it is made to connect to a lamp holder of the Edison screw pattern such as is used in Germany. For that matter there is no reason why it should not be adapted equally well for attaching to a bayonet socket holder. The lamp is made for direct current in two sizes. The lesser of these consumes one ampere at 110 volts, while yielding a mean hemispherical candle-power of 150; it will burn 10 hours. On the other hand, the larger size takes 3½ amperes at 110 volts, yielding a mean hemispherical candle-power of 600, and burning 20 hours. The line resistance is enclosed in the lamp, the hood of which is corrugated (as shown in the accompanying illustration), so as to radiate the heat generated. Another advantage of the lamp is that there need be no waste of carbon, since the remnant of the upper carbon can be used up in the lower holder. Four lamps were on view, two of each size. They were giving a beautiful white light, and burning with great steadiness. I understood the lamps were recently exhibited in Berlin, where orders for over 300 were quickly taken. In Cassel, orders for about 50 lamps had been secured up to the time of my visit. Apart from the convenience which it offers for fixing the price of this lamp is all in its favour, being in the case of the smaller size £1 and in that of the larger size £1. 10s.



Siva Arc Lamp.

The makers are Messrs. Ehrick and Graetz, Berlin So. 36. Among the other exhibits I noticed one by the well-known firm of Mix and Genest, which included some lever switches with porcelain bases and handles. They looked very nice and clean mounted on a switchboard, and no doubt possessed very high insulation resistance, but what about mechanical strength? It had never occurred to me that porcelain was a suitable material for a switch lever, and I still have my doubts upon the point despite its application for the purpose in this case.

(To be continued.)

LIFE OF INCANDESCENT LAMPS.

BY C. A. B. GARRETT.

The curves given in this paper were obtained recently in a series of tests of incandescent lamps under ordinary working conditions in the Electrical Laboratory, University College, Nottingham. The results obtained, though not entirely new, were so striking as to appear to deserve attention. Eight lamps in all were used, two being selected from each of four well-known makers. These were joined up on a base-board connected to the ordinary Corporation lighting mains. They were then run night and day continuously, and the maximum candle-power measured at a fixed hour every day by means of a photometer. All the lamps were thus compared every day with a separate incandescent lamp (Standard A). Now, the absolute candle-power of a lamp depends on the pressure at which the lamp is being run; but it was found at first by a separate series of experiments on all the lamps that the fractional variation in candle-power due to change in pressure, within the limits of the experiments, was the same for these lamps. Then, since the lamp under test is on the same circuit and at the same pressure as Standard A, its candle-power relative to A can be determined. Standard A was compared occasionally with a second Standard B, kept for reference. Finally, the absolute candle-power was found by comparison with a pentane standard lamp.

The pressure of 209 volts, which seemed to fairly represent the average pressure of the supply, was taken as standard; the real pressure was constantly varying, but we waited until it came to 209 volts before any readings of current were taken. The current taken by each lamp was measured every day. Thus, at any time, we know

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the power absorbed by every lamp, and the amount of illumination given by it. As the lamps were made for 200-volt circuits, it is obvious that they were very greatly over-run, yet it is an interesting fact that not one of the eight lamps was "burnt out" whilst running 1,500 hours, after which no further measurements were taken. The lamps of the different makers, nominally of the same candle-power, did not agree with each other, but those of the same maker agreed much more closely. This justifies us in taking a mean of the two lamps in each case as representing a given make of lamp.

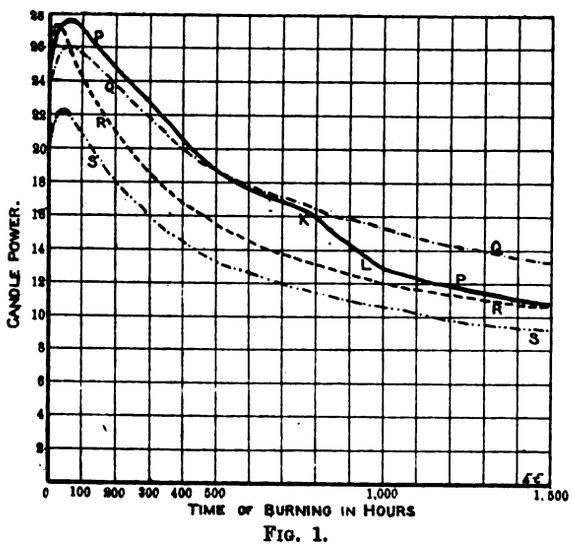

FIG. 1.

The curves given in Fig. 1 show how the candle-power of the lamps changes with time. The curve represents the mean of the two lamps in each case. Nominally, they were all 16 c.p. when run at 200 volts. It will be seen that at first they gave at 209 volts values of candle-power ranging from 20 c.p. to 24 c.p. Then we have a rapid rise in candle-power in every case during a period varying from 20 to 50 hours, when the maximum is passed, and a rapid fall sets in. This continues for 300 or 400 hours, and afterwards the fall becomes more gradual, though still fairly rapid. At the point K in curve P_1, after 750 hours, a

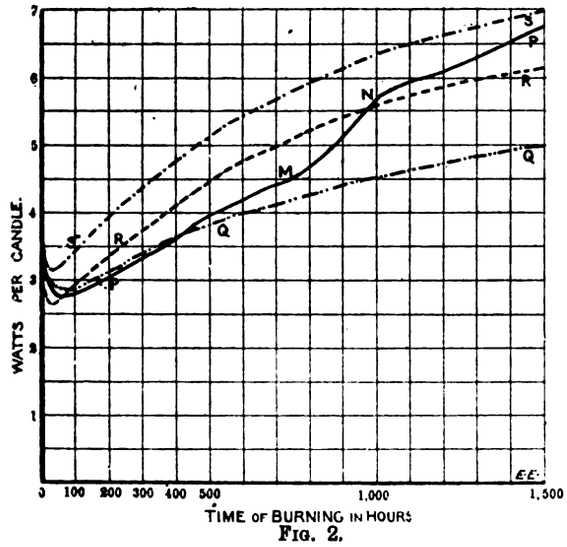

FIG. 2.

sudden change took place in one of the lamps; its candle-power fell to a much smaller value, though it continued to burn to the end. It might have been thought that the lamps of lower candle-power had been made specially to stand more than 200 volts, and consequently would not fall so rapidly as the others. This at first sight seems to be correct, as the curves get closer together as time goes on. On further examination, however, this is not confirmed; for instance, take the ratio of the ordinates of Q + S at 100 hours and 1,500 hours, they are 1·27 and 1·44 respectively, so that Q has increased its superiority over S, instead of decreasing.

This is shown more clearly in Fig. 2. The ordinates give the inverse of efficiency, for they show the power required for a given light. The rapid rise in candle-power during the first 20-50 hours, shown in Fig. 1, accounts for the first part of the curve, the efficiency gets better—*i.e.*, the power absorbed per candle decreases. The part K L of P_1 (Fig. 1) is easily recognised at M N, a sudden rise in power absorbed per candle. Although the power absorbed by any lamp decreases continuously as time goes on (owing to the increase in resistance of the lamp) the rapid diminution in candle-power more than makes up for this,

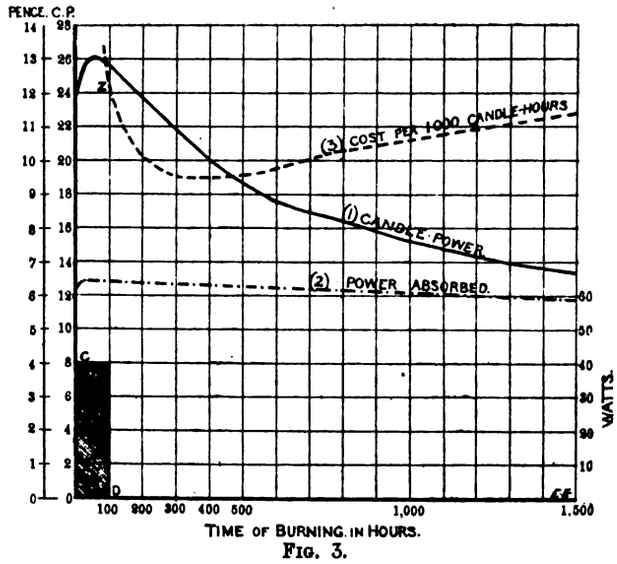

FIG. 3.

and, whereas the lamp at first takes three watts per candle, after 1,500 hours it takes six watts per candle. The superior lasting powers of the Q lamp are very plainly shown on the diagram, confirming the facts deduced from Fig. 1.

Fig. 3 contains three curves, all referring to the Q lamp. The first is the candle-power curve of Fig. 1, from this we can obtain the number of candle-hours obtained by running the lamp t hours. This is given by the area enclosed between axes of co-ordinates, the curve, and the ordinate at $x = t$. The second curve gives power absorbed by the lamp at any time; a similar area on this curve gives the total cost of power used in the given time; if we add to this an area, C D (shaded), representing the cost of the lamp, we have the whole cost of lighting. Finally, dividing the whole cost for time, t, by the number of candle hours obtained, we get the cost per candle-hour of the light which has been obtained. By calculating this for all values of t, we construct the third curve of Fig. 3. In order to understand the meaning of this curve, take as an example the point Z (100 hours, 1s. 0¼d.). This means that if we discard

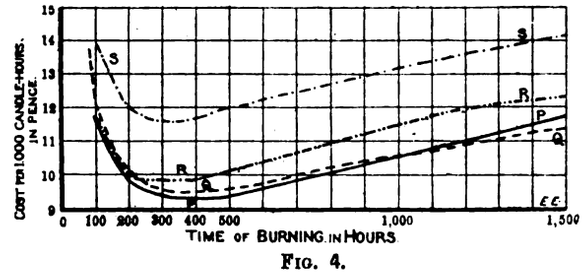

FIG. 4.

each lamp after burning 100 hours and replace it by a new one, every 1,000 candle-hours costs us 1s. 0¼d. The curve has a minimum at 400 hours, showing that if we wish to work most efficiently we must replace each lamp after burning 400 hours. If, on the other hand, as observed by Prof. Fleming, we can do with less light, it is obviously *cheaper* to burn the lamp until it breaks, both on account of the cost of a new lamp, and also of the fact that an old lamp uses less power than a new one. Several experimenters have recommended that the lamps be discarded when their candle-power has fallen to 70 per cent. of the original value. In the case considered here, to secure maximum efficiency we discard the

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lamp after 400 hours, at which stage the candle-power has fallen to 77 per cent. of the maximum value attained.

Hitherto, in practice, the cheaper plan seems to have been generally adopted, burning the lamp either until it breaks or until the candle-power has fallen very low. Note that in these tests, after 1,500 hours burning, the candle-power has fallen off to 50 per cent. of the maximum value, though the lamps did not appear to be seriously blackened. Curve 3 of Fig. 3 is repeated in Fig. 4, together with similar curves for the other lamps. P + Q lamps run very close, P being a little better if the lamps are discarded early, while Q shows better lasting qualities.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Ninth Annual Convention.

This convention at Derby was opened on Wednesday last by the Mayor (Councillor C. Boam), who extended a hearty welcome to the members. He said the association had honoured Derby by electing Mr. Wilmshurst as its president. They respected him highly in Derby, and were gratified to find that his fellow members did so also.

Alderman BUTTERWORTH, the chairman of the Electric Light Committee, also welcomed the association, and referred to the hospitality which had been extended by the adjoining towns of Nottingham and Sheffield.

Mr. WILMHURST, on behalf of the Municipal Electrical Association, thanked the two speakers for their kind words. He then read the following address:

Presidential Address.

BY T. P. WILMSHURST, BOROUGH ELECTRICAL ENGINEER, DERBY.

At the commencement of our ninth annual convention it is with great pleasure that I am able to congratulate you on the continued growth in numbers and importance of our association. When our first president, Mr. Arthur Wright, addressed you, he referred to the fact that our members controlled undertakings with a capital outlay amounting to £4,000,000. Within eight short years this has risen to £25,000,000, and, including the tramway undertakings with which many of us are connected, it may be safely said that our members control an industry with a capital of nearly £40,000,000.

Before going further, however, I must refer to the grievous loss which we, and, in fact, the whole profession, sustained by the sudden death at an early age of Mr. Quin. For several years he served on our Council; his opinions always commanded respect, and his abilities were such that all who knew him prophesied for him a brilliant career.

When reviewing the influences which affect for good or evil the undertakings we control, the attitude of Parliament and parliamentary committees cannot fail to have a great interest for us, since anything tending to unreasonable restriction cannot fail to have an adverse influence on our prospects. One cannot, therefore, view without a certain amount of uneasiness the want of continuity of policy in parliamentary committees. I will give you one or two instances. The Committee of the House of Commons which sat in 1900, under the chairmanship of Sir James Kitson, to consider the question of power schemes generally, laid down the following principle: "A local authority which undertakes and is prepared to give a full and ample supply of electrical energy for all purposes to consumers within its district ought not, without its consent, to be required to give facilities for the supply within its district of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide on reasonable terms and within a reasonable time a full and adequate supply of electrical energy for any purpose to any company or person applying for same within its district, such company or person should be at liberty after notice to the local authority to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose." In other words, peaceable possession was to be given in return for good behaviour. This principle was adopted, and in consequence all important towns having electric supplies were excluded from the many power schemes which were promoted during the next two or three years. It was therefore a considerable surprise to us when another parliamentary committee reversed this principle and allowed the city of Bristol to be included within the area of a power company. In this case at any rate there was no question of an inadequate or defective supply being furnished by the Bristol Corporation; in fact considerable expense had been incurred in providing special arrangements for the supply of electric power for local industries.

Another instance is the insertion in a Bill of the famous—or infamous—Bermondsey clause, which might have been invented with the object of strangling an industry in its early days, while in other Bills the clause has been refused; allied to this is the Willesden clause, which will be fresh in the minds of many of you. Yet another instance is the electrolysis clause which has been inserted in a number of tramway Bills, while in other cases we have been refused this clause, but instead have been told to comfort ourselves with the assurance that we are amply protected by the existing Board of Trade regulations. The recent decision of a parliamentary committee to grant to a company powers to run over the lines of the Newcastle Corporation tramways is a new departure, which if confirmed by parliament will have far-reaching results. Another novel decision recently given is the case of a certain corporation, which in promoting an Omnibus Bill sought and obtained power to give a supply of electricity to a number of villages within its sphere of influence with the consent of the local authorities controlling this village. The proviso was inserted, however, that the consent of the corporation should not be required in the event of a certain power company also wishing to supply these villages.

I have said enough to show how injurious to us may be the effect of this unfortunate want of continuity of policy. We often hear the complaint that Parliament is overloaded with minor details, and that the consideration of purely local matters could better be left to certain decentralised bodies to deal with. A little consideration shows that this would prove an aggravation of rather than a panacea for our troubles. Obviously these troubles arise from the fact that similar questions involving the same principles are dealt with by several different parliamentary committees, the members of which may hold widely divergent views on such questions as municipal trading. The only remedy that I can see is to delegate matters involving the same questions of principle to one committee or to a body of commissioners similar to that which adjudicates on light railway schemes, or by conferring wider powers on the Board of Trade.

We have been accused in some quarters and occasionally in the technical Press of looking on the power companies as our natural enemies. This view is entirely wrong, and somewhat unjust to us as engineers. We all recognise that power companies have a distinct sphere of utility in supplying the large and small industries outside the reach of the local municipal or company supply, and in giving the benefits of an electric supply to small towns which hesitate to lay down their own plant. I do not say for a moment that we welcome their competition in

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our towns—if we did we should probably not be believed—but what we most strongly object to is their attempting to obtain terms and exemptions which we are denied under the Electric Lighting Acts and our provisional orders. For instance, Section 19 of the Electric Lighting Act, 1882, provides that the undertaker shall supply anyone who demands a supply, subject only to certain very limited safeguards; the power companies are, however (or seek to to be), relieved of this obligation. In other words, while we are compelled to take the rough with the smooth, the power companies seek only the plums. Again, in a number of power schemes which I have had occasion to examine within the last few years, the promoters have made comparisons of the cost to the consumer under their scheme with the cost of the municipal supply, invariably to the disadvantage of the latter. Cross-examination, however, has usually brought out the fact that while the municipal supply is given at a pressure suitable for immediate use, in the rival scheme it is proposed to give the consumer a supply at 5,000 to 10,000 volts, leaving on him the onus of providing his reducing and converting machinery. This comparison is as unfair as a comparison of the cost per ton of a finished article with that of the raw material from which it was made.

The growth of our business, as shown in the periodical returns which are available, is very satisfactory. It is advisable, however, to remember the great progress which is also being made by our competitors. In recent years the gas business has received an enormous impetus from the introduction of the Welsbach mantle, and it would be folly on our part to disregard their experience. Rather let us see if the methods they adopt cannot also be adopted with benefit to ourselves. When the old flat-flame burner was in general use the burner was of the simplest possible character and if kept clean would last an indefinite time without attention. The old order, however, changed with the extended use of the Welsbach mantle. This gradually deteriorates with use, and has to be replaced at more or less frequent intervals. Neglect of this results in discredit being thrown on the supply. Gas engineers have not been slow to see that for the credit of their undertakings some sort of supervision of the consumers' fittings is to the interest of both buyer and seller. We find, therefore, an increasing tendency for arrangements to be made whereby, for a small payment, a periodical inspection is given.

Now, the position of the incandescent electric lamp is analogous to that of the mantle. It is a device requiring technical knowledge in its selection, so that lamps of reasonably high efficiency and long life may be used. Yet how many of our consumers consider life and efficiency before first cost when purchasing? The result is, inefficient lamps are used and are allowed to burn beyond the "scrapping point," and heavy bills follow; the supply is blamed as "not being so good as it used to be," and strained relations arise between our consumers and ourselves. I believe, therefore, that if we wish to continue and increase our rate of progress, the following suggestions are worthy of consideration: (1) the periodical renewal of consumers' lamps free or on easy terms; (2) the periodical inspection of consumers' lamps *in situ*; or (3) the free testing of and reporting on consumers' lamps. I am aware there are deeply rooted objections to the first two courses. Many engineers (and their consumers) shrink from organised domiciliary visits and from interference of any sort beyond the meter. Another objection often urged is that we do not purvey light, but electrical energy, and consequently it is no concern of ours how that energy is used.

Though I have no sympathy with the principle of the municipality undertaking wiring or interfering with the legitimate business of the local contractor, I believe that only good can result from our selling lamps of good efficiency at the lowest possible price. The opponents of municipal trading will, I think, admit that this is germane to the business of electricity supply, and Parliament has recognised this by permitting in many local Acts the clause authorising us to "sell, let on hire, and otherwise deal with electric lamps, etc." Personally, I am strongly in favour of the policy of testing free of charge all lamps which the consumer likes to send us: the expense to us is very small and there should be no difficulty in arranging for the tests to be carried out during the night shift or some other convenient time.

We are handicapped in the pushing of our business by the fact that our capital charges are so heavy as compared with our revenue. This is, I believe, largely due to the want of a cheaper and more efficient method of storage. As a matter of fact, the average percentage of our revenue to capital only amounts to 10 per cent., as compared with 24 per cent. of gas undertakings. It is a sign of promise for the future, however, that the increasing use of power during the hours of daylight is helping towards the solution of the problem of this small percentage. This, however, should be sold at the lowest possible price, and, if necessary, encouraged by letting out the motors on hire. The progress of power supply in many of our towns is so marked that I believe it is having, and will have, a distinct influence in those towns which wish to retain old and attract new industries. Just as in foreign countries we find new and thriving trades settling round the sources of cheap water power, so I believe the best industrial inducement we can offer to the manufacturers to settle within our boundaries will be the offer of cheap electric power. In our own town of Derby the progress of power supply has been most encouraging. Five years ago we gave a supply to 20 motors aggregating 70 kw. At the present time we have a total of 250 motors aggregating 1,300 kw. connected to our single-phase mains, while the percentage of units sold for power to total units sold amounts to 30 per cent.

Allied to the foregoing is the vexed question of the proper apportionment of charges for energy for tramways between the two committees interested. Many members of tramways committees who have usually not had the opportunity of studying the considerations which underlie the costs of production, fail to see why they should be asked to pay say 1½d. to 2d. per unit, while smaller consumers of energy for industrial purposes only pay say 1d. to 1½d. per unit. A little consideration shows that there are at least two good reasons why this is so. The cost of producing electrical energy is independent of the purpose to which that energy is applied, and it depends chiefly on the rate of production; in other words, on the load factor. Now, experience shows, contrary, perhaps, to what one would expect, that, as a rule, a motor load has a higher load factor than a tramway load; quite frequently it is 10 to 15 per cent. higher, owing partly to the fact that the traction plant running has to be larger than the actual load.

The second consideration is that in the case of the traction supply the energy must be taken from a separate plant to that supplying the lighting, and also a separate and distinct switchgear and set of mains must be provided, whereas the motor load is taken from the same machinery and mains as is supplying the lighting. For towns of moderate size I look to the battery and reversible booster as an important factor in reducing tramway costs. I do not, however, wish to trench further on the question, as you will have on Friday an opportunity of fully discussing it.

In our endeavour to improve our costs of production I often think that we do not sufficiently consider the importance of the item, "rent, rates, and taxes." From the fact that we have no hand in fixing the amount of our assessments, we are rather apt to dismiss the question of these charges as being unimportant, or, at any rate, as a burden to be borne with resignation, and as engineers we often know very little of the methods on which our assessment is based. I think this question of the equitable assessment of electricity works is one which our association might profitably take up in the near future. To illustrate its importance, I need only say that reference to the columns of the *Electrical Times* shows that in five towns the rating is heavier than the coal bill, while in 20 towns it is over half the amount of the coal bill. It is only natural that in those towns where the rating of the works is low the engineer does not look too closely into whether the basis of his assessment is equitable, provided the amount of money which he has to contribute is reasonable.

There is a somewhat extraordinary divergence of practice in the methods adopted by the various rating authorities.

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In some towns it depends solely on the caprice of the assessment expert; in some an amount is arbitrarily fixed for a few years until it is seen what development takes place; in others it is based on the capital expended, while in others again it is based on the total horse-power installed. The result of such discordance is that this item in our cost-sheets varies from ·02d. per unit sold in one town to ·7d. in another, and this can hardly be due to variation to this extent in the amount of the rates. The generally recognised custom seems to be to treat the undertakers as an "hypothetical tenant," deducting the working expenses from the gross receipts and making certain allowances for stock in hand, working capital, and depreciation. As to whether this is the fairest method I fear I am not competent to express an opinion, but if we could bring about greater uniformity in this matter, and so help some of our undertakings who are groaning under unduly heavy rating burdens, we should be worthily fulfilling one of the primary objects for which our association was formed.

In conclusion, I would make an earnest appeal to all our members to do what in them lies to support the work of the Engineering Standards Committees. By more rigid adherence to standard designs and by judicious stifling of that natural desire for originality which smoulders in the breast of every well-regulated engineer, we shall be making an important step in the reduction of our capital expenditure. I fear you will have found this address somewhat tedious by comparison with those of my predecessors in the chair, but I feel that the points alluded to are of some importance to us in the conduct of our concerns. I am glad to think that the papers to be read at this convention are of an eminently practical character, and I venture to hope that your visit to the Midlands will not be without profit and pleasure to you all.

A cordial vote of thanks, proposed by Dr. PANTON (of Bolton) and seconded by Alderman PEARSON (of Bristol), was given to the president. The seconder quite agreed with the remarks as to the vacillating decisions obtained from parliamentary committees. He thought that the results of spinning a coin by the two leading barristers would give about equal justice as the decision arrived at by the parliamentary committee after a fortnight's work.

The following paper was then read:

Commercial Practicability of Electric Traction by Surface Contacts.

BY C. E. C. SHAWFIELD, A.M.I.E.E., M.I.MECH.E, BOROUGH ELECTRICAL AND TRAMWAY ENGINEER, WOLVERHAMPTON.

Many municipalities contemplating the adoption of electric traction are making enquiries into the merits of that most abused of all methods of electric traction—namely, the surface-contact system. As the author has had charge during the past 2½ years of the only surface-contact system of electric traction in commercial operation in Great Britain, he has ventured to place some of his experiences and the conclusions he has deduced therefrom on record, in the hope that they may be of interest to the members of this association, and that they may give rise to an interesting discussion. It is not the intention of the author to discuss in this paper the respective merits or demerits of the various contact systems now on the market, but rather to make certain comparisons between the overhead system, which is so universally adopted in this country, and the surface-contact system which has been under the control of the author at Wolverhampton. The surface-contact system in operation at Wolverhampton was first introduced into England by the Lorain Steel Company of America, who had previously experimented with the system at Washington. It was first brought before the notice of the Wolverhampton Tramways Committee in March, 1901, and after lengthy negotiations a contract was entered into between the Corporation and the Lorain Steel Company by which the latter were to equip about 11½ miles of single track with their surface-contact system, and allow the Corporation to operate the lines so equipped for a period of 12 months. It was a condition of the contract that if the system proved itself a commercial success during the period of experimental operation, the Corporation were to take over and pay for the same at an agreed upon rate, but if it failed to prove itself safe and reliable and commercially successful, the Lorain Steel Company were to remove their apparatus and bear the whole cost of the experiment. The 12 months' experimental operation terminated on April 17, 1903, and although there was a great deal of difference of opinion in the Town Council as to the advisability of retaining the system, it was eventually decided on Sept. 11, by a large majority, that the system should be accepted. Shortly afterwards it was decided to proceed with the reconstruction of existing routes operated by horse traction and the construction of new routes, amounting in all to an additional seven miles of single track, and the Council decided that these extensions should also be equipped with the Lorain surface-contact system. About five miles of these extensions have already been completed, and it is expected that the remainder will be finished very shortly. The design and general arrangement of the Lorain surface-contact system has already been fully described and illustrated in the technical Press, and is probably well known to the majority of the members of this association, and therefore the author does not propose in his paper to give any technical description of the system itself, but hopes to have samples of the various parts and large scale drawings at the meeting for the inspection of members, and for the better illustration of certain points raised in this paper. In comparing the respective merits of the overhead system and the surface-contact system, the author proposes to do so from the following standpoints—namely: (1) safety to human beings and animals; (2) reliability of operation; (3) cost of operation and maintenance; (4) cost of installation; (5) disfigurement of streets and obstruction to traffic.

SAFETY.

In any electrical or mechanical system, probably the most important point to be considered is the safety of the general public, and it is doubtless the appreciation of this fact that has led the legislature to impose stringent regulations and conditions upon the use of electricity for the purpose of tramway operation. In comparing the respective advantages from the point of view of safety of the overhead system and the surface-contact system, it is evident that only one source of danger need be seriously considered—namely, that of electric shock—as practically all other risks are common to all systems of electric traction. In the case of surface-contact systems it is evident that the only portion of the apparatus exposed to the public from which a shock could, under any possible conditions, be obtained is the metal stud in the centre of the track, and that this can only become or remain alive (except when it is covered by a car) in the event of some failure of, or defect in, or damage to the mechanism which operates it. The actual value of this risk may best be estimated in the light of actual experience, and the author has therefore analysed the records of defective boxes during the past 12 months, and has extracted therefrom the following particulars.

TABLE I.—Defective Boxes Found During 12 Months Ending March 31, 1904.

Quarter ending.	Cups damaged by short-circuit.		Moisture in granite basin.		Total.	
	E.M.F. above earth, as shown on Weston voltmeter.					
	Volts 10 to 49	Volts 50 to 500	Volts 10 to 49	Volts 50 to 500	Volts 10 to 49	Volts 50 to 500
June 30, 1903	10	14	0	1	10	15*
Sept. 30 ,,	14	23	0	2	14	25*
Dec. 31 ,,	12	6	2	0	14	6*
Mar. 31, 1904	10	11	2	2	12	13*
Totals.....	46	54	4	5	50	59

* Average per mile of single track per annum, 10.

It will be seen from the foregoing table that a total of 109 boxes were found more or less alive during the 12 months in question, 59 of which were alive at an E.M.F. of over 50 and under 500 volts. The author has divided the live boxes into two sections—namely, those under and those over 50 volts—as he has found by experiment that it is quite impossible for any person or animal to feel the slightest sensation of shock from a box which gives a reading of 50 volts or under, and it is only in rare cases that anything approaching a shock can be obtained from a box which gives a reading of less than 100 volts. It will be noticed that out of the total of 109 defective boxes, in nine cases the trouble was due to moisture in the granite basin—that is, to the accumulation of water on the surface of the granite basin under the dope, which formed a leakage path to the top plate. This may be said to be due in every case to carelessness in fixing in the first instance, sufficient care not having been taken to see that the interior of the granite basin was thoroughly clean and well brushed over with a coating of hot dope before the remainder of the dope was poured in. The remaining 100 defective boxes were the result of damage done to the interior of the cups by heavy and repeated short-circuits. These short-circuits are caused by pieces of scrap iron which are picked up by the magnet system and come in contact at the same time with the collecting skate and with a cross-rail at junctions and turnouts. The effect of a number of short-circuits on any one cup is that

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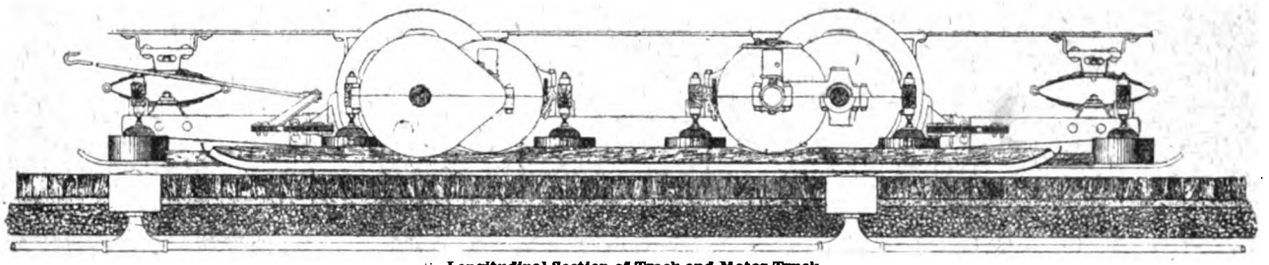
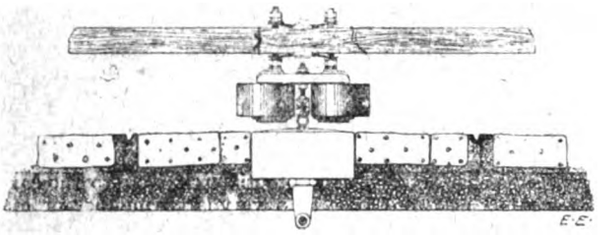
the interior of the top half of cup becomes burnt and charred, and thus loses its insulating properties; consequently the top plate or stud becomes alive at an E.M.F. which may be anything from a few volts up to nearly the full line pressure.

In this connection it is interesting to note that recent experiments made by the author show that the degree of damage to the cup in the event of a short-circuit entirely depends upon the time element of the circuit breaker controlling the main feeder. When the traction switchboard was installed at the power station, the possibility of the adoption of a surface-contact system had not been considered by the Tramways Committee, and the circuit breakers for the tramway feeders were specially designed to give a comparatively slow break, with the object of preventing the rise of pressure which is frequently caused by the sudden rupture of an inductive circuit. Experience has shown, however, that this is the very worst type of apparatus that could have been selected for use with the surface-contact system, as it allows the heavy current due to a short-circuit to flow for a sufficient length of time to give rise to a considerable amount of arcing or flashing between the carbon contacts inside the cup, resulting in the charring of the latter, and sometimes in the fusion of the copper ribbon. The author is now replacing the original circuit breakers with others of a new type which give a more rapid break with magnetic blow out, and as a result of experiment he has found that with the circuit breaker set to operate at 600 amperes the tramway 'bus bars may be short-circuited a large number of times in rapid succession through the contact making mechanism of the cup without the latter receiving any appreciable damage, and he has every reason to believe that this alteration in the type of circuit breaker will very greatly reduce the number of defective boxes in the future. It will be observed that instances of defective boxes due to short circuits are more frequent in the summer than in the winter months, the reason for this being that light pieces of iron or steel are more easily picked up by the magnet when the track is dry and dusty than when it is covered with wet and sticky mud.

The presence of a metallic stud in the street surface electrically charged at a pressure of 500 volts above earth would at first sight appear to constitute a grave source of danger, but the author would point out that in speaking of a stud being alive at 500 volts it does not necessarily imply that the stud is capable of transmitting a dangerous shock to any animal or person stepping thereon; as an actual matter of fact this is by no means the case, as, owing to the comparatively high resistance of the conducting path formed by the charring of the interior of the cup, the quantity of current that can pass is exceedingly small, and in many cases the readings obtained from the same "live" stud by different voltmeters will vary enormously, a difference of one or two hundred volts being by no means uncommon, this variation being simply due to the difference in internal resistance of the respective voltmeters. In only one instance has the shock received from a "live" stud been attended with serious results, and this occurred on Feb. 17, 1904, when a sheep and a dog were electrocuted through treading on a faulty box on the Tettenhall-road route. This accident was the result of a curious combination of conditions, the absence of any one of which would probably have prevented its occurrence. In the first place, the box had been improperly fixed, the vulcabeston cup was cracked, and the space around it was not properly sealed with dope. A car passing over the box picked up a large piece of scrap iron, causing a heavy short-circuit, which completed the fracture of the vulcabeston cup and separated the top half from the bottom. Secondly, owing to a heavy snowfall the track in the vicinity had been salted, and at that particular spot was more or less covered with a fairly strong solution of brine. Owing to the absence of the proper seal of dope, this brine found its way into the interior of the cup, establishing a low-resistance connection between the "live" lower contact and the top plate, and causing the top plate to become "alive" at practically full line pressure. Lastly, the animals to which the accident happened had been travelling for some considerable distance along the salted track and their feet were saturated with brine solution, thus greatly reducing the resistance of their bodies to the passage of an electric current. Immediately after the accident to the sheep and the dog, and before any warning could be given, a horse attached to a butcher's cart stepped on the same box and was brought down by the shock. It got up again immediately, however, and when examined shortly afterwards by a veterinary surgeon was reported as being none the worse for its adventure. As a result of actual experiments the author is inclined to believe that horses, in spite of the fact that they are shod with metal shoes, are much less sensitive to a shock sustained by stepping on a charged metallic substance than to a shock received from a live conductor falling on them from above.



Longitudinal Section of Track and Motor Truck.



Section of Track with Magnets and Contact Shoe shown above.

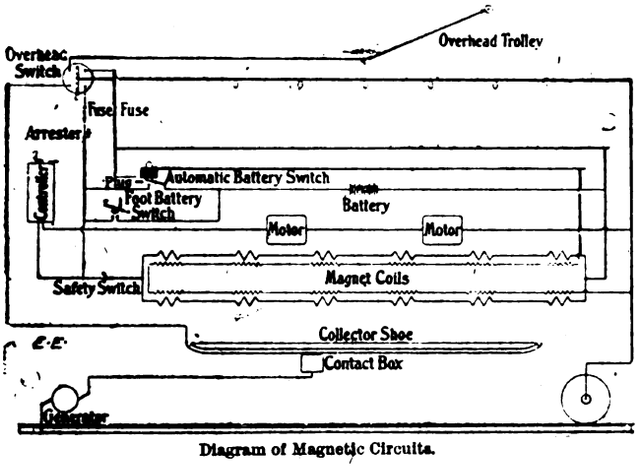
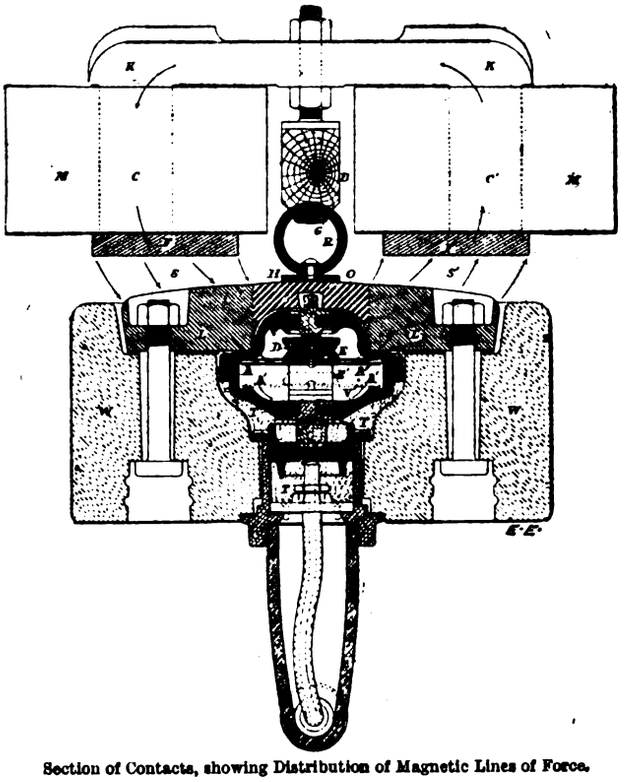


Diagram of Magnetic Circuits.



Section of Contacts, showing Distribution of Magnetic Lines of Force.

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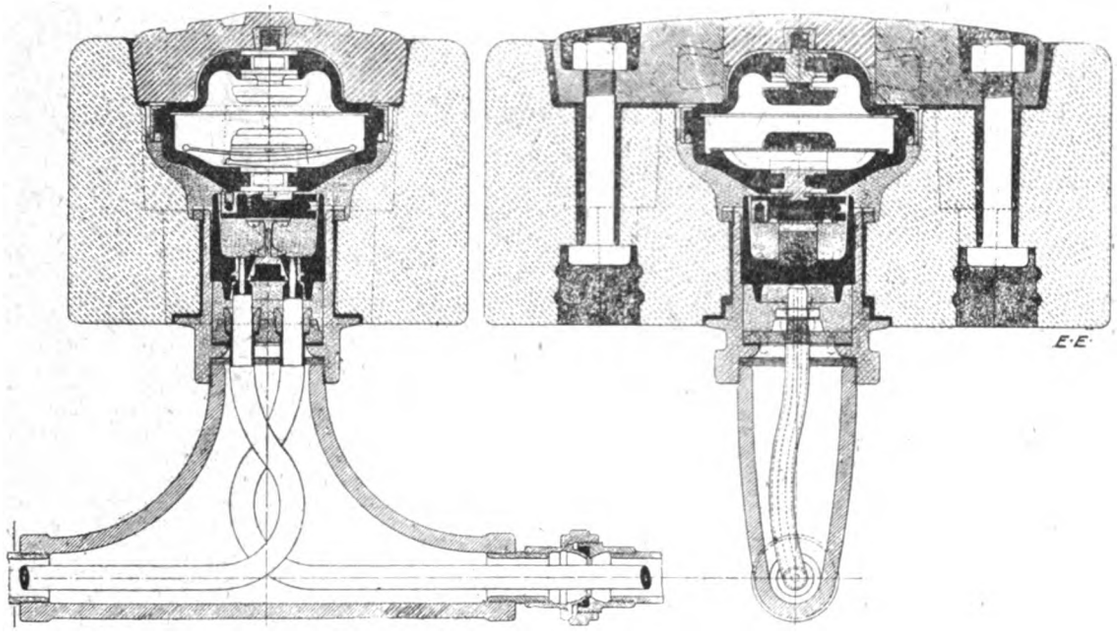
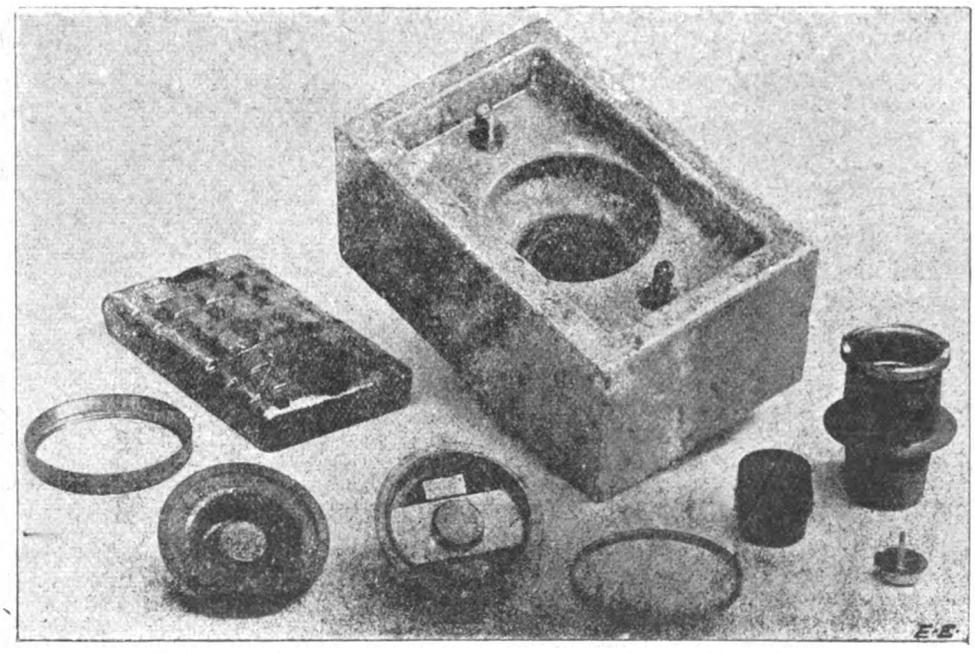
Several instances have occurred of horses stepping on boxes, which when tested with a Weston voltmeter gave readings of 500 volts and over, and although in the majority of cases the animals were brought down, in no case was there any resulting injury from the shock. The author has on more than one occasion watched a pedestrian step on a box which he has known to be "alive" at a pressure of 500 volts, as recorded by a Weston voltmeter, but in all cases the individual was apparently quite unaware of the fact. The comparative harmlessness of the shock received from studs "alive" at the apparently high pressure of 500 volts is, of course, due to the comparatively high resistance of the charred surface of the vulcabeston cup, and to the fact that there is never under any conditions of breakdown or defect any metallic connection between the top plate and the supply main.

In the case of the overhead system it is evident that there is risk of electric shock from any one of three causes—namely, a fallen trolley wire; a fallen telephone, telegraph, span, or guard wire; a pole which has become alive through the failure of the insulators. Wolverhampton is situated in the midst of a network of tramways, all of which are operated on the overhead trolley system, and, judging by the frequent occurrence of accidents due to one of the three causes mentioned above, the author is of the opinion that the risk of electric shock from one of these causes is at least as great as that arising from the occurrence of a "live" stud. The recent accident in a Midland town, whereby three horses were killed and the man in charge thereof injured by a shock received from a tramway pole in the centre of the street, is a grim illustration of the fact that the dangers of the overhead system are by no means confined to falling trolley wires or charged telegraph wires.

On a large percentage of the tramway systems of this country centre-pole or side-pole bracket-arm construction is largely used, and in accordance with the usual practice the poles are erected in concrete. It is well known that under certain conditions which may frequently occur in practice, these poles are virtually insulated from the general mass of the earth, and can, therefore become charged at a high potential relatively to the earth. When it is considered that in a very large number of cases single insulation only is used between the trolley wire and the bracket arm, it is evident that failure of the straight line insulator which supports the trolley wire—either from mechanical stress or other cause—may result in a pole becoming "alive" at an E.M.F. of anything up to 500 volts, and prove a source of very serious danger to human beings and animals in the vicinity. It is evident, moreover, that the failure of an insulator under the conditions named would not be easily detected under ordinary service conditions, and there would be nothing to indicate the fact that anything was wrong until an accident had occurred. That instances of falling trolley wires and "live" tramway poles do occur with startling frequency in many districts where tramways are operated on the overhead system is undoubtedly true, and that these mishaps are not more frequently attended by injury to human beings or animals



Longitudinal and Transverse Sections of Contact Box.



Photograph of the Component Parts of the Lorain Magnetic Switch and Street Contact.

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TABLE II.—CAR MILES LOST DUE TO DEFECTS IN ELECTRICAL EQUIPMENT OF TRACK AND CARS.

Quarter ending.	Miles of single track in operation.	Total car miles run.	Total car miles lost.	Total car miles lost per 10,000 miles run.	Car miles lost due to faults in Lorain system			
					Lorain car equipment.	Lorain track equipment.	Total.	Total per 10,000 miles run.
June 30, 1903	11	139,563	177	12·7	43	—	43	3·1
Sept. 30, 1903.....	11	131,805	172	13·0	39	—	39	2·9
Dec. 31. 1903	11	122,576	147	12·0	38	27	65	5·3
March 31, 1904	11	121,434	248	20.4	26	—	26	2·1
Totals	—	515,378	744	14·4	146	27	173	3·3

appears to the author to be largely due to the beneficent interposition of Providence. It must be remembered, moreover, that a shock received from a falling trolley wire or a live telephone wire is of necessity infinitely more dangerous than any shock which can be received from stepping on a "live" stud, as in the former case the shock is generally transmitted through the most sensitive part of the body, and there is much greater risk of the "live" substance coming in contact with bare flesh. In proof of this contention it is only necessary to refer to the files of the daily Press, from which it will be found that in nearly, if not quite, every instance where a shock has been received under these conditions, it has proved fatal in the case of animals, and has always been attended with serious and sometimes fatal results in the case of human beings. In conclusion, so far as the question of safety is concerned, the author is of opinion that the balance of advantage lies with a well designed and carefully installed surface-contact system.

Reliability of Operation.

Of almost equal importance to the question of the safety of the public is that of reliability of operation, and no system of electric traction will ever have the slightest chance of success unless it can be regarded as thoroughly reliable under all conditions of service. Owing to the entire absence of any statistical information regarding the number of journeys lost through defects in or failures of the overhead electrical equipment on tramways where the overhead system is adopted, it is very difficult to institute anything like a comparison between the overhead system and the surface-contact system so far as reliability of operation is concerned. From the very commencement of the operation of the tramway system in Wolverhampton the author has kept minute records of every delay that occurred on any route and the cause thereof, together with the number of journeys lost by the cars affected by such delay or stoppage. Thus, if an accident occurs causing a delay of 15 minutes on any one route, the mileage lost is reckoned as the total mileage that would have been run by each car affected by the delay during the period that the stoppage occurred. The accompanying Table II. shows the total mileage lost due to faults in the electrical equipment of the Wolverhampton tramways during the 12 months ending March 31, 1904. Out of a total of 173 car miles lost due to defects in the Lorain surface-contact equipment during the period covered by the above table, it will be seen that only 27 are debited against the track equipment. These were due to the following causes: three car miles were lost owing to a delay arising from an improperly soldered joint in a cable terminal, the remaining 24 miles being lost owing to a top plate situated very close to a cross rail being permanently earthed thereto by a piece of iron wedged between the plate and the rail, it being about 20 minutes before the source of the trouble was discovered. One hundred and forty-six car miles lost due to defects in the car equipment may be classified as follows:

Table III.—Details of Miles Lost Due to Faults in Lorain Car Equipment.

	June quarter.	September quarter.	December quarter.	March quarter.	Total.
Earthed magnets ...	22	21	16	20	79
Buckled skates	10	7	20	3	40
Battery faults	8	6	—	3	17
Other causes	3	5	2	—	10
	43	39	38	26	146

It will be seen that during the period in question the total number of car miles lost due to defects in the electrical equipment of both cars and track averaged 3⅓ car miles out of every 10,000 car miles run, and having regard to the fact that during the months of February and March there were frequent and heavy snowfalls, the author is of the opinion that this constitutes a record of regularity and service which it is difficult to surpass.

In considering the car miles lost due to the Lorain-car equipment, it must be remembered that the defects which were the cause of the delays have a parallel in the case of the overhead system in respect of broken and damaged trolley wheels and trolley poles, and in the earthing of the cables inside the trolley standard. The first heavy snowstorm since the system has been in operation occurred on Feb. 17, 1904, when about 6in. level fall of snow occurred in the early hours of the morning. The electrically-driven snow sweeper was at once put into service and the lines were kept clear without difficulty, and no delay of any kind occurred. It is noteworthy that although the snowfall in the surrounding districts, operated on the overhead trolley system, was not quite so severe as it was at Wolverhampton, yet considerable difficulty was experienced, especially in the early morning, in maintaining a regular service. Owing to an abnormal rainfall in the early part of September certain routes were flooded, and at one point the track was submerged for a considerable distance to a depth of nearly 2ft. No trouble, however, was experienced as regards the running of the cars, and no defects developed in the car equipments, in spite of the soaking to which they had been subjected.

In considering the respective liabilities to breakdown of the rival systems, it should be borne in mind that in the case of the surface-contact system as installed at Wolverhampton, any accident or breakdown can only affect one, or, in very rare cases, two boxes, and the momentum of the car is sufficient to enable it to coast over the short length of track thus disabled. Further, any faulty box can be removed and replaced by a new one in an average time of 15 minutes, without any interruption of service. It may in effect be said that the surface-contact system is equivalent to an underground trolley wire divided into 10ft. sections, each of which is independent of the rest, and may be removed and replaced without interference with the efficient operation of the remainder. It is in this respect that the surface-contact system has, in the author's opinion, a distinct advantage over the overhead system, inasmuch as with the latter an accident of any kind to the overhead equipment usually means the putting out of service temporarily from a quarter of a mile to half a mile of route, and a total cessation of traffic along the section affected for a more or less lengthy period. Another respect in which the surface-contact system possesses a marked advantage over the overhead system is that the conductors are free to devote the whole of their time to the collection of fares and to looking after the convenience and comfort of passengers. In nearly all of the tramway systems at present in operation in this country a considerable proportion of the conductor's time is occupied in nursing the trolley pole through frogs and crossings or round awkward curves on the overhead equipment, but in spite of the care which is taken in this respect, interruptions of service are frequently caused through the trolley pole jumping and displacing a portion of the overhead equipment. Similarly also, no reversal of the collecting apparatus is required when changing the direction of running of a car, whether at a terminus or elsewhere on the line, and consequently there is no risk of an accident occurring through forgetfulness or carelessness on the part of the motorman or conductor.

One of the most attractive features of the surface-contact system as installed at Wolverhampton is that it is virtually "fool proof," inasmuch as it is practically beyond the power of the motorman to inflict damage thereon by careless or incompetent handling of his car, and in this respect it possesses an advantage which is not shared by any other system of electric traction. As a result of the 2½ years' experience the author has had of the operation of a surface-contact system, he believes that for reliability of operation it has many and noteworthy advantages over either the overhead trolley system or the conduit system.

Cost of Operation and Maintenance.

This question must always be a determining factor in the choice of a system of electric traction, as under the present *régime* of municipal control, with its attendant low fares and high wages, it is becoming an increasingly difficult matter in many cases to maintain a tramway system as a paying concern, and consequently it is of great importance that the system of traction adopted should be one that will require the minimum annual expenditure to maintain it in a safe and efficient working condition. It must be admitted at the outset that from the point of view of cheapness of operation and maintenance, no system of electrical traction can rival the overhead trolley system. The following statement shows the expenditure on the maintenance of the Lorain surface contact system at Wolverhampton during the 12 months ending March 31, 1904.

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TABLE IV.—Repairs and Maintenance Costs of Lorain System for 12 Months ending March 31, 1904.

Track Equipment.

	Total cost.	Cost per mile of single track.	Cost per car mile.
Repairs and maintenance of cups and top plates	£125 5 5	£11·3	·058d.
Raising top plates	5 19 2	0·5	·002d.
Miscellaneous repairs	12 2 1	1·1	·005d.
Inspection and testing of track	94 15 6	8·6	·044d.
	£238 2 2	£21·6	·11d.

Car Equipment.

	Total cost.	Cost per car per annum.	Cost per car mile.
Repairs and maintenance of magnet systems	£72 13 2	£3	·033d.
Repairs and maintenance of switches and batteries, including charging	20 3 4	0·8	·009d.
Repairs and maintenance of collecting skates	115 11 8	4·7	·053d.
Inspection and adjustment of magnet systems and collecting skates	102 13 11	4·2	·047d.
	£311 2 1	£12·9	·144d.

The expenditure under the heading of track equipment the author considers to be very reasonable, and is of opinion that it will bear comparison with the cost of maintenance of any similar length of overhead equipment running in a busy manufacturing town. The whole of the work of inspection and testing of the electrical equipment of the track, the removal and replacement of faulty boxes, and the execution of all repairs of every kind required in connection with the maintenance of the electrical equipment of the 15 miles of single track is performed by two men, who are paid wages of 32s. and 28s. per week respectively. The working day of approximately 17 hours is divided into two shifts, so that there is only one man on duty at a time. Every box is tested once a week, and the boxes in the vicinity of points and crossings and other special track work where there is a liability to short-circuits are tested daily. During the period covered by the foregoing statement of costs, the average time required to test about 11 miles of single track was 10 hours, the apparatus used for testing consisting of a portable Weston voltmeter slung round the neck of the operator, the flexible leads from the voltmeter being attached to terminals on a pair of walking sticks, one of which was placed on the box to be tested and the other on the rail. As this method of testing proved to be a slow process, the operator not being able to cover more than about one mile of single track per hour, the author has devised an arrangement by which a light trolley carrying a contact skate can be towed behind any car in service, and by this means every box on about 15 miles of track can be tested in 2½ hours. It is expected that this will result in a considerable reduction in the expenditure on inspection and testing of the track. The expenditure on the inspection and maintenance of the car equipment has been rather heavy, the items relating to the magnet systems and batteries being, in the author's opinion, abnormal, and considerably in excess of what may be expected in the future. It is impossible to obtain reliable figures as to the cost of inspection and maintenance of the trolley wheels, trolley poles, and standards in the case of the overhead system, as records apparently are not kept separately of the expenditure incurred in these respects, but it is probable that the car equipment of the overhead system can be more cheaply maintained than that of a surface-contact system.

One of the most serious disadvantages of the surface-contact system is the increased consumption of electrical energy involved. The additional quantity required varies according to the type of surface-contact system adopted, but with practically every type of system there are three causes which must involve additional current consumption, and these are as follows: firstly, the energy required to operate the circuit closing mechanism of the track equipment; secondly, the additional energy necessary for the propulsion of the cars owing to the extra weight of the special apparatus carried on the car; thirdly, the surface leakage from box to rail over the paving under each car on the track. Of the above-mentioned sources of power waste, the first two only need be seriously considered, as in the case of the third the amount of energy wasted by surface leakage is so small as to be negligible.

(To be continued.)

TWENCEN DOMESTIC TELEPHONES.—The Berliner Telephone Manufacturing Company, 200, Upper Thames-street, London, E.C. (fifth edition), gives illustrated particulars and prices of accessories for domestic telephones, bells, hand-combinations, portable telephones, switchboard accessories, etc.

WIRELESS TELEGRAPHY IN WAR.

We publish, by special permission of the editor of the *Times*, the following extract from a private letter received by mail from their operator at the wireless telegraphy station at Wei-hai-wei:

De Forest Wireless Station, Wei-hai-wei,
North China, April 10, 1904.

I have delayed writing until I could give definite statement about the work. Owing to the movements of the boat we did not have an opportunity to get a good test-out until last night.

Before saying more I will relieve your mind. One-hundred and fifty miles both ways in calm weather and 125 at other times will be good enough, don't you think? That was the result of the test last night, first test, and I am sure it will stand good. In rough weather the boat rolls, shakes, and jars so badly that Brown can't hear me beyond 125 miles.

The troubles and snags I've been up against on other jobs fade to a mere shade compared to this. Placed as we are, in an out-of-the-way corner, where it is well nigh impossible to get anything done, it doesn't take much to put you in a bad hole in this work. A few more jobs like this and I'd begin to sprout grey hairs . . . that's no dream.

Perhaps the importance of our mission and the fact that all eyes were upon us, as it were, spurred us on. The country is full of wireless, and we are showing 'em a thing or two.

I can't begin to tell you all the trouble we had. Anyway it would make poor reading, and I don't know that I care to rehearse it either.

The topmasts fitted on the boat at Shanghai went down the first night out. On our arrival here there were a few old junk masts lying on the ground, no houses for us, nothing even started. It took several weeks to raise a mess of rotten wood about 170ft. high. The country hereabout, by the way, is almost devoid of timber, and it is very hard to get any kind of poles.

Several of our cases were badly damaged on the trip, mostly the Secor stuff, and that gave us a lot of trouble. The engine-houses fared worst, and small parts on engine were broken and bent in bad shape. The bright gentleman who packed the engine oil put the tins in a box and drove nails through them. About half the oil, rather, nearly all in some cans, had leaked out when we unpacked. That damaged engine gave me the time of my life, but I finally mastered it, and now it is doing its part all right.

While the "Haimum" was coaling in Japan another topmast was fitted up, but only one, so that we can only run wires straight up and not across from mast to mast. They didn't seem to want to go to the trouble of two topmasts, so we get along with one.

Owing to the peculiar circumstances in erecting the pole, the shacks were not built until the pole was up, and of course, with Chinese to build the shacks, that in itself was a big job. A Chinaman works half an hour, and then sits down and smokes for a quarter of an hour. If there are 20 on a job, five will be working and the others squat around smoking and looking on. At the time the shacks were built it was the Chinese New Year, which lasts from one to three weeks. It was very difficult to get any of them to work, and those who did went their own gait or not at all.

Although the putting up of the poles and the houses took several weeks, the correspondents seemed to have an idea our part would take no time at all, and as soon as their part was finished were in a great hurry. You said in your memo., "Stations must be working within three weeks."

Including nearly, or the best part of 3½ days' work on engine and generator, we equipped the shore station in six days, and equipped the boat in one day completely. We didn't twiddle our thumbs much that week.

Nine days after we began to work the pole blew down, and another week was required to repair it. During that week I strung up two wires about 80ft. high, and we worked that 60 miles, losing no time on our work.

There is an almost continuous succession of high winds here, and my antennæ have been carried away three or four times.

On the boat we are grounded to the hull, and have a four-wire antenna a little less than 100ft. high.

With the repaired pole on the shore station we have a scant 150ft. of antenna. The site is on the top of a cliff, about 150ft. above the sea, with a rocky hill sloping sharply up to one side, rising higher than the pole. I forgot to mention that we are on an island 1½ by two miles in area, a mass of rocky hills rising several hundred feet above sea-level. The site we have is the best procurable on the island—Liukungtao—and there is no suitable site on the mainland within four or five miles of the office.

I am going to have several photos taken, and will forward them within two weeks.

As I said before, the country is full of wireless, and we have any amount of competition; not in Press work, however. All the British warships, from the third-class cruisers up, are equipped with Marconi, about 24 in all; nearly all the Japs have wireless equipment; the Russian ships are equipped, and several German vessels. One or another of them can be heard any time, day or night. The Japs are particularly numerous, and we are at it all the time.

We laugh at them, for we have struck some good points in tuning, which settle them very nicely. On the boat, when receiving our stuff, two of the four wires are grounded directly, which gives best results. Any resistance between those wires and the ground weakens the signals. If we want to hear the Japs call, disconnecting ground wire entirely from syntoniser of the receiver brings them in strong, while with the ground wire on, as in receiving our stuff, the Japs come very faintly.

On the shore station it is different. Three wires are best in receiving

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up to 100 miles, with the other two wires free, at which time the Japs came in weakest. By grounding the other two wires the Japs come in very strong and our stuff weakest. Above 100 miles our stuff comes best with two wires grounded directly. That, of course, allows others to come in, but they are not strong enough to prevent my reading through. So far that tuning is best, and certainly gives very satisfactory results.

There are always one or more British warships lying here, and we have them all wondering. The lieutenants of two torpedo boats have told me they do not depend on more than 40 or 45 miles regularly, and another says he can depend on 60 miles. The last one has 160ft. of wire to do his 60 miles, while our boat has a scant 100ft. of wire, and easily covers more than double the distance. Our speed is a source of wonder and admiration to these British officers. I saw some of their tape after we got through with it, and couldn't read a word.

MUNICIPAL ELECTRICAL UNDERTAKINGS.

The Select Committee referred to in our leader in the last issue have formulated the following clauses in lieu of the Bermondsey clause:

1. The undertakers shall, so soon as the annual statement of accounts of the undertakings under this order and under the ——— Electric Lighting Order, 1898, has been filled up in the form prescribed by the Board of Trade under the Electric Lighting Act, 1882, publish in a newspaper circulating in the borough a notification that such statement of accounts has been filled up, and that copies of it can be obtained at the offices of the undertakers at a price not exceeding 1s. a copy, and such publication shall be in addition to, and not in substitution for any publication prescribed by the Board of Trade under the Electric Lighting Act, 1882.

2. The undertakers shall on the expiration of the third complete financial year after they have commenced to supply electrical energy under this order and on the expiration of each third succeeding year reconsider, and if necessary revise, so far as is reasonably practicable, and thereafter maintain the scales of prices charged for electrical energy under this order and under the ——— Electric Lighting Order, 1898, respectively so that no rate will be required for the purpose of defraying the future expenses of the said undertakings during the next three years: Provided, nevertheless, that (*a*) the prices to be charged shall not exceed the *maximum* prices which may be charged under this order and the ——— Electric Lighting Order, 1898, respectively; (*b*) the scales of prices so reconsidered and revised may be from time to time in like manner reconsidered and revised by the undertakers.

3. Nothing in this section contained shall prevent the undertakers from entering into contracts for periods which may extend beyond the periods at which any revision may take place under the provisions of this section on special terms under special circumstances not applicable to ordinary consumers, but each such contract shall provide that the price to be charged for energy supplied under such contract shall either (*a*) be subject to revision at the next triennial revision provided for in this section, or (*b*) vary in the same proportion as the prices charged to ordinary consumers. Provided that the undertakers shall not without their consent be required to accept any price lower than the *minimum* price mentioned in such contract.

TRADE NOTICES AND NOVELTIES.

A Model Cable Factory.

Messrs. Johnson and Phillips have now completed the recent extensions to their cable department, and we understand that the new shops include the very latest equipment for the manufacture of dry-core telephone cables, and they are at present engaged on an order for the General Post Office amounting to some 730 miles. The whole of the new machinery is of their own design and manufacture, as also are all the motors and electric power plant used in the factory, and it is satisfactory to know that this latest system of driving shows a considerable saving over the former method of using separate steam-engines. A construction and cable-laying department has now been organised, and is fully employed on Admiralty contracts for the Portsmouth and Pembroke dockyards, as well as cable-laying at Handsworth, Weymouth, Birkenhead, and Ipswich extensions. We understand that at the end of the present financial year the firm propose opening up a vulcanised bitumen shop and laying down certain wire-drawing plant for drawing their own copper wire.

Electrical Pumping Machinery for Ashington Colliery.

We are informed that Messrs. Ernest Scott and Mountain, Limited, of the Close Works, Newcastle, have recently secured a contract from the Ashington Coal Company, Limited, for an extensive installation of electrical pumping machinery for their Ashington collieries. The current will be taken in two circuits from the main switchboard in the generating-room, one circuit being taken down the Bothal shaft and the second circuit down the Carl shaft, and from the bottom of these shafts the three-phase current will be distributed at a pressure of 500 volts to the various pumps underground. From the Bothal shaft an existing endless-rope haulage gear will be driven by a 30-b h.p. electric motor, and from the same cables current will be taken to the five sets of pumps with a total capacity of 750 gallons per minute against heads varying from 120ft. to 329ft. In the Carl pit there will be two pumps at the shaft bottom delivering 75 gallons of drinking water per minute each against a head of 600ft., and, in addition, there will be four sets of pumps distributed underground having a total capacity of 650 gallons per minute, delivering against heads varying from 150ft. to 290ft. In the relief pit a set of main shaft pumps will also be provided to deliver 300 gallons per minute against a head of 317ft. The whole of these pumps, together with the electric motors, which will be of the three-phase, slip-ring, induction type, will be of Scott and Mountain's manufacture. The whole plant will be made at their works in the Close, Newcastle-on-Tyne. The pumps are of the firm's three-throw horizontal type, fitted with gunmetal rams, the pump barrels, valve boxes, suction and delivery branch pipes being independent and interchangeable. The electric motors will be of the three-phase, slip-ring, induction type, wound for 500 volts, and all motors will be complete with motor-room switchboards fitted with the latest type of switches and instruments. In the shafts the cables will be of the three-core type, armoured with galvanised iron wires; and underground the in-by cables will also be of the three-core type, but unarmoured but suitably supported. This installation, when completed, will be the largest three-phase electric pumping installation in the North of England. The same firm, we understand, have a considerable number of other contracts in hand for collieries, etc., including Consett Iron Company, plant delivering 4,500 gallons per minute, against a head of 300ft.; Croxdale Colliery, 2,000 gallons per minute, 750ft. head; Beckermet Mines, Cumberland, 600 gallons per minute, 1,800ft. head; Barton Coal Company, three sets of pumps delivering collectively 700 gallons per minute, 1,600ft. head; Benwell Colliery, 300 gallons per minute, 600ft. head, together with a large number of less important contracts for pumping, hauling, coal-cutting, etc.

Catalogues.

S.E.C. Electric Motor Fans.—The Sun Electrical Company, Limited, 118 and 120, Charing Cross-road, W.C., descriptive of motor fans for cooling, ventilating, exhausting, and blowing purposes.

Telephones.—Telephone switchboards, wire, insulators, fire-alarms, and all accessories. Ninth edition. General Electric Company, Limited, Queen Victoria-street, E.C.

The Compleat Controller.—Sturtevant Engineering Company, Limited, 147, Queen Victoria-street, E.C. Gives particulars of the Sturtevant electric motor and dynamo controlling apparatus.

"Patrick's" Metal.—Under the above name J. C. Lyell and Co., Limited, 55, Victoria-street, S.W., are placing on the market a new alloy, as a substitute for nickel plated goods, which is silver-white through and through. It is claimed that the new metal resists most acids, and is not affected by sulphur, lime, salt-water, etc., and that it will easily solder and braze, and will take good threads. It is supplied in ingots for casting purposes, and also in the finished goods in the form of electrical fittings, motorcar fittings, etc.

Safety Valves.—J. Hopkinson and Co., Limited, Head Office and Works, Huddersfield (London office and depôt, 165, Queen Victoria-street, E.C.). This list (No. 150) has been issued June, 1904, and fully describes and illustrates the various types of Hopkinson's patent valves, spring relief valves, lever safety valves, and accessories. We also note Hopkinson's "metallic" cement and "graphite" jointing material for high-pressure steam joints.

APPOINTMENTS VACANT.

Switchboard Attendant, Swindon Corporation. Wages £1. 7s. 6d. per week, increasing £6. 10s. per annum for the first two years. Applications by July 5. See advertisement in former issue.

Borough Electrical Engineer, Limerick. Salary, £160 per annum. Applications by July 4.

Electrical and Mechanical Engineer and Draughtsman speaking English, German, and French. Apply to F. L. M., *Electrical Engineer* Office. See advertisement.

Premium Pupil, power and lighting company. See advertisement.

Three Switchboard Attendants at 22s. each per week, one Fireman at 20s., one Dynamo Attendant at 18s., Londonderry.

Rolling-Stock Superintendent, London County Council Tramways Department. Salary, £400 per annum. Applications by 10 a.m. on July 16.

Parcels Superintendent, Bradford Tramways Department. Salary, £150 per annum. Applications by July 9.

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THE

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All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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CONTINUITY OF POLICY.

In his Presidential Address Mr. T. P. Wilmshurst has called attention to lack of continuity of policy in legislation. The reason for the state of things that brings about lack of continuity is simple—there is no policy, never has been, and possibly never will be. Legislative policy is a cork borne hither and thither according to the formula and fashion of the moment, or like the thistle-down the sport of every cross gust of political wind. You can get whatever you want from Parliament provided there is no opposition. So far from being a benefit to industry the legislature has from time immemorial always provided a drag upon natural means of expansion, and it is continually chopping and changing its attitude so that capital has to fight more up-hill than would be found necessary if there existed a good or even a bad policy in any direction. Electrical progress has been, and is, hindered on all sides by the flabbiness of legislation. Mr. Wilmshurst points out a variety of directions in which one thing has been done at one time and the opposite permitted at another time. The famous or infamous Bermondsey clause seems in a fair way of extinction; but we are not sure that the clause in substitution will be found flawless. To put this matter a little bluntly, there are two classes concerned in electrical undertakings: (1) those who desire them, (2) those who oppose, these latter being generally competitors of some kind or another. Most of these electrical undertakings are of the nature of businesses. If that is so, they should be organised and conducted as businesses, and every outside interference with a business is bad for that business. All such clauses as that known as the Bermondsey clause and its substitutes are unmistakably interferences and bad. At the present juncture neither municipalities nor companies know exactly where they are. A graver, and even more far-reaching case, is the permission of competing undertakings within the same areas. If the competitors alone were concerned we should not object, but anything that interferes with the general public in the use of roads and streets leads to indirect as well as direct losses, which in the aggregate must be enormous, and which seem never to be taken into consideration. Mr. Wilmshurst calls attention to other vagaries, such as laying obligations upon one undertaking, and leaving the competitor free from any similar obligation. With this cumulative evidence of crass stupidity, it is difficult to realise that the legislative body is composed of men supposed to know something of trading conditions and requirements. The association in whose name Mr. Wilmshurst is speaking is, as he says, a responsible body, controlling a capital of nearly forty million pounds. In order to utilise this vast capital to the best advantage as few restrictions as possible should be placed upon the enterprise, and those so placed should certainly not be dictated by industrial competitors. Another point referred to in this very suggestive address is that of assessment, and here we venture to think that the municipal enterprises are sometimes treated more generously than those of companies. It is hardly correct to say that those controlling the municipal enterprises "have no hand in fixing the amount of our assessments.' Theoretically that may be so, and in the abstract what is sauce for the goose is sauce for the gander, but practically the assessors, if they have a leaning at all, will have that leaning towards their employers. It is true that there is divergence of practice, but the discordance is often of such a character that it would be difficult to standardise. Attempts have been made to do so, but as yet no one has suggested a scheme that meets with general acceptance. The problem is a very difficult one, but, as we say, all engaged in the industry

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are subject to the same trouble. We must congratulate Mr. Wilmshurst for his boldness in writing so suggestive an address. The points he makes will meet with general acceptance, and should cause those who have power in simplifying industrial operations to think of the effect of constant vacillation upon development.

WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

(Continued from page 922, Vol XXXIII.)

Wireless Telegraphy in France.

France has not been behindhand in this matter. We have already referred to the classic experiments of Prof. Branly in connection with phenomena previously noticed by Prof. Hughes and Prof. Calzecchi Onesti—viz., the fact that an imperfect contact (microphonic or that of filings) becomes comparatively a good conductor under the influence of electrical pressure, due (amongst other things) to ether waves from a distance. Onesti introduced his filings into the secondary of a Ruhmkorff coil, Branly found that the spark of a coil or condenser at a distance rendered his coherer or "radio-conductor" conducting. Since this important discovery was made many experimenters have been at work at various times in France.

In 1898 M. Ducretet made experiments between the Eiffel Tower and the Pantheon in Paris, a distance of 4 km. (2½ miles), and found that the Eiffel Tower worked well as a receiving station, but not as a transmitting station In 1899 M. Ducretet made other experiments between Sacré-Cœur and the Pantheon, and also over the fortress of Bicêtre, between Villejuif and the station in Rue Claude-Bernard (5½ km.). These experiments attracted little attention as the distances were small, and they were undertaken in a city. M. Ducretet used different kinds of apparatus, patenting most of them either in his own name or in conjunction with Prof. A. Popoff, whose important work deserves special notice.

In 1899 M. Tissot (a naval lieutenant) made experiments with the Ducretet apparatus between the lighthouse at Trézien in Corsica and that at Stiff (Ushant), the distance being 32 km. (20 miles); also between Stiff and the lighthouse at Vierge Island, 42 km. (26¼ miles). Further reference to M. Tissot's results will be made presently.

Experiments of Popoff.—In 1895 Prof. A. Popoff, the distinguished physicist of Cronstadt, made many experiments on atmospheric phenomena. He connected a coherer fitted with an automatic tapper to a lightning conductor, and with a relay and Morse printer in the circuit obtained important records of electrical disturbances at a distance. Prof. Popoff has made many experiments since that time, and has lately brought out a new coherer which has been successfully employed in conjunction with a telephone receiver. In this coherer little bands of platinum are placed in proximity to each other in a small tube of glass or other insulating material. In the interior of the tube, and in the spaces between the bands, are grains of steel. The distance apart of the platinum bands is determined by the fineness of the grains. The state of oxidation of the surface of the grains assures great sensitiveness in the apparatus. The novel point in the coherer seems to be that the surfaces of the platinum are lengthwise in the tube instead of across it, as in most coherers. Thus, the surface exposed to the action of the steel dust is greater, and the sensitiveness is correspondingly increased. The general form of the coherer may be gathered from Fig. 51, which also shows the arrangement of receiving circuit adopted.

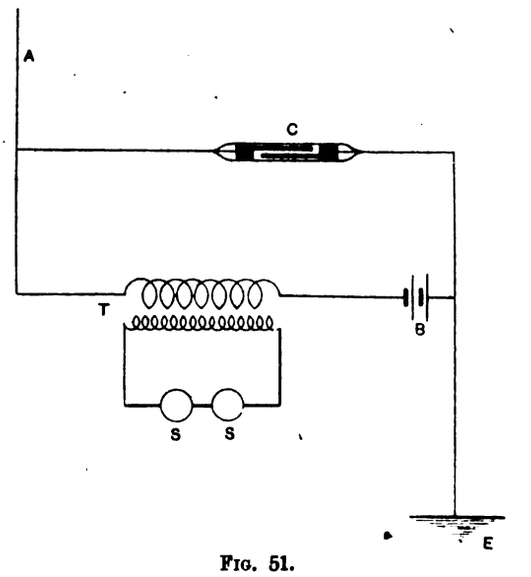

Fig. 51.

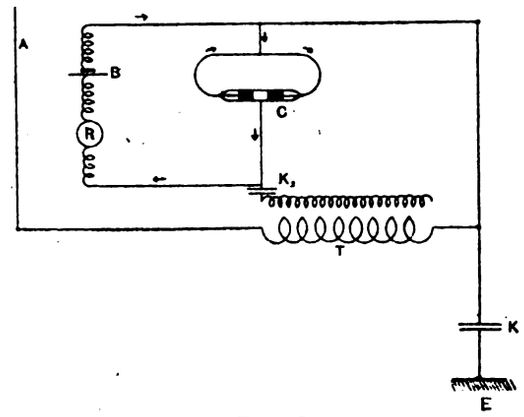

Fig. 52.

A is the aerial or antenna, having in its prolongation the primary coil of the transformer, T. B is a battery and C the coherer. The secondary coil of the transformer has the telephone receiver, S S, in its circuit. The battery is not indispensable, but strengthens the received impulses. Prof. Popoff, using this method, has been able to attain regular transmission of messages over distances of from 36 km. to 50 km. (22½ to 31¼ miles). For instance, communication has been established since February, 1900, between an island in the Gulf of Finland (Hogland) and the continent. One of the stations is placed near a country wood, and several islands intervene between the stations. The masts carrying the antennæ are 48m. (157½ft.) high, and a regular service of communication is carried on.

The Ducretet System.—M. Ducretet, as already stated, has made many experiments and tried various systems at different stations in France. In Fig. 52 one of these is represented in outline as far as regards the receiving circuit and apparatus. The waves received by the aerial, A, traverse the primary coil of a transformer, T, and are directed towards the ground through a condenser, K, the secondary coil of the transformer being in communication with the coherer, C, through an intermediate condenser, K_2. The coherer forms part of a circuit comprising the relay, R,

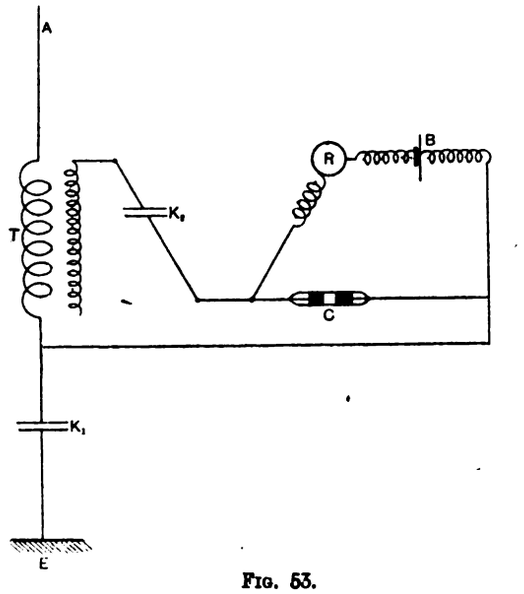

Fig. 53.

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and cell, B, which circuit communicates with the earth through the condenser, K. Another arrangement is shown in Fig. 53, where the coherer has *three* terminals instead of two, as before. The filings or metallic dust used in this coherer are of steel mixed with silver or rhodium. The arrangement will be understood from the figure. There is the transformer as before, the two condensers, the coherer, and choking coils to prevent the vibrations received through the antenna being wasted in the cell or relay.

Experiments of M. Tissot.—Many of M. Tissot's important experiments deal especially with syntonisation. He has tried to realise syntonic transmission by utilising the arrangements described by Mr. Marconi, especially that including the "jigger." Although he has tried to follow scrupulously the indications furnished by Mr. Marconi in connection with the subject, he has not been able to realise the hoped-for results as far as regards syntony, neither at Trézien nor at the station at St. Martin, where the experiments were carried out. M. Tissot concludes that if Mr. Marconi has realised the transmissions which have solved the problem of syntonisation, it has been by the use of methods other than those described. In the course of his experiments M. Tissot was led to adopt an arrangement which, if not solving the problem of syntonisation, at least augmented the security of selective reception. His arrangement is shown in Fig 54, where A, the antenna, is joined to earth through the primary of an induction coil, T. A wire from the antenna goes to one terminal of a condenser, K, of which the other is connected to earth at E through the medium of the coherer, C. A shunt from the ends of the coherer contains a cell, B, and a relay, R. (For further particulars the reader is referred to M. Turpain's excellent work, "Les applications pratiques des Ondes Electriques.") More recently M. Tissot has been able to increase the distance of signalling very appreciably by employing a peculiar form of coherer. M. Tissot places the coherer tube in a magnetic field, of which the lines of force are parallel to the axis of the tube. The field is produced by a permanent magnet, or, better still, by a coil encircling the coherer tube.

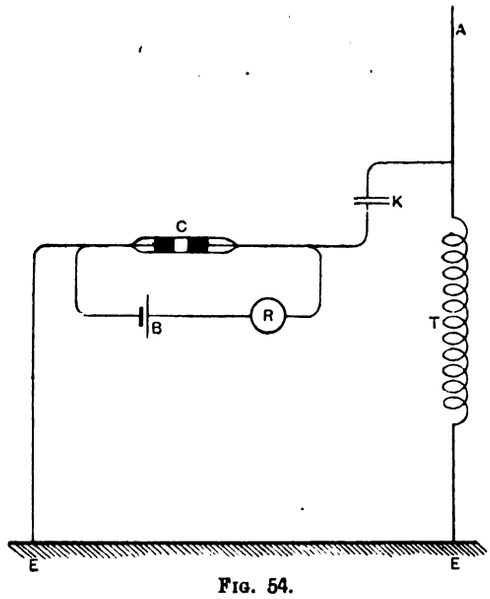

FIG. 54.

In and since 1900 M. Ducretet has to a considerable extent used the telephone as a receiver in the secondary of a transformer or induction coil, and has increased the distance of signalling, as might be expected. He has also in his later coherer employed only a very small quantity of filings between two metal plugs, and has, further, made use of a regenerative coherer of the Blondel type, in which there is a reserve chamber of filings.

M. Rochefort is another successful worker in this field. The Rochefort transmitter has such special features as the Rochefort rotary interrupter and the Rochefort unipolar transformer. In the latter, the whole of the pressure is on one side of the pole—viz., on that side connected with the antenna. He has a receiver the sensitiveness of which can be regulated by a magnet, and he uses the automatic Morse machine of the French Government type, with a resistance in circuit with the coherer to regulate the sensitive of the (Claude) relay. This arrangement has been very successful. Twenty-four stations in and at the disposal of the French navy have been fitted with Rochefort apparatus. M. Rochefort has found out a very important thing—viz., that a coherer can be made to decohere automatically by the passage of a small current through it. When the coherer has been influenced by ether waves, if a current of n milliamperes be sent into it, then under succeeding waves the needle of the ampere-meter in series oscillates between values greater and less than n, returning to about n when the waves have ceased. The value of n depends on the resistance in circuit, the intensity of the waves, and the difference of potential applied to the terminals of the coherer. Stations have also been installed on the French coast fitted with Rochefort-Tissot apparatus. The average distance of signalling between vessels and these stations is about 40 or 50 miles. Vessels fitted with the above apparatus are able to read messages sent out by vessels of the German navy, and also by vessels fitted with Marconi apparatus as well as from the Marconi station at the Lizard.

Marconi's Experiments in France.—In March and April, 1899, Mr. Marconi established communication between a station at Wimereux in France and the South Foreland, a distance of 28⅔ miles, also with a third station at the lightship "Goodwin." These experiments were very successful, clear signals being obtained at all times. Experiments were also tried between the stations named and two vessels, the "Ibis" and "Vienne." The distance of the "Vienne" from the South Foreland was on one occasion 52 km. (32½ miles), and messages were received *by the ship*. Experiments on screening, and also on syntony, were carried out, but an accident prevented the final tests from being carried out. However, between the "Vienne" and Wimereux some experiments showed that messages could not be received by one from the other when they were differently tuned *as long as the distance apart was greater than a certain amount*, but when nearer than this signals could be read just as clearly as if syntonised to suit each other. M. Ferrie, himself an expert in this subject, superintended these experiments for the French Government. M. Ferrie also installed a provisional station at Dunkirk on the occasion of the departure of the French squadron for Russia. He was able to receive telegrams from a number of English Marconi stations, and gives it as his opinion that syntony, as practised at that time, is no protection, or at least only a very limited protection against messages being read.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

701. A few weeks ago I was staying with a friend, when I dropped across something new (to me). He said he had an appointment with a friend, and would I care to accompany him. I consented. It turned out they were experimenting with wireless telephony, one of them worked an ordinary spark coil, giving about an eighth spark. The rest at that end I was not privileged to see, but we got on our cycles and rode to the local club, taking an ordinary receiver of a telephone with us. We connected one wire to the water tap and the other to the gas bracket, and could hear every word that was said at "the other end," about two miles away. Has anyone else seen or heard of anything similar? if so, perhaps the transmitting apparatus would be interesting to others, as well as BRACKLEY-LIAMENA.

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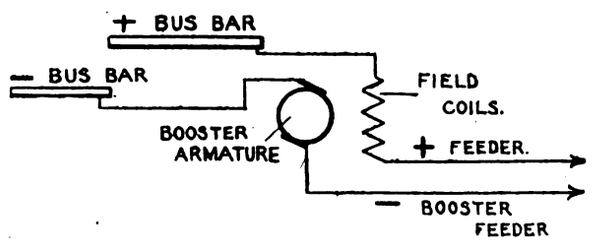
702. On a 500-kw. Parsons turbo generator the two brushes on both poles nearest armature wear down to a knife edge on a 10-hour run; the others doing 40 hours, have changed brushes, and found all contacts to be good. I should be glad if any of your readers can explain this, also give remedy for the same.—W. E. D.

ANSWERS.

Question No. 694.—It is found necessary on a certain tramway route to instal a track booster to reduce the R drop along the rails caused by the current taken by the cars: (1) How would you determine the "boosting point" so that a minimum length of boosting cable may be required? (2) What conditions must be fulfilled by the booster (assuming it to be series-wound generator driven at constant speed) so that it may automatically maintain the rail-drop within certain limits, and also avoid circulating a current when no cars are running? (3) Explain the action of the booster-generator, showing how the potential at the boosting point is reduced and kept at the reduced figure.

Answer to No. 694 (*awarded 7s. 6d.*).—The "boosting point," or position where booster cable should join track, is at a certain point where the drop in voltage on rails from end of track approaches seven volts. The Board of Trade regulations state that there shall not be more than seven volts drop on any uninsulated return. They also compel a tramway authority to keep a continuous record of the drop in the uninsulated return between points furthest from and nearest to the generating station If it is required to use only the shortest possible length of booster cable, almost the whole seven volts drop can be allowed in the rails. In order to determine this the length of line under consideration should be laid out to scale. Cars should be marked thereon, according to service—*i.e.*, on a three-minute service at a speed of eight miles an hour there will be 0·3 of a mile between cars running in same direction. According to size of tramcars, they will take on an average 25 to 50 amperes each at 500 volts. This average can easily be checked by assuming, and marking on plan, that a certain number of cars are stopped or wasting when others are starting or climbing hills. Drop in voltage on rails should be worked out and also marked on plan. Thus it will be seen at a glance where to connect booster cable—*i.e.*, at a point where there is a drop of about seven volts from end of line. It is well to be ·5 to 1 volt, or, perhaps, two volts on low side to allow for emergencies, such as bond loose or race meeting, etc. In the question it is stated that minimum length of booster cable is wanted. It is considered bad practice to lay the minimum length of this cable. When track and bonding is new it will be an easy matter to keep drop in rails within the seven volts, but after a few years' wear and tear it may be necessary to supplement track return by lengths of trolley wire or extend booster cable.

2. The conditions to be fulfilled by booster are very simple. It is to be capable of creating a potential difference across its armature equal to drop in volts on booster cable + drop in armature and fields + a margin for safety or extensions; booster to be able to deal with maximum current likely to be returned through it. A negative booster is generally a serious-wound machine, whose potential difference is proportional to the current returning by the booster feeder. This is one condition required making the machine automatic in action whilst at work. A shunt coil is generally added to give a greater range of action. An improvement in this design, by Mr. Parshall, is shown in sketch. In this machine the field coils are in



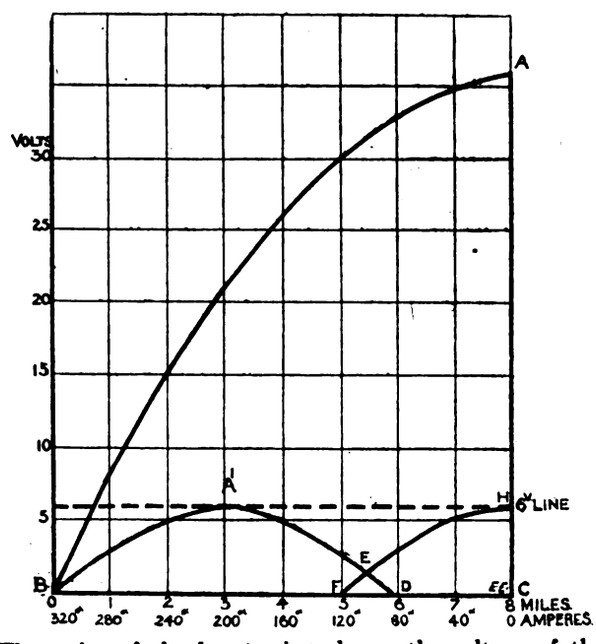
series, with the positive feeder going to the section of line where the booster cable is connected. Thus the booster excitation, and consequently voltage, is automatically regulated in proportion to the load on that particular section. The writer has never heard of any device to prevent a current circulating when no cars are running. A booster, not being an entirely automatic machine, is generally shut down when there is a very light service running, or when that district which it serves is not in use. It is possible to place reverse-current cut-outs on the other earth return feeders, to prevent current leaving negative 'bus bar, going through negative feeder to track, through booster feeder and booster back to negative bar This, to the writer's knowledge, has never been done and is not recommended, it being better to shut down a short-circuit booster when not required to be used.

3 The action of a negative booster-generator has really been explained above in stating that it creates a potential difference across its brushes. By doing this, it reduces the voltage at the station end of the booster cable below that of the negative 'bus bars and track, thus sucking the current along the cable instead of it returning along the rails. A more correct explanation may be that a booster creates a line of lesser resistance through it and its cable than through the track and other earth feeders.—J. H. S.

Answer to No. 694 (*awarded 7s. 6d.*).—To answer the first part of the question satisfactorily it will be necessary to take a concrete example. Let us assume the route is eight miles long and all double track; also 16 cars running, eight on the up track at intervals of a mile, and similarly eight on the down track. We will also assume that two of the cars are at the terminus—one arriving and one departing. Let each car take 20 amperes, and let the resistance per mile of track be $\frac{1}{10}$ ohm. The fall of potential along the track will be:

Terminus									Station.
Miles..	8	7	6	5	4	3	2	1	0
Current (amps.)	40	80	120	160	200	240	280	320	
Potential drop (volts)	36	35	33	30	26	21	15	8	0

On plotting these results we get the accompanying diagram. Now cut a cardboard template to the shape B A C. We will allow six volts as the maximum drop of potential in the rails, which will give a margin of one volt below the Board of Trade limit Set the template on the diagram with the point A on the six-volt line, the side A C vertical, and the curve passing through the origin. This will give the curve B A'. Turn the template over and draw the curve A' D. Again, set the template on the diagram, but with the point A on the six-volt line, and the side A C coincident with the side A C of the original, as shown. This gives the curve F H, cutting A' D in E. The point E, which in the present case is 5½ miles from the station, will then be the best position for connecting the negative booster feeder.



The action of the booster is to lower the voltage of the booster feeder at the station end below that of the track at the station, so that the current will tend to come back through the booster feeder. The line current for the section in which the booster feeder is connected is taken, first through the field coils of the dynamo side of the booster; and, provided the magnets are not saturated, will automatically regulate the voltage according to the load. If

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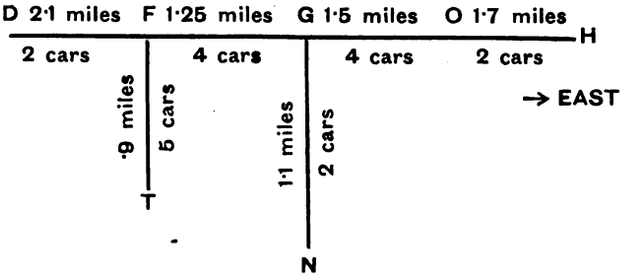
connected up in this manner there will be no current circulating when the cars are not running.—C. L S.

Answer to No. 694 (*awarded* 7*s.* 6*d.*).—(1) Assume that the track is single and laid with 90lb. rails or 180lb. rails per yard of track. Assuming the resistance of the rail to be 11 times that of copper of equal section, and that the joints add 5 per cent. to that resistance, a mile of bonded track will have a resistance of ·0289 ohm. To allow for possible increase of service, abnormally busy days, and bunching of cars, the limit calculated on should be five volts, not the whole seven volts allowed by Board of Trade regulations. The integrated product of amperes into miles to give this drop will thus be $\frac{5}{\cdot0289} = 173$ ampere-miles. Starting from the station, sum the product of amperes into miles until this product equals the constant corresponding to the limiting drop—*e g*, 173 in the present case. It is at once clear that all current from cars beyond this point has to return by track feeders. From this point start the integration afresh, and go on until the constant is again reached. At this second point the rails should be at earth potential. Recommence again from the second point and go on till the constant is once more reached. Then all current due to cars between the first and third points should return to the station by a track feeder connected at the *second* point, and so on in succession, the even points marking feeder connections kept at earth potential and the odd points marking the points of maximum potential difference above earth. Obviously, the calculation above described will only give correct results for the distribution of traffic and current assumed. Such assumption can only approximate to average working conditions, and it is only prudent to allow a margin on the upper side for growth and other possibilities. Should there be a large junction near the spot calculated for the track feeder, it would be far better to put that feeder at the junction connecting it to all the branching rails. The following example may make the matter clear, and is taken from Mr. H. Sayer's paper on "Distributing System of Electric Traction": Rail resistance, ·0289 ohms per mile; drop allowed, five volts; amperes × miles constant for five volts; current per car, 15 amperes; cars passing in pairs.



T is the power station. From T eastwards.

	Cars.	Amp.		Miles.		Product.		Sum.
T to F, five cars ·9 miles	First pair.....	30	×	·3	=	9	...	—
	Second pair...	30	×	·6	=	18	...	—
	1 at F	15	×	·9	=	13·5	...	—
	2 on line D F..	30	×	·9	=	27	...	67·5
F to G, four cars 1·25 miles	First pair.....	30	×	1·21	=	36·3	...	103·8
	Second pair...	30	×	1·83	=	54·9	...	158·7
	2 on line N G.	30	×	2·15	=	64·5	...	223·2

As the sum is brought over the constant by the current flowing in at G from branch N G, G should be a point of change of direction. The product of amperes × miles on branch N G is 15 × 1·1 = 16·5. This added to the 158 7 at G = 175·2—a little over the limit. Hence the whole of the 30 amperes from branch, N G, should flow east, and the integral of ampere-miles from G to feeding point should be 173 − 16·5 = 156·5 to keep N at five volts. Then from G eastwards, section G O, four cars, 1·5 miles long, current flowing east 30 amperes from branch, N G.

Cars.	Amp.		Miles.		Product.		Sum.
At G	—		—		16·5	...	—
G to first pair	30	×	·375	=	11·25	...	27·75
First pair to second pair.....	60	×	·75	=	45·00	...	72·75
Second pair to O	90	×	·375	=	33·75	...	106·50

H being terminus, and only two cars between H and O, it is obvious that feeding point should be west of O, so sum westwards from H.

	Cars.	Amp.		Miles.		Product.		Sum.
H to O 1·7 miles.	First pair to O	30	×	·85	=	25·5	...	—
	O to second pair G O...	30	×	·375	=	11·25	...	36·75
	Second to first pair G O	60	×	·75	=	45·00	...	81·00

Feeding point will thus be between the first and second pair of cars east of G. It should be exactly ·825 mile east of G. The product from this point will be 54·75 to the terminus H and to N, corresponding to 1·58 volts drop. Hence the feeding point may be 3·42 volts above earth. The track feeder will have to carry back 120 amperes, and be 2 975 miles long. Section should be ·39 square inch, and the drop in it will be 15 06 × 2·975 = 45 volts; but as its end may be 3 42 volts above earth, the booster will have to give only 41·58 volts, and have an output of 41·58 × 120 = 5,000 watts.

(2) and (3) can be more easily answered together. The positive pole of the booster is connected to the negative bus bar, and the negative pole to the track feeder. The field coils are connected in series therefore with the track return. The booster by reducing the potential at the station end of the track feeder below that of the rails at the station, and thus drawing as it were more current by that return feeder than would otherwise return by it. The difference of potential between the two ends does not remain the same, consequently the voltage of the booster automatically varies. Its effect is such that the current returning by the track feeder is $\frac{E + A R}{r + R}$, whereas if no booster is used it would be $\frac{A R}{r \times R}$; A = total current in the return circuit of the section; E = voltage of booster; *r* = resistance of booster cable and armature; R = resistance of rails. In installing a booster the voltage it should generate can be found from the formula: $E = C (R + r) - A R$, C being the current in the return feeder.—C. A. B.

Question No. 695.—Please give detailed description of the various steps taken to prevent explosions in underground conduits for electric wires. Have any improvements been made in insulators, has glass been substituted anywhere for earthenware with advantage, and is it possible to do without ventilation? One central station using bare copper strip conductors forces hot air into the conduit to keep it dry. Has this been found successful and generally adopted? Are bare conductors now employed underground, or are they now superseded in best practice by insulated conductors? Is bitumen laid in wooden or earthenware troughs found satisfactory insulation, or does the conductor sag too much?

Best Answer to No. 695 (*awarded* 10*s.*).—The usual method adopted for preventing explosions in underground conduits is to seal up all possible passages through which coal or sewer gas can enter the conduit, and deal with the gas which permeates through the material of which the conduit is composed, by either fans or natural ventilation. Fig. 1 is the general form of ventilating box. The gases usually met with in the subsoil are about half the specific gravity of air, and so tend to rise to the highest part of the conduit and leave by the nearest ventilator, being replaced by air at the lower parts, and so the conduit is kept free from explosive mixtures. The insulators as used on the early systems of bare copper conductors, such as the Kennedy and Crompton, have changed very little up to the present time, and they are usually of the petticoat, or modification of that type of insulator, with additional ridges to prevent a film of moisture forming and so arrest any surface leakage. Glass has been largely used for insulators of a squat design, but it is very expensive as compared with earthenware, and the small projections, such as the extensions at sides to prevent the conductor leaving the insulator, will give trouble, as these extensions will probably be broken off if any great strain is put on them, and so porcelain or earthenware is generally used.

With regard to ventilation, it is better to provide for it if possible, as it will, in addition to clearing away any explosive mixture, also prevent fungous growth with its attendant leakages. The system of forcing heated air into the conduit would certainly have a good effect in drying the insulators, but I do not think it is in general use. The bare copper strip systems of underground mains are now very seldom put down, partly due to the excessive cost of construction, and also the uncertainty of finding sufficient space in the footpaths for them. The system is certainly an ideal one if we could prevent flooding, keep the conduit dry and free from gas, as it makes

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use of the cheap and permanent insulator, "dry air"; but as the distances between conductors must be such that earthing or actual contact cannot occur, even when heavy currents are flowing and expansion and mutual attraction are taking place, the conduit becomes too large, and as the working pressures are on the increase, we find it superseded by insulated conductors. Vulcanised-bitumen insulated cables laid in wooden troughing, filled solid with bitumen, have been very largely used and have proved very satisfactory, but this class or insulation has the same fault

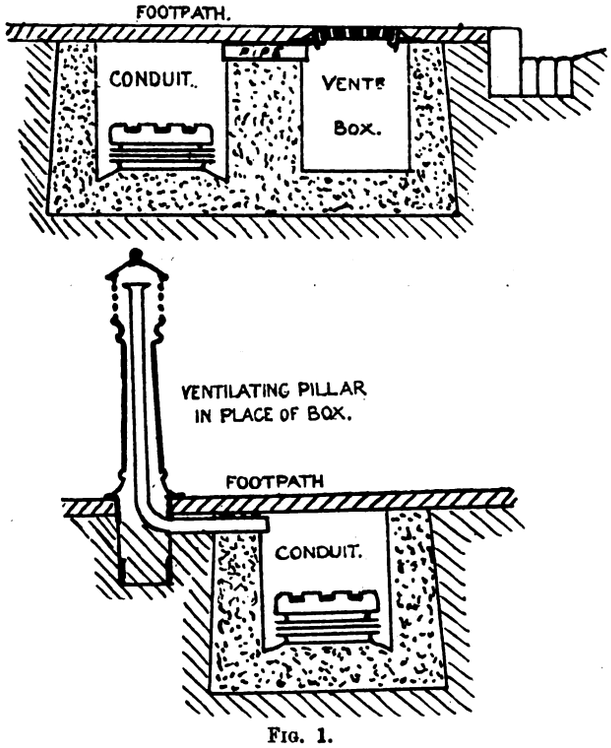
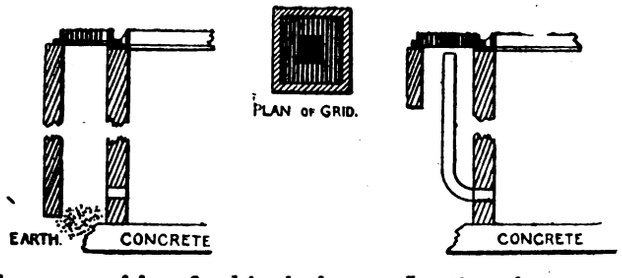


FIG. 1.

as rubber, in that it becomes plastic at high temperatures and gives off inflammable gases, and a short circuit is generally attended by a lot of damage to other cables if in close proximity. Manilla paper treated with resin oil is an excellent insulation for cables, and most cablemakers are now supplying this for extra high-tension work with great success; but as it is very hygroscopic, it must be placed in a watertight envelope made usually of lead, and greater care must be taken than with vulcanised bitumen, as the ends must be immediately sealed when cut, and all chances of moisture reaching the insulation prevented whilst jointing, and any blowhole in the lead detected before the cable is put to work. With paper-insulated cables we are not troubled by decentralisation as with insulations which become plastic at high temperatures, and thus the copper can be worked at higher density per square inch, where drop in pressure is not important.—A. T.

Answer to No. 695 (*awarded* 5*s.*).—The various steps taken to prevent explosions in underground conduits for electric mains are devoted to two ends—namely, exclusion of gas and ventilation. In New York and also in parts of the Manchester scheme air is driven through the conduits



by means of fans fixed in the boxes. In other places ventilating pipes are taken from the junction boxes to the top of some adjacent house, or even to the base of a convenient arc or tramway pole, in which case the pole would act as a chimney in creating a draught. In yet other places ventilating grids are fixed in the box covers, or a ventilating grid is fixed near the rim of the box and connected by a pipe or brickwork passage to the lower part of the box, as per sketches. To exclude gas, the boxes, where possible, should be made of cast iron. If brick is used, cement should be used for setting, and the walls served on the inside with cement. The floor should be of concrete, and fitted with a trap to carry off any water that may find its way into the box. Glass insulators are now used in many cases. They are lighter and cheaper than glazed earthenware ones, and, although not so strong mechanically, do not depend on the integrity of a thin glaze for their non-hygroscopic qualities.

Until we find a thoroughly gas-proof system it is impossible to do without ventilation. Bare conductors are still employed in many cases, due to the ease with which connections for services, etc., can be made, and the facility for increasing the area of conductors when required. The system most in use at present is Crompton's. It consists of strained copper strip laid on insulators. Either brick or iron culverts may be used. The iron ones are more expensive, but on the other hand there is not that injurious deposit of salt on the negative conductor insulators, which occurs when brick or concrete conduits are used. Lead-covered cables laid in bitumen, in wood or earthenware troughing, with properly spaced distance pieces, say, 18in. apart, have been found to be quite satisfactory, and are in use in many towns.—C. L. S.

Answer to No. 695 (*awarded* 5*s.*).—The chief steps taken to prevent explosions in underground conduits have been to endeavour to render them both water and gas proof. These conditions are practically impossible to maintain. In any extensive system the conduits are laid with a fall which will carry any water, whether from condensation or surface water, to the nearest manhole, and thence, if the quantity is considerable, it is usual to connect, through a non-return trap, to the sewers. The surface frames and covers of the manholes are designed to prevent access of water, and yet ventilating to allow a free passage into the atmosphere of any gas which may have accumulated. Sometimes a pipe is taken from the manholes up the adjacent walls instead. In New York, owing to the soil being gas-ridden, it has been found necessary to continually blow a current of air through the conduits and manholes; this, however, is very expensive. Some engineers prefer the manhole covers to be water and gas tight, and trust to frequent inspection to remove any gas accumulations.

The earliest system of placing bare underground mains in culverts was that introduced by Messrs. Crompton and Co., consisting of a concrete trough in which the conductors are carried on glass insulators, these being mounted on a wooden cross-bar, and the trough covered in with stone flags. In the more recent system due to Prof. Kennedy the insulators are of stoneware, but porcelain has also been used. Generally speaking, all these are satisfactory materials, but as it depends on the shape and non-absorptive properties of the insulator rather than on the material, it would be incorrect to say that glass is better than porcelain. The point to be considered is that the insulators are so designed to make the surface leakage a minimum. At Manchester glass insulators have superseded the original porcelain system owing to excessive leakage. At Glasgow, owing to contacts between the copper strips and the iron culvert in which they were placed, subsequent extensions have been made with insulated cable, both fibrous and rubber.

Bare conductors are still employed underground where there is sufficient space under the pavements for very large mains, and if tapped for frequent services. Here they are undoubtedly best and cheapest, always provided that they are so installed as to prevent sagging of the conductors and leakage. The best practice for smaller-size cables is to have them paper insulated and lead covered, either laid solid in stoneware or wood troughing, or steel armoured and laid direct in the ground where the soil is suitable, these being much cheaper to instal, and take up less space than conduits.

With regard to the question raised as to whether bitumen laid in troughs is found satisfactory insulation, it is not very definite whether this refers to bitumen-insulated cables or simply the suitability of bitumen as a filling-in compound. If the former, V.B. is satisfactory, providing the section of the copper strand is large enough to carry the current

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without undue heating, otherwise the core decentralises and sinks through the insulation. If the latter, bitumen is thoroughly suitable, but should not be considered as an insulator, but merely as a mechanical protection to the cable. A new system has recently been introduced of laying bare conductors mounted on porcelain insulators in a wooden trough and filling the trough in with compound. This has not been used to any extent, but there is no reason why it should not be satisfactory, always providing that the strand does not work at too high a rate of conductivity, otherwise the conductors will sag, and may even touch each other, with more or less disastrous results. It would also be better to use stoneware troughs instead of wood.—L.H.E.

Answer to No. 695 (*awarded* 5*s.*).—I will reply to the queries in the order set forth in the question. Gas may, of course, filter through the walls (or joints) of the conduit whether of concrete, earthenware, or iron, and also through the brickwork of surface-boxes; and this has often led to explosions of gas, and sometimes serious consequences. This is especially likely to occur where bare mains are laid in concrete culverts, for here the gas can accumulate in large quantity. Opinions differ as to the best means of ventilating the conduit in order to prevent explosions, and it is not at all an easy matter to lay down any hard and fast rule on the subject. Many systems run ventilating pipes from the surface-boxes up the side of the nearest house wall, and this is a good method if provision is made for inlet pipes to take in pure air, for supplying the place of the gassy air removed. This would be a system of natural draught. Some systems have small air-shafts, with 3in. by 6in. iron gratings over, this shaft being built by the side of, and entering into, each surface box. Others use surface box covers with slots or holes for ventilation, but my own experience is that these slots and holes very soon get choked up with dirt, and I think the ventilating pipe up the wall is the best arrangement, though more costly. Ventilating by forced draught should be the best safeguard against explosions, but it is a difficult thing to carry out, and I have not known any place where they do this except Manchester.

In the case of ordinary conduit work I believe that the best thing to prevent explosions is to send a man round very early in the morning to open all the surface boxes by removing the covers for a few minutes, this being done every day. Both glass and glazed stoneware bearers are used for bare copper strip Glass is stronger, but dearer, and I cannot imagine anything better than well glazed and vitrified stoneware for this work. Bare conductors are very rarely employed now for mains, insulated cables being generally used, for the following reasons. The first cost of a culvert to contain bare copper strip is considerably more than for insulated cable. The bare mains in a culvert occupy a much larger space under the pavement than an insulated cable, and in large towns, where the gas and water pipes are already there, no room is left by the gas and water engineers for culverts. The mains' man is lucky to get room for one insulated cable, and then he has to dodge gas and water services at all heights and all angles. Then, again, the culvert requires a straight run between points, whereas an insulated cable can be taken round obstacles to a greater extent.

When overloaded, bare copper mains are liable to warp and twist, putting heavy strains on the bearers and sometimes short-circuiting themselves. This is particularly the case when the copper is of heavy section, made up of a number of strips. The leakage is necessarily high, because the insulation resistance is low and very variable with the weather. The culvert is always liable to flooding by heavy rains or the bursting of a water-main, and this means a serious breakdown. The insulated cable is free from these perils. I have never heard of bare copper laid in bitumen in wooden troughs, and cannot think it would be a success. The trough would have to be very deep to prevent the strip sagging to the bottom—porcelain bearers would be required and great care taken in filling in with bitumen. Even then, when the strip got hot under load, the bitumen would melt, giving off vapour which would provide a passage for moisture from outside. If "Water" *does* try this, I should like to hear the result after, say, 12 months' working. It would be particularly interesting if the main were put down as a distributor with services tapped off, though I shouldn't care to do it myself.—DUPLICATOR.

SWITCHBOARD SONG.

For Use on Holiday Shift.

BY "SIMPLEX."

Wheels!—Wheels!—Turnin' in me 'ead!
Sixteen hours on duty. Wish that I was dead!
Regulatin' voltage till me achin' noddle reels.
Wheels! Wheels! Wheels!

Grunt! Grunt! Piston runnin' dry!
Driver, *can't* you watch it? Want me standin' by?
Like to 'ear it 'owlin' like a dyin' elephunt?
Grunt! Grunt! Grunt!

Crash! Bang! *Knew* how it would be!
Nothin' *ever* happens unless there's only me!
Telephonic message! Lights are out? Oh, *hang*!
Bang! Crash! Bang!

D——n! D——n! Will it never cease?
Haven't got a minute to take me tea in peace!
Bluebottle is dyin' in me *only* pot of jam.
——! ——!! ——!!!

PERSONAL.

The first annual outing of the Brighton Corporation tramways' depôt repair staff took place on Saturday. Under the direction of Mr. M. H. Volk, jun., workshop engineer, the party of 25 drove through Falmer, Lewes, Offham, Plumpton, Westmeston, Ditchling, over the Common to Burgess Hill, and on to Friar's Oak, the residence of Mr. and Mrs. Volk, sen., where a meat tea was provided.

The Southend Town Council have increased the salary of Mr. Heenan by £50 per annum.

Plymouth Corporation tramways inspectors, motormen, and conductors, to the number of 47, had their annual outing on Saturday. The party journeyed to Wadebridge by train, and after having breakfast drove to Newquay in wagonettes. After a short stay at Newquay for lunch, the return journey to Wadebridge for dinner was made. After dinner songs, etc., were indulged in, and Chief Inspector W. Turpin moved a vote of thanks to Messrs. M. H. Maddick and Wilce, secretary and treasurer respectively, for making the arrangements for the trip.

The Epsom Council have increased the salary of the electrical engineer by £25 to £250 per annum from Oct. 1 next, and the salary of the chief assistant by £16 to £120.

On Saturday last, June 25, the second annual outing of the staff of the Stepney Borough Council electricity department took place to Margate. The party travelled in reserved compartments from Cannon-street, arriving at Margate shortly before 10 a.m. At the dinner at Munn's Hotel, in the unavoidable absence of Mr. W. C. P. Tapper (the engineer), the chair was taken by Mr. W. Young, supported by Mr. Mr. A. J. Somerville, in the vice-chair. The latter proposed a vote of thanks to the hon. secretary (Mr. T. J. Archer) and the hon. treasurer (Mr. G. B. Davies) to whose untiring efforts, he said, the great success of that day's outing was largely due. We are informed that the committee are again indebted to Mr. Alderman R. A. Kearsey (chairman of the Electricity Committee), Mr. Alderman C. E. Osman, Mr. W. C. P. Tapper, and also to Mr. Arthur Wright (the consulting engineer) for financial support in connection with the outing.

Mr. John Brindle, who has been manager of the Bury, Rochdale, and Heywood Tramway Company's undertaking for the past six years, has been appointed general manager of the Paisley district electric tramways.

Mr. R. C. Bullough, of Manchester, has been appointed manager of Colchester borough tramways at a commencing salary of £300 per annum.

The Aberdeen Electricity Committee have decided to increase the salary of the chief clerk at the Ferryhill electricity works from £117 to £135 this year and to £150 the following year.

At Worcester, on Thursday last, the Electricity Committee granted a day's holiday to all that could be spared from the staffs of the two generating stations to play a cricket match, played at Powick. After a very enjoyable game the New Station won by 40 runs. Birrell and Gardiner captured all the wickets for the winners, the former in the first innings having an average of six wickets for nine runs. For the losers Knott and Wood bowled exceedingly well. At 1.30 an adjournment was made to luncheon, provided by Mr. C. J. Sutherland, the chief engineer. At the termination of the match Mrs. Sutherland presented the winning team with a handsome silver cup, which he has given to be played for each year.

Mr. F. E. Wilkinson, of Redhill, Surrey, at present engineer-in-charge of the Reigate Corporation electricity works, has been appointed to the post of engineer-in-charge of the York electricity works at a salary of £100 a year.

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LEGAL INTELLIGENCE.

FEES TO EXPERTS.

An action was brought by the Lincoln Tramways Company, Limited, in the Lincoln County Court to recover damages from Mr. Alfred Dickinson, civil engineer, of Birmingham, for breach of contract. Mr. Hollis Walker (instructed by Messrs. Hebb and Sills, Lincoln) appeared for the plaintiffs; and Mr. Lindley (instructed by Messrs. Dingnans and Elliott, Walsall) for the defendant.

The proceedings occurred in connection with the sale of the plaintiffs' undertaking to the Corporation. The contention of the company was that the defendant's contract bound him to give evidence before an arbitrator if required, as well as to value the undertaking, for the inclusive fee of 50 guineas. It was stated that after being paid 50 guineas for his report on the concern the defendant wrote asking to be liberated from giving evidence before the arbitrator on the ground of illness. Thereupon, the plaintiffs called his attention to his previous promise, and defendant replied that in the event of his appearing before the arbitrator he should require a certain fee. Eventually the company engaged another expert, a Mr. Fell, to whom they paid a fee of 50 guineas. The matter was finally settled between the company and the Corporation without going to arbitration, the company getting £10,400 for the undertaking, which was £300 in excess of the valuation of Mr. Dickinson. The company now alleged breach of contract against Mr. Dickinson, and claimed 50 guineas damages, which was the amount of the fee they had to pay Mr. Fell.

His Honour, after hearing arguments, said the action arose through want of force in the expressions used by the plaintiffs to the defendant in a certain letter, but when he read that letter with the other correspondence he was distinctly of opinion that the letter was an order to the defendants to inspect the tramways, and undertake to advise the company as to the value, with the proviso that if the sale did not take place the defendant would be required to give evidence before the arbitrator; and he considered that the defendant so understood. Judgment would therefore be for the plaintiffs, with costs.

CORPORATION OF NORWICH v. NORWICH ELECTRIC TRAMWAYS COMPANY.

This case came before Mr. Justice Phillimore on circuit, without a jury. Mr. Macmorran, K.C., and Mr. E. E. Wild represented the plaintiffs, and Mr. Low, K.C., and Mr. F. H. T. Heale appeared on behalf of the defendants.

The dispute hinged upon a clause of the Norwich Electric Tramways Act, 1897. Under the General Tramways Act the Norwich Tramways Company had to keep in repair that part of the roadway which was between the tramrails and 18in. outside as well. The local Act adopted the General Tramways Act, but in the local Act a further burden was placed upon the Norwich Tramways Company, and it was in reference to this that the dispute arose. The local Act provided that if the company failed to maintain and keep in good condition to the satisfaction of the Corporation "the junction of the paving laid and maintained by the Corporation," the Corporation might themselves at any time after seven days' notice to the company, do the work necessary for the repair and maintenance of the road, and the expense reasonably incurred by the Corporation in so doing should be repaid to them by the company, with the addition of 5 per cent. on such expense. The maintenance of the paving involved an expenditure of £700 a year.

Mr. Macmorran explained that where granite blocks were laid in a macadamised road there was a tendency for the macadam to wear quickly. While the granite setts lasted for many years, the macadam used up quickly. He contended that by a section of the local Act it was incumbent upon the company to keep a uniform surface at the junction of the setts with the macadam. The company had failed to do the work, and the Corporation had undertaken it.

The **City Engineer** (Mr. A. E. Collins), **Mr. J. W. Cockrill**, borough surveyor of Great Yarmouth, and **Mr. E. J. Silcock**, of Leeds, gave evidence on behalf of the Corporation.

Mr. Alan Neville Bannister, A.I.E.E., manager of the defendant company, said the roads of the plaintiffs where these steps occurred were generally bad.

Mr. Isaac Emerson Winslow, consulting engineer to the New General Traction Company, and **Mr. Stephen Sellon** also gave evidence on behalf of the defendants.

Counsel on both sides having addressed the Court, his **Lordship** said he would take time to consider the matter.

COMPANIES' MEETINGS AND REPORTS

ISLE OF WIGHT ELECTRIC LIGHT AND POWER.

The annual meeting of the shareholders of the Isle of Wight Electric Light and Power Company was held at the works last Friday, Mr. F. E. Gripper presiding.

In moving the adoption of the report and balance-sheet, the **Chairman** remarked that very satisfactory progress had been made during the year. The Company had practically completed the whole of their undertakings in the island, having supplied East and West Cowes and established works at Ryde. The additions in the number of lamp connections were very satisfactory. At Ventnor they had increased from 12,900 to 15,300, at Sandown and Shanklin the number had increased from 8,100 to 10,100, and at Newport the number had jumped from 6,800 to 16,000. At Ryde and St. Helen's up to the end of the year they had installed 5,000 lamps. This made an aggregate of 46,900, as against 27,900 at the end of the previous year. Taking the first four months of this year, they had had applications for, or had connected up, between 7,000 and 8,000 lamps. Turning to the financial statement, the Chairman said he regarded this as satisfactory, considering that the Company was young. Including a small balance carried forward from the previous year, the profits amounted to £5,640, of which sum £5,400 had been made on the year's working, thus showing that when the directors prophesied a profit of £5,000 when appealing to the public to subscribe to the share capital they were on the right side. The profits for the first four months of the year amounted to £2,641, as against £1,390 for the corresponding period last year. The revenue had been applied to paying interest on their debentures and preference shares; they had written off £500 for renewing accumulators at Ventnor, and were carrying forward a sum of £344. As to the capital expenditure, the Chairman explained that the directors believed in the policy of supplying current to various parts from which applications had been received, and they had invariably found that the number of consumers soon increased very satisfactorily. Their total capital expenditure was £224,000, and they had spent £100,000, £46 000 being in Ryde and St. Helens, and £28 000 in Cowes. In conclusion, the Chairman expressed himself in confident terms as to the ample security held by the shareholders.

Colonel Hamilton seconded the motion, and said that the investment in preference shares and debentures was as satisfactory as one could wish for.

The motion was carried unanimously.

Mr. Gripper was cordially re-elected a director, and Mr. A. H. Crowe was reappointed auditor, his fees not to exceed 25 guineas.

The **Chairman** mentioned that heretofore the directors had not asked for any fees for their services, and he thought the time had come when a nominal sum should be paid. It was decided to pay the five directors £150 per annum, to be so divided as they deemed fit.

Thanks were voted the chairman and directors, and the meeting closed.

BRITISH ELECTRIC TRACTION.

The report for the year ended March 31 last states that the total amount for appropriation, including £24,912 brought forward from last year, is £274,730. The premiums, amounting to £30,042, received in respect of debenture stock issued during the year, have not been brought into this account, but have been carried direct to reserve. After providing for interest on debenture stock, dividends on preference shares, and interim dividend at the rate of 6 per cent. per annum on the ordinary shares for the half-year ended Sept. 30, there is a balance of £78 138. The directors propose a dividend at the rate of 6 per cent per annum on the ordinary shares for the half-year ended March 31, carrying forward £38,148. The sale of the Poole undertaking to the Bournemouth Corporation will be brought into the next year's account. During the past year £232,407 5 per cent. perpetual debenture stock has been issued. An issue has also been made of £250,000 4½ per cent. second debenture stock. The net premiums received in respect of the issues amount to £30,042, and the whole of this amount has been added to reserve. The subscribed share and debenture capital at March 31 was £1,333,010 in ordinary shares of £10 each, £1,564,370 in 6 per cent. cumulative preference shares of £10 each £1,256,225 in 5 per cent. perpetual debenture stock, £250,000 in 4½ per cent. second debenture stock. Since the closing of the books arrangements have been made with a syndicate for the sale of £50,000 5 per cent. perpetual debenture stock and for an advance to the company of £550,000 by instalments with a view to the development and completion of undertakings in hand, and an option has been given by the company to the syndicate to call for allotments, at any time before Dec. 31, 1905, of debenture stocks and shares of the Company, the proceeds of any such allotments to be applied in the first instance to repayment of the above advances, with interest at the rate of 4½ per cent. per annum. The present policy of the directors is to limit, as far as possible, the further capital commitments of the Company. The total mileage of lines in operation by the Company and all its associated companies, by electric traction, steam, and horses, at Dec. 31, 1903, was 327·44, as against 288·77 in the previous year; and the mileage of omnibus routes was 68·87, as against 71·62. The total number of passengers carried on the lines open for traffic in 1903 was 219 714,189, showing an increase of 29 per cent. upon the preceding year; and the total traffic receipts amounted to £1,162,005 showing an increase of 26 per cent. upon the preceding year. The total amount received for electricity sold by the Associated Electric Power and Lighting Companies in 1903 was £40,345, showing an increase of 50 per cent. upon the preceding year. The Company's investments in the tramway companies in Birmingham and adjacent districts have been merged in the Birmingham and Midland Tramways, Limited, whose capital has been increased to £1,050,000, and a joint committee of the Boards of the associated companies has been constituted to operate about 95 miles of tramways and light railways in the district. The directors believe that these arrangements will lead to increased economies in working, and enable greater travelling facilities to be afforded. These arrangements should also enable the further capital required by these companies to be raised independently of the British Electric Traction Company, and an issue of £200,000 debenture stock has recently been made by the Birmingham and Midland Company. Allusion is made to the Bill promoted in the last session of Parliament, which proved unsuccessful, for obtaining running powers over the tramways of the Birmingham Corporation after the expiration of the leases in 1906 and 1911. Temporary agreements have since been made with the Corporation in regard to some of the routes. Further progress has been made by the Metropolitan Electric Tramways, Limited, with the important scheme of tramways in North London and light railways in Middlesex and Hertfordshire, and the first section of about six miles

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will, it is expected, be open for traffic on the overhead system of electric traction in the course of a few weeks. The Metropolitan Electric Tramways Company has also purchased from the British Electric Traction Company all the shares in the North Metropolitan Electric Power Supply Company, which owns Acts of Parliament giving the right in perpetuity to supply electricity in bulk over an area of about 325 square miles north of London, and an extensive business is in course of being established. A large power-house has been erected at Enfield, and another power-house at Willesden has been acquired from the Urban District Council, who were advised that it would be more economical to purchase the electricity from the supply company in bulk than to generate it themselves for the purpose of retail distribution under their electric lighting order. The undertaking of the British Electric Traction Company to provide capital for the Metropolitan Electric Tramways Company to the extent of £500,000 has been fully discharged. The directors have given much attention to the question of motor haulage and motor omnibuses, and have entered upon several experimental enterprises, but so far without obtaining satisfactory results, and all the expenses incurred have been written off. Experience, however, has been gained in connection with the new industry, which is likely to be of value to the Company in future. No return has yet been received upon the ordinary shares held by the Company in the Brush Electrical Engineering Company, in which the Company is now largely interested, but that company has made satisfactory progress during the past year. The Company and the Brush Company jointly obtained a concession for electric tramways at Shanghai, on condition that substantial commencement of the works should be made within one year from April 21, 1903. In view of the political outlook in the East last year, an application was made for extension of time, which the municipality declined to grant. There was, therefore, no alternative but to accept the suggestion of the municipality and to withdraw from the business, as the directors felt that the expenditure of a large capital on tramways in Shanghai at the present time could not be justified. The Brush Company has secured a valuable interest in a concession for electric lighting and tramways in Bombay, and the works for electricity supply are being proceeded with, but the electric tramway enterprise is delayed by various negotiations, and by arbitration proceedings between the Corporation of Bombay and the existing owners of the tramways.

NEW COMPANIES REGISTERED.

Phonograph Record Manufacturing Company, Limited.—Capital, £1,000. Object: to carry on the business of manufacturers of and dealers in gramophones, phonographs, talking machines, records, electrophones, telephonic apparatus, etc. Registered office: 99 to 119, Rosebery-avenue, E.C.

Liens Registered.

Kyma Car Company, Limited, Peckham Rye, S.E.—Debenture registered June 17, for £140; charged on the undertaking and all the property, including the uncalled capital for the time being.

Bromley (Kent) Electric Light and Power Company, Limited. An acknowledgment of indebtedness under seal, dated June 6, 1904, creating £20,000 further debenture stock (making, with £50,000 already created, a total of £70,000, and being supplemental to a trust deed, dated July 7, 1902), has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees—F. T. Medcalf, 9, Great St. Helen's, E.C.; and W. R. Davies, 10, Moorgate-street, E.C.

Midland Electric Corporation for Power Distribution, Limited, Liverpool.—Discharge registered June 22 of mortgage dated Nov. 13, 1902, for £100,000.

British Electric Calibrated Fuse Company, Limited.—Issue on June 6 of £300 debentures, part of a series created Dec. 4, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder—J. Lang, 137, Fenchurch-street, E.C. No trustees. Total amount previously issued of same series, £1,350.

Birmingham and Midland Tramways, Limited, London, W.C. Trust deed registered June 21 for £200,000 first debenture stock, with power to issue further stock, ranking *pari passu*, up to one-half the subscribed capital. Trustee—Electric and General Investment Company, Limited. A special charge upon certain assets and property, consisting of land at Smethwick, a power-house in course of construction, tramways owned by the company (except those it is under obligation to sell), and securities in certain tramway companies, and the floating charges on all the remaining assets and property, present and future.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Aurelia (Perugia, Italy).—The Municipality require tenders for an electric lighting installation by Aug. 18.

Worksop.—Tenders are to be obtained for cables, etc., for mains, and additional feeder, estimated at £1,000.

Heston and Isleworth—The Council invite tenders for electricity meters. Tenders by July 4. See advertisement in former issue.

Radcliffe.—The surveyor has been instructed to obtain revised tenders from the firms who tendered previously for the special tramway track work.

Rochdale.—Tenders are invited for the supply and laying of high and low tension feeder cables, etc. Tenders by July 5. See advertisement in last issue.

Penrith.—The Council require tenders for oil or gas engines, dynamos, switchboard boosters, storage battery, and mains. Tenders by July 5. See advertisement in former issue.

Kingston-upon-Thames.—The Corporation invite tenders for addition to electric works building. Specification, etc., may be obtained from the Borough Surveyor. Tenders by July 14.

Dublin.—The Electricity Committee invite tenders for the supply of 100,000 pairs of arc lamp carbons. Specifications, etc., may be obtained from Mr. F. J. Allan, secretary. Tenders by July 9.

Batley.—The Corporation invite tenders for one 350-kw. steam dynamo and switchboard extension for same. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by July 16.

Halling (near Rochester).—Tenders are invited for electrical installation at the cement works of Messrs. Wm. Lee, Son, and Co., Limited, Halling. Particulars may be obtained from the Works Manager.

Devonport (Tasmania).—The Town Board invite tenders for the supply and delivery of alternatively 50 or 100 smallest-size meters to read direct in B.O.T. units on 220 volt direct-current circuits. See advertisement.

Priego (Province of Cordova, Spain).—The Municipality require tenders for installation and working until Dec. 31, 1922, of electric lighting. Particulars may be obtained from the Secretary of the above. Tenders by July 10.

Felixstowe.—The Urban District Council invite tenders (Section C) extensions to feeders. Specifications, etc., may be obtained at the offices of Mr. Regina'd P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on July 9.

Glasgow.—The Trustees of the Clyde Navigation invite tenders for two electric 32-ton coaling hoists for Clydebank Dock. Specification, etc., may be obtained from Mr. Geo. H. Baxter, 16, Robertson-street, Glasgow. Tenders by noon on July 25.

Ashton-under-Lyne.—Tenders are invited for lighting by electricity St. Michael's (Parish) Church, Ashton-under-Lyne. Particulars may be obtained from Mr. T. J. Barlow, Athol House, Fraser-street, Ashton-under-Lyne. Tenders by July 7.

Hounslow.—The Heston and Isleworth Urban District Council invite tenders for the supply of electricity meters. Specifications, etc., may be obtained from Messrs. J. and J. S. Enright, 68, Lincoln's-inn-fields, London, W.C. Tenders by July 4.

Whitby.—The Urban District Council invite tenders for (a) distributor and street-lighting cables; (b) network and service-boxes. Specifications, etc., may be obtained from Mr. H. S. King, electrical engineer. Tenders by 10 a.m. on July 18.

Stourbridge.—The Urban District Council invite tenders for the supply and laying of electric mains. Specifications, etc., may be obtained of the Electrical Engineer, Town Hall, Stourbridge. Tenders by noon on July 8. See advertisement in last issue.

Maidstone.—The Electricity Committee of the borough invite tenders for the supply and delivery of coal to their electricity works, Fair Meadow, Maidstone, until June 1, 1905. Specifications, etc., may be obtained from the Borough Electrical Engineer.

Erith.—The Urban District Council invite tenders for (1) rails, fishplates, and bolts; (2) permanent-way construction. Specifications, etc., may be obtained from Mr. C. H. Fry, Council Offices. Tenders by 12 noon on July 11. See advertisement in former issue.

Suakim.—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

Manchester.—The Highways Committee invite tenders for laying underground telephone pipes (Contract No. 10), with other appurtenant works. Specifications, etc., may be obtained at the City Surveyor's Office, Town Hall, Manchester. Tenders by 10 a.m. on July 11.

Aston Manor.—The Corporation invite tenders for the supply, delivery, and erection complete of pipework, etc. Specifications, etc., may be obtained from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on July 28. See advertisement in last issue.

Stepney.—The Electricity Committee invite tenders for the supply during the year of ampere-hour meters, demand indicators, arc lamp carbons. Specifications, etc., may be obtained from Mr. Wm. C. P. Tapper, 27, Osborn-street, Whitechapel, E. Tenders by July 4. See advertisement in last issue.

Middleton (Lancs.).—The Corporation invite tenders for the supply of 3,000 tons of engine coal to be delivered at the Electricity Station, Townley-street, Middleton, during ensuing 12 months. Particulars may be obtained from Mr. S. Pauls, borough electrical engineer. Tenders by July 11.

Leicester.—The Tramways Committee invite tenders for various machine tools to be delivered, erected, and set to work at their Abbey Park-road car depot, and at the fitting shop, power station, Belgrave-road. Particulars may be obtained from Mr. E. George Mawbey, M.I.C.E., Town Hall, Leicester. Tenders by July 5.

St. Pancras.—The Borough Council invite tenders for the supply and erection of main switchboard at the King's-road power-house, Camden Town, N.W. Specifications, etc., may be obtained at the offices of the Electricity Department, 57, Pratt-street, N.W. Tenders by 12 noon on July 19. See advertisement in last issue.

Bridgend.—The Committee of Visitors invite tenders for supply and erection of a complete telephone and fire-alarm installation for the Angelton and Parc Gwyllt Asylums, Bridgend. Specifications, etc., may be obtained from Mr. W. E. R. Allen, Glamorgan County

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Council Offices, Cardiff. Tenders by noon on July 6. Note.—Tenders already received have not been opened.

Dartford.—The Urban District Council invite tenders for carrying out an extension of underground and pilot cables drawn into existing spareways, and for the laying of private and public lighting cables, together with all necessary roadwork, junction boxes, etc. Specifications, etc., may be obtained from Mr. W. Kay, clerk to the Council. Tenders by 12 noon on the 19th proximo. See advertisement.

Bristol.—The Electrical Committee invite tenders for h.t. switchgear, water-tube boilers, two 1,000-kw. three-phase extra high-tension turbo-alternators, two 500-kw. induction-type motor-generators, e.h.t. to d.c., e.h.t. cables, e.h.t. transformers, e.h.t. switchgear. Specifications, etc., can be obtained from Mr. H. Faraday Proctor, city electrical engineer. Tenders by 10 a.m. on July 15. See advertisement.

Hastings.—The Corporation invite tenders for the supply for their electric light works of about 2,500 tons of best Welsh smokeless steam coal, either Glassbrook Merthyr, smokeless unscreened large coal, Bwllfa No. 1 large smokeless, or Nixon's Navigation large coal, to be delivered within ensuing 12 months. Specifications may be obtained from the Borough Electrical Engineer, Electric Light Works. Tenders by 12 noon on July 5.

Warrington.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, trolley wires, etc., forming complete overhead equipment for about 550 yards of double track, including special arrangements at the swingbridge over the Manchester Ship Canal. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by 12 noon on July 12.

Handsworth.—The Urban District Council invite tenders for the supply and delivery of the following in connection with the electric lighting: (4) water-tube boilers; (5) engines and dynamos; (6) overhead hand travelling crane; (7) storage battery; (8) arc lamps and posts; (9) switchboard and boosters. Specifications, etc., can be obtained from Mr. H. Ward, The Council House, Handsworth, near Birmingham. Tenders by July 11.

Derby.—The Corporation invite tenders for the making, erecting, setting to work, and maintaining in good order for twelve months on the site of the intended pumping station, of various machinery, including an electric light installation, consisting of compound high-speed engine and dynamo and sundry fittings, etc. Specifications, etc., may be obtained at the office of Messrs. James Mansergh and Sons 5, Victoria-street, Westminster. Tenders by noon on July 13.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the Electricity Works, Rochdale, Lancashire, of two steam turbines direct connected to two 3-phase alternators, or alternatively for alternators connected to high-speed triple-expansion engines (Contract No. 7); and also for one motor-driven 3-phase alternator (Contract No. 8). Specifications, etc., may be obtained at the offices of Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster. Tenders by July 18. See advertisement.

St. Marylebone.—The Borough Council invite tenders for supply and erection of constructional steelwork and buildings for their generating station in Richmond-street, Maida Vale, W.; also for steam generating plant, steam turbines, electrical generating plant and cables. Specifications, etc., for constructional steelwork, steam and electrical generating plant and cables, can be obtained at the offices of Mr. Arthur Wright, 30, Moorgate-street, E.C.; and for the buildings from Mr. H. T. A. Chidgey, architect, Charing Cross-chambers, Duke-street, W.C. Tenders before 12 noon on July 6.

Greenwich.—The London County Council invite tenders for the supply, delivery, and erection of three 3-ton electric travelling jib cranes and two electric locomotives upon the wharf of the electricity generating station now being erected by the Council at Greenwich. The jib cranes will be operated by three-phase alternating currents, and the locomotives by direct current. Certain parts of the locomotives—viz., the motors, controllers, wheels, and axles—will be delivered to the contractor by the Council. Specifications, etc., may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on July 12.

Reichenberg (Austria Hungary).—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

RESULTS OF TENDERS.

Worksop.—The tender of Scott and Mountain has been accepted or repairs to machinery at £47.

Brighouse.—The Corporation have accepted the tender of W. T. Glover and Co., Manchester, for laying cables in the borough.

Melton Mowbray.—The Urban District Council have accepted the tender of the Electric Light Company, at £325 per annum, for street-lighting for a term of five years.

Cardiff.—The tender of Merrilees, Watson, and Co., Glasgow, at £2,127, has been accepted for the provision of condensing plant at the Canton electric light power station.

Bristol.—The Electrical Committee have accepted the tender of R. Wilkins and Son, Bishop-street, for the construction of switchrooms at the Temple Back electricity works.

Southampton.—The Town Council have accepted the tender of J. R. Wood and Co. for the supply of small coal to the electricity works at 10s. 9d. per ton delivered, for 12 months.

Colchester.—The Corporation have accepted the tender of Marshall and Co., High-road, Leytonstone, E., for the supply and erection of the electric lighting installation at the car depôt and offices.

Stretford (Lancs.).—The Urban District Council have accepted the tender of the Lancashire Dynamo Motor Company, Trafford Park, Manchester, at £2,663, for a 400-kw. set with Belliss and Morcom engine.

Cooling Towers.—Matthews and Yates, Limited, Cyclone Works, Swinton, Manchester, report orders for 9ft. fans from Donat and Co., of Manchester (for the Preston Corporation towers), and from the Klein Engineering Company, Limited (for Calcutta).

London, N.—The tender of C. Ford, Willesden Junction, at nearly £25,000, for power and generating station at Brimsdown, Ponders End, Middlesex, and £30,000 for car-sheds, sub-stations, offices, battery-rooms, etc., in the parishes of Wood Green and Finchley, has been accepted.

London, N.—The Middlesex County Council have accepted the tender of C. Ford, Willesden Junction, at £21,351, for construction of railways No. 16 and 17, including two lines of double tracks, with crossovers and contingent road works, etc., through the grounds of the Alexandra Palace, Hornsey, and Wood Green.

East Barnet Valley.—The Urban District Council have received the following tenders for telephones connecting the police station, fire-station, call boys' residence (East Barnet-road), and captain's residence (Station-road): National Telephone Company, £14 per annum; General Post Office, £13 per annum (accepted).

Bray.—The Urban District Council have received the following tenders for scrap iron at electric light works: Louis Clein, at 28s. per ton mixed metal, 8s. per cwt. old lead, and 3½d. per lb. for copper; McGowan Bros., 38s. per ton iron and metal (accepted); A. Finlay and Co., £5. 10s. for lot; Tonge and Taggart, £5. 10s. for lot.

Switchboards.—Cowans Limited, 82, Victoria-street, S.W., report the following contracts: Ealing—H.T. feeder-board and extension to generator-board; Aston—extra H.T. main switchboard; Cardiff—main L.T. switchboard; Bristol—arc-lighting switchboard; Royal Courts of Justice—main switchboard; Poplar—L.T. switchboards for motor-generators, etc.; Fife—extra H.T. main switchboard.

Belfast.—The Electricity Committee have accepted the following tenders: Lancashire Dynamo Motor Company, for 5 and 7½ h.p. motors; Electromotors, Limited, ½, 1, and 4 h.p. motors; Bruce Peebles and Co., 2, 10, 15, and 25 h.p. motors; British Westinghouse Electric and Manufacturing Company, 3 h.p. motors; Fairbairn, Lawson, Combe, Barbour, Limited, pipework; and M'Dowell, Leathem, and Fraser, gangways.

Hammersmith.—The Council have received the following tenders for two slow speed generating sets, without condensers:

Siemens Bros. and Co., Cole-Marchant-Morley engine (five alternatives)	£20,525
Cole, Marchant, and Morley, E.C.C. alternator	21,026
Electrical Company, Musgrave engine (no condensers)	21,787
British Westinghouse Company, Musgrave engine, Westinghouse alternator (94 revs. per minute)	21,890
Dick, Kerr, and Co., Musgrave engine (one alternative)	22,194
General Electric Company (less £2 106 for condensing plant)	22,458
Wallsend Slipway Company, Musgrave engine, G.E.C. alternator	22,710
Mather and Platt, Wallsend engine	22,864
Electric Construction Co. (less £2,430 for condensing plant)	23 355
Combe, Barbour, and Co., Mather and Platt alternator	24,231
Witting, Eborall, and Co. (less £2,070 for condensing plant)	25,270
Musgrave and Co., Musgrave engine, Siemens alternator (including £2,277 for condensing plant, three alternatives)	25 628
D. Stewart and Co. (incomplete)	25,899
Labmeyer Electric Company, Musgrave engine (including £2,311 for condensing plant)	25,266

For steam turbines.

	Two turbines.	Condenser plant.	Exciters.
Willans and Robinson	£12,008	£2,446	£1,046
Ditto	12,008	3,104	1,046
Bruce Peebles and Co.	12 838	2,416	965
Siemens Bros. and Co.	13,155	2,492	1,031
Howdens	13,500	2,500	1,130
Richardson, Westgarth, and Co.	14 540	3 200	967
British Thomson-Houston Co.	14,545	2 072	740
Ditto (alternative)	14,545	2 814	740
Ditto (alternative)	14,545	3 251	740
Brush Company	15,000	2,110	619
C. A. Parsons and Co.	15,050	2,416	890
British Westinghouse Co.	15,186	2,512	772

Accepted tenders: Richardson, Westgarth, and Co., one turbo-generator £7,270, two condensers £3,200; British Thomson-Houston Company, one turbo-generator £7,272. 10s., exciter plant £740.

Wigan.—The Corporation have received the following tenders for 12 bogie cars, single-deck, two-motor equipment: British Westinghouse Manufacturing Company, Manchester (accepted); Dick, Kerr, and Co., Preston; Hurst, Nelson, and Co., Glasgow; British Thomson-Houston

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Company, Rugby; Brush Electrical Engineering Company, Loughborough; Witting, Eborall, and Co., London; International Electric Company, London.

Chesterfield.—The Town Council have accepted the following tenders: British Insulated and Helsby Cables, Limited, at £41,257. 15s 4d., to completely equip the permanent way, overhead electric lines, underground feeders, etc., of the 3½ miles of tramways sanctioned by the new Improvement Act; British Westinghouse Company, at £2,640, to electrically equip the cars; Brush Electrical Engineering Company, at £3,960, to supply the necessary car bodies.

Exeter.—The following tenders have been received for the tramways:

No. 1.—Permanent way, paving, and bonding.

				Old material.		
Acme Flooring and Paving Company	£28 143	18	4	£251	0	0
Dick, Kerr, and Co. (accepted)	29,225	5	2	376	16	4
W. Underwood and Bro.	30,885	11	3	465	0	0
W. C. Shaddock	31,197	19	6	150	0	0
J. Brunton	31,778	0	0	380	0	0
W. Griffiths and Co.	31 557	14	9	265	0	0
J. G. White and Co.	31,624	12	3	232	13	10
G. Wimpey and Co.	31,626	1	2	241	0	0
R. W. Blackwell and Co.	31,722	15	8	439	12	5
A. Krauss and Son	31,156	17	8	373	0	0
E. Nuttall and Co.	32 679	14	11	314	0	5
Willey and Co.	32 888	0	0	373	0	0
British Westinghouse Company	32,888	4	3	373	16	3
G. Law	33,112	14	1	433	0	0
G. Taylor	33,125	15	6	376	16	4
J. Dickson	34 173	4	11	340	0	0
R. C. Brebner and Co.	34,595	8	5	492	6	6
Pethick Bros.	35 159	9	11	240	9	11
Macartney, McElroy, and Co.	36,882	19	3	250	0	0
J. and W. S. Briscoe	40,627	8	4	377	0	0
T. Doney	45,168	8	7	125	0	0

No. 2.—Overhead equipment.

British Thomson-Houston, Spencer poles, weight 877/1275, Brooklyn strains 7,500, £3,180. 5s. 3d., circular bases 18s. 6d., oval bases £1. 8s. 6d., rosettes £2. 15s., side guard wires £2. 18s., centre guard wires £5. 17s. 6d., rosettes £3. 2s. 6d.

R. W. Blackwell and Co., Spencer or Stewart and Lloyds poles, weight 730/1100, Brooklyn strains 16,641, £3,286. 0s. 2d., circular bases £1. 1s. 10d., oval bases £3 5s. and £3. 15s., rosettes £4. 5s. 10d., side guard wires £3. 6s. 3d., centre guard wires £4. 6s. 3d., rosettes £7. 2s. 1d.

Brush Company, Spencer poles, weight 870/1270, Brooklyn strains 7,000, £3,305. 12s. 4d., circular bases £1, oval bases £3, rosettes £2. 10s., side guard wires £2. 10s., centre guard wires £2. 10s., rosettes £2. 10s.

Griffiths (no particulars), £3,387. 15s. 6d., circular bases £1, oval bases £3, rosettes £2. 10s., side guard wires £2. 10s., centre guard wires £2. 10s., rosettes £2. 10s.

J. G. White and Co., Spencer poles, weight 820.1230, Brooklyn strains 4,480 (?), £3 437. 7s. 7d., circular bases 18s. 6d., oval bases £1. 15s., rosettes £4. 6s. 4d., side guard wires £2. 13s. 9d., centre guard wires £3. 19s., rosettes £11. 9s.

British Electric Equipment Company, Spencer poles, weight 877/1275, £3,511. 4s. 8d., circular bases £1. 8s. 8d., oval bases £6. 1s., rosettes £4. 10s. 8d., side guard wires £2. 16s. 3d., centre guard wires £5. 5s. 6d., rosettes £7. 12s.

Law, Spencer poles, weight 877/1275, £3,511. 4s. 8d., circular bases £1. 8s. 8d., oval bases £6. 1s., rosettes £4. 10s. 8d., side guard wires £2. 16s. 3d., centre guard wires £5. 5s. 6d., rosettes £7. 12s.

Dick, Kerr, and Co., approved poles, weight 877/1275, approved strains, £3,641. 5s. 5d., circular bases £1. 1s., oval bases £3, rosettes £3. 19s., side guard wires £3, centre guard wires £4. 7s. 9d., rosettes £4. 7s. 9d. (accepted).

British Insulated Wire Company, Spencer poles, weight 877/1275, Brooklyn strains 5,500, £3,659. 9s. 10d., circular bases £1. 2s. 9d., oval bases £3 2s. 6d., rosettes £3. 7s. 2d., side guard wires £3, centre guard wires £6, rosettes £3. 12s. 6d.

British Insulated Wire Company, £3,713. 17s. 10d.

Underwoods, Spencer poles, weight 877/1275, £3,899. 17s. 6d., circular bases £2. 2s., oval bases £3. 10s. 6d., rosettes £1. 10s., side guard wires, £6, centre guard wires, £9, rosettes £7. 10s.

Macartney, McElroy, and Co., Spencer, Stewart, and Lloyd, or Russell poles, weight 877/1275, approved strains, £3,926. 16s. 4d., circular bases £1. 8s. 1d., oval bases £7. 10s., rosettes £1. 11s. 3d., side guard wires £1. 10s. 4d., centre guard wires £3. 2s. 6d., rosettes £1. 17s. 6d.

Willey and Co., approved British poles, weight 877/1275, approved strains, £4,053, circular bases £1. 7s. 6d., oval bases £3. 10s., rosettes £3. 10s., side guards wires £1. 10s., centre guard wires £4, rosettes £3. 10s.

British Westinghouse Company (see Willey and Co.'s tender), £4,294. 5s. 6d., circular bases £1. 8s. 6d., oval bases £3. 13s. 6d., rosettes £3. 13s. 6d., side guard wires £1. 11s. 6d., centre guard wires £4. 4s., rosettes £3 13s. 6d.

Hill and Co., weight 877/1275, Brooklyn strains 8,000, £4,515. 14s. 2½d., circular bases £1. 6s. 6d., oval bases £5. 12s. 6d., rosettes £3. 2s. 6d., side guard wires £1. 10s., centre guard wires £3, rosettes £2. 10s.

No. 3.—Feeder Cables, etc.

Western Electric Company, di-electric paper, ducts fibre, £2,695. 1s. 4d., maintenance rate 1 per cent. on £1,662. 5s. 6d., time required six weeks.

Western Electric Company, di-electric paper, ducts Suttons, £2,716. 10s. 6d.

British Electric Equipment Company, di-electric and ducts (maker not given), £2,749. 12s. 10d., maintenance rate 2 p.c. on invoice price.

St. Helen's Cable Company, di-electric paper, ducts Stanley, £2,756. 15s. 11d., maintenance rate 2 p.c. on £1,650, time required 12 weeks, arbitration clause essential.

St. Helen's Cable Company, di-electric dialite without lead, £2,582. 16s. 4d., not to specification.

J. G. White and Co., di-electric paper, ducts Suttons, £2,841. 16s., maintenance rate 1 per cent. on £1,750, time required three months.

Siemens Bros., di-electric paper, ducts Suttons, £2,860. 14s 8d., maintenance rate 1 per cent. on £1,783. 8s. 10d., time required four months, arbitration clause suggested.

Dick, Kerr, and Co., di-electric paper, ducts Suttons, £2,897. 12s. 10d., maintenance rate 1½ per cent. on £1,810. 4s., time required three months (accepted).

British Insulated and Helsby Cable Company, di-electric paper, ducts Suttons, £2,917. 6s. 7d., maintenance rate, 1½ per cent. on £1,765, time required 14 weeks, arbitration clause asked for.

British Insulated and Helsby Cable Company, di-electric paper, ducts fibre, £2,878. 7s. 5d., prices subject to rise of metal.

W. T. Glover and Co., di-electric diatrice paper, ducts approved, £2,948. 6s. 8d., 1½ per cent. on total invoice value of contract, time required four months, arbitration clause asked for.

W. T. Glover and Co., ducts fibre, £2,894. 11s. 8d., arbitration clause asked for.

Underwood, di-electric paper (Siemens), ducts Suttons, £2,970. 19s. 10d., maintenance rate 1 per cent. on £1,950, time required six months, arbitration clause asked for.

W. T. Henley's Works, di-electric paper, ducts Albion clay, £2,973. 18s. 10d., maintenance rate 1½ per cent. on £1 973. 18s. 10d., time required 12 weeks, forms of tender not filled in or signed.

Willey and Co. (see Westinghouse tender), £3,009.

British Westinghouse Company, di-electric paper, ducts approved British make, £3,009. 5s. 11d., maintenance rate 1 per cent. on £1,783. 10s., specified time.

Callender's Cable Company, di-electric paper, ducts Albion clay or Doulton, £3,059. 18s., maintenance rate 5 per cent. on total price, time required four months or less, arbitration and electrolysis clauses.

Griffiths Bros., di-electric (as Callender's), £3 059. 18s., maintenance rate 5 per cent. as above, time required four months, conditional on acceptance of tender for contract No. 1.

Johnson and Phillips, di-electric paper (no Sutton's bitumen), £3.211. 19s. 11d., first year 1½ per cent. on £1,660, second year 2½ per cent., after 5 per cent., time required four months.

Macartney, McElroy, and Co., di-electric, Johnson's, Phillips, Glover, or other approved, £3,630. 19s. 3d., maintenance rate 1½ per cent. on £2,973. 18s. 10d.

No. 4.—Double-Decked Motorcars.

Willey and Co. (particulars as per Westinghouse tender), £6,701.

British Westinghouse Company, car bodies Electric Railway and Tramway Car Works or Brush, trucks Brill £52. 6s., Brush £52s. 6s., Peckham £52. 6s., motors Westinghouse No. 46, controllers 9 O.M., notches 8 power, 7 brake, £6 701. 17s. 7d., extra for steel tyres £126, extra for magnetic brakes £384 (Newell), extras—folding steps "Leicester" type £96. 12s., E. R. and T. C. Works type £55. 4s.

Fisher Bros., car bodies Plymouth Wagon Works, trucks Brill 21E £64, Peckham £80 motors B.T.H., controllors B.T.H., notches 8 power, 5 brake, £6 738. 11s., extra for steel tyres £72, extra for magnetic brakes £720 (?). Rates and details omitted. Body has reversed stairway, which is not in accordance with specification.

Dick, Kerr, and Co., car bodies Dick, Kerr, trucks Brill 21E only, motors DK 6A, controllers DB 1E, notches 7 power, 5 brake, £6,933. 16s. 8d., extra for steel tyres £114, extra for magnetic brakes £360 (?) Motor details incomplete. Steel tyred wheels 31½in. (accepted).

Brush Electric Engineering Company, car bodies Brush, trucks Brush, Brill interchangeable with Brill 21E £50, £7,176, extra for steel tyres £108, extra for magnetic brakes £300 B.T.H., £480 Newell. Extra for B.T.H. equipment £144.

Witting, Eborall and Co., car bodies Brush, trucks Brill 21E £71 10s., Brush £69, motors W and E. T 1 V (and 1850 DBP), controllers own type magnetic blow out, notches 5 brake, £7,361, extra for steel tyres £108. One-set Commutator tools and spanners £7.

British Thomson-Houston Company, car bodies Brush, trucks Brill £64, Brush £55. 10s., motors GE 58/6 turn (1540 DBP), controllers B 18, notches 2 running, 6 resistance, 6 brake, £7 386. 11s. 6d., extra for steel tyres £108, extra for magnetic brake £225 (B.T.H.) on Brill trucks, £276 (B.T.H.) on Brush trucks. Do not recommend electric skotch.

J. G. White and Co., car bodies Dick, Kerr, trucks Brill £64 only, motors Dick-Kerr Equipment, £7 482. 2s. 5d., extra for steel tyres £120, extra for magnetic brakes £336 (B.T.H.).

Parliament.—The following Bills have been read a third time in the House of Lords: Bristol Tramways (Extension), Baker-street and Waterloo Railway, Manchester Corporation Tramways, L. and N.W. Railway, Harrow-road and Paddington Tramways. In the House of Commons, Lancashire Electric Power. The Duke of Northumberland's Committee have refused to allow the Doncaster Corporation to extend their area, and have struck out the electricity portion of the Bill altogether. The preamble has been found proved of the Electric Lighting of London Bill, in which the Board of Trade seek to adjust the area of supply for electricity of the various local authorities and companies in London.

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BUSINESS NOTES.

TRACTION.

Leeds.—A further conference is to be held with the employés on the question of "split turns."

Bury, Rochdale, and Oldham Tramways.—The arbitration proceedings have been completed.

Glasgow Tramway and Omnibus Co.—The reconstruction of this concern has been decided upon.

Blackpool.—The latest returns of the Corporation tramways show substantial increases over last year.

Preston.—Further branches of the tramways will be inspected by the Board of Trade in a day or two.

Wicklow.—An enquiry has been held by the Board of Works into the tramway proposed by Lord Fitzwilliam.

Harrow and Uxbridge Railway.—This new line was formally opened yesterday, and will be ready for traffic on Monday.

Wigan.—Rapid progress is being made in the laying of the broad gauge lines on the Platt Bridge route of the Wigan Corporation tramway system.

Chesterfield.—A special meeting has been convened to consider tenders for the electrification of the tramways and an extension to Whittington Moor.

Harrogate.—The National Telephone Company has withdrawn its opposition to the passing of the Harrogate Tramroads Bill through committee of the House of Commons.

Poole.—Further evidence has been taken in connection with the arbitration between the company and the Bournemouth Corporation in relation to the sale of the company's undertaking.

Bury.—Work on the Manchester-road section is being pushed on very rapidly, and there is a good prospect of the reconstruction being carried out considerably earlier than was expected.

Erith.—A proposition that the tramway scheme should not be proceeded with, owing to industrial depression, was defeated by a large majority, only the mover and seconder voting for it.

Metropolitan Electric Tramways, Limited.—The electrification of these tramways is now approaching completion. It is expected that the Board of Trade inspection will take place in a few days.

Southend.—The tram receipts during the last three months show an increase of almost 2d. per car mile over the receipts for the corresponding period last year, and 64,094 more passengers were carried.

Bills in Parliament.—In the House of Lords the following Bills have been read a third time: Bristol Tramways (Extension), Baker-street and Waterloo Railway, and Manchester Corporation Tramways.

Dundee.—At a meeting of the Tramways Committee the engineer was asked to bring forward his scheme for motive power charges at a future date, giving the members fuller details and longer time to consider the matter.

Portsmouth.—Some of the cars have been fitted with small brushes fixed on the truck between the wheels so that they just touch the lines and sweep away the dust which collects in windy weather, the collection of dust having given considerable trouble.

Leicester.—The traffic returns having exceeded expectations, the Tramways Committee recommend that an order be placed with Messrs. Dick, Kerr, and Co. for 40 additional cars at £510 each. Additional shed and office accommodation is also required.

Pontypridd.—The District Council have accepted the tender of the British Thomson-Houston Company for the supply of tramcars, and in the event of Milne bodies and trucks being unobtainable, Brush car bodies and Brill trucks are to be substituted for them.

Rochford.—The District Council have approved the plans of the generating station and car-shed for the Canvey Island tramway, but have deferred their consent to the plan of the track, as further details are required, the track crossing the Council's road near Leigh Beck.

Cape Electric Tramways Co.—An interim dividend of 5 per cent., free of income tax, has been declared, payable to shareholders registered on July 6 and to the holders of Coupon No. 7 attached to warrants to bearer. The transfer register will be closed from July 6 to July 12 inclusive.

Southampton.—At the last meeting of the Council it was stated that there was a slight improvement in the traffic on the Hampton Park section during the fine weather, and that the committee had decided to continue to run the cars there in the hope that the improvement would be maintained.

Llanelly.—The long-deferred scheme of electric traction was discussed at a committee of the Borough Council last Friday. It was decided to appoint a deputation, consisting of the chairman and the vice-chairman, to wait upon the wire company to see what the intentions of the latter were.

Bradford.—At the meeting of the Tramways Committee on Monday a deputation of ratepayers from Bolton Woods and Windhill attended for the purpose of urging upon the committee the necessity of the construction of a tramway route along Canal-road. The committee promised to consider the matter.

Proposed Light Railway.—Public meetings have been held at which resolutions were passed in support of the construction of a light railway from Haverfordwest to St. David's. A similar proposition was made some time ago. The length of the proposed service is about 26 miles, and the estimated cost £130,000.

Cleckheaton.—At a meeting of the General Purposes Committee of the District Council a letter was read from the Board of Trade stating that an order had been forwarded to the Electric Traction Company extending until June 22, 1905, the time for completing the railways authorised by the Spen Valley Light Railways (Extension) Order, 1901.

Shipley.—Complaints have been made to the District Council of the inconvenience caused by the discontinuance of the through service from Thackley to Nab Wood. It appears, however, that this method of working the Shipley traffic does not pay, but a quick and cheap through service from Shipley to Bradford has been provided.

Exeter.—The City Council have awarded the contract for the electric tramways to Messrs. Dick, Kerr, and Co., whose tender was £42,055. The work will commence at once. The first section of the line will be laid throughout the main streets, and the total length is 5½ miles. It is hoped to have the work completed by November.

Christchurch (New Zealand).—The New Zealand Electrical Construction Company, Christchurch, have received intimation that the first shipment of rails for the electric tramways for this city will be shipped from New York in May, and should arrive there about the third week in July, when a start will be made with the laying of the rails.

Birmingham.—The Birmingham Tramways Company have adopted a method for inducing their employés to deal expeditiously with breakages of electric wires. The men on the electric cars have been trained to remedy defects of this kind, prizes being offered every three months. The record in quick time is credited to a man who satisfactorily mended such a breakage in 16 seconds.

Camberwell.—The Borough Council having received from the Board of Trade a copy of Colonel Yorke's report upon the London, Camberwell, and Dulwich tramlines, recommending that they be removed in the interests of public safety, as they had deteriorated so much as to be useless, a recommendation was submitted at Wednesday's meeting of the Council that the Board of Trade be asked to sanction the removal of the lines.

Blaydon.—The Parliamentary Committee of the Whickham Council and a committee of the Blaydon Council have decided to ask the County of Durham Electrical Power Distribution Company to meet the two committees at Blaydon for the purpose of discussing the possibility of establishing a tram service from Dunston to Blaydon. Plans have been prepared by the surveyor to each Council showing the proposed route for such a service.

Beckenham.—The British Electric Traction Company have written to the Urban District Council suggesting that, owing to the lack of unanimity in regard to the tramways proposed to be constructed through the district, the agreement between the company and the Council providing for the construction and leasing of the lines should be cancelled. A motion to this effect was submitted at the last meeting of the Council, but was defeated by one vote.

Wolverhampton.—Colonel Yorke, on behalf of the Board of Trade, inspected the new tramway section constructed from the centre of the town to Heath Town, a distance of 1½ miles, on the 22nd ult. He was so satisfied with the way the work was done and the smooth running of the cars that he passed it for traffic at once. The section is on the Lorain surface system. A quick service of cars was then put on the line, and during the evening 1,400 passengers were carried.

Ayr.—Intimation has reached Ayr from London that at the hearing of the application of the Ayr Corporation in connection with the proposed tramways order the chairman, after discussion, decided that the general orders are not to be dispensed with in respect of tramways Nos. 1, 2, 3, and 4, and the promoters not having complied with these the numbers referred to have been struck out. This means that the proposed extension from Prestwick Cross to Monkton has been disallowed.

Salford.—The Corporation have commenced the work of relaying the lines between the Unsworth boundary and the present terminus of their system at Whitefield railway station. When this is completed the lines will be laid down Radcliffe New-road as far as Dales-lane, where Radcliffe will eventually be coupled up, and then the men will be transferred to Besses, where they will commence work on Bury Old-road and connect the existing system with the Cheetham Hill and Heaton Park lines.

Batheaston.—At its last meeting the Somerset County Council considered an application from the Bath Electric Tramways Company for leave to construct a new loop line at Batheaston, and several petitions against it. It was decided to refuse consent. With reference to the extension of the Bristol tramways, the County Works Committee recommended that a special committee be appointed to confer with the county surveyor and take such action as they might deem necessary as the roads in Long Ashton and Keynsham were likely to be seriously affected by the scheme.

Southport and Lytham Tramways.—The Southport and Lytham Tramway (Extension of Time) Bill, to secure an extension of the time allowed for the construction of the tramway until 1907, came before a committee of the House of Commons as an unopposed Bill. It was stated that all the land required had now been obtained by the company, and the capital for the first portion of the work had been raised. The promoters were now proposing to carry out the scheme forthwith. The Southport Corporation consented to the proposals of the company. The Bill was ordered to be reported for third reading.

Hanley.—Residents have petitioned the Council to bring pressure to bear upon the Potteries Electric Traction Company, Limited, to extend their line now in course of construction to Providence-square. The Council will recommend the company to extend the line to the borough boundary. At a meeting of the General Purposes Committee a letter was read from the secretary of the company stating that he would submit the suggestion from the Council in regard to contract tickets at the next meeting of the Board, but it was improbable that the request could be granted, as the fares were already very low.

Sheffield.—The receipts for the quarter just ended amounted to £60,336, 19s. 9½d. Although this is not the largest amount yet

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received—it is nearly £1,000 less than the total for the third quarter last year—it is satisfactory to note that the decline recorded in the last quarter of 1903 and the first quarter of this year has been checked. The income for the 13 weeks is over £5,000 more than the quarter ended March 31 this year, and £3,000 increase over the takings for the corresponding quarter last year. The takings during Whit week were over £5,000, and the average per week for the quarter was nearly £4,642.

Tottenham.—In connection with the approaching service of electric cars in the populous districts of Tottenham, Wood Green, and Edmonton, it is interesting to note that the power by which the cars will be worked is transmitted over a great distance from the modern power station recently erected by the North Metropolitan Electric Power Supply Company on the banks of the River Lea at Brimsdown, Enfield. The pressure adopted is 11,000 volts at Brimsdown. The energy is conveyed by a duplicate system of high-tension mains laid underground, which are tested up to 20,000 volts. This is reduced at various sub-stations in the tramway area to 500 volts continuous current. The pressure transmission is presumably the highest in this country for tramway purposes.

Tarporley Light Railway.—At the meeting of the Northwich Rural Council a letter was received from the County Council stating that the plans of the proposed Tarporley light railway had received the consideration of the county surveyor, who had reported to the Main Road and Bridges Committee that they did not effect any main roads either in the urban or rural districts. The surveyor pointed out, however, that the plans contemplated raising the level of the highway between Delamere and Winsford, so as to make the gradient of approaches 1 in 20. As that highway was of some considerable importance, the county surveyor suggested that such approaches should not be of less gradient than 1 in 30, and should have a width between the fences and the bridge of 36ft. The Northwich Council have referred the matter to their Highways Committee.

Dewsbury and Ossett.—The approval by the Select Committee of the House of Lords of the tramway schemes promoted by the Corporations of Dewsbury and Ossett and the Soothill Nether District Council has given great satisfaction to the residents in the districts concerned. With the exception of Soothill and Ossett, all the townships in this district are now connected by tramways. Two years ago the Wakefield District Light Railways Company sought powers to construct a line from Wakefield to Dewsbury along the main road. This scheme was rejected, but the company obtained powers to make a line to Ossett from Wakefield *vid* Horbury. A second effort was made last year to secure running powers into Dewsbury, but it was not successful. The Dewsbury and Ossett Corporations and the Soothill Nether District Council then took the question up, and decided to apply for powers to carry out a joint undertaking.

Belfast.—An enquiry was submitted to the Chief Secretary for Ireland as to whether his attention had been called to a meeting of the Law Committee of the Belfast City Council with representatives of the Belfast and County Down Railway Company, with regard to the Belfast Tramway Bill now before Parliament, at which an agreement was arrived at which, if carried out, will place a monopoly of the passenger traffic of an extended area on the County Down side of Belfast in the hands of the County Down Railway Company, and prevent that whole district from being opened up by the Belfast City Council's tramways; and if so whether, in view of the principles involved in this arrangement, he would take steps to secure its exclusion from the Bill when it comes before the House of Commons for further consideration. Mr. Wyndham replied that the Bill was a private one, not calling for the intervention of the Government.

Bath.—A report was presented at the last meeting of the Town Council in connection with the widening at Odd Down necessitated by the electric tramway route. Having been unable by agreement to obtain possession of the land required by them on satisfactory terms, the tramway company had deposited £292. 6s. (the sum named by a Board of Trade valuer). The company having also given the necessary bond, the land had been pegged out, and the work necessary for the widening of the road commenced. A dispute having arisen as to the nature of the fence to be erected, the Board of Trade had appointed Colonel Sir Colin Scott Moncrieff, R.E., to arbitrate upon the question. Subsequently the owner expressed his willingness to accept a payment of £150 towards the cost of erection of the fence, leaving him to erect the fence at his own expense and to his own satisfaction. The hope was expressed that the matter would be arranged amicably, so as to avoid litigation.

Metropolitan District Railway.—The omnibus Bill promoted by the Metropolitan District Railway came before a Select Committee of the House of Commons on Wednesday. The Bill has already passed the House of Lords. Mr. Freeman, K.C., stated that the Bill asked for an extension of time until 1908 for the completion of the deep-level line between Earl's Court and the Mansion House. Until the completion of the electrification of the District Railway it would be difficult to know exactly what would be the effect on the deep-level line. With regard to the application of the London County Council for the provision of workmen's trains on the new line, Mr. Freeman said that the deep-level line was not calculated or intended to convey workmen; it was for running an express service with few stoppages. The Bill further proposes a revision of fares, the zone system being desired. It is also proposed to restrict the amount of luggage to be allowed each passenger to 28lb. The Bill is opposed by the London County Council and the Fulham Borough Council.

Wellington (New Zealand).—The contractors for the construction of the Wellington tramways (Messrs. M'Elroy, Macartney, and Co.) have received a demand from the Government for the payment of 1s. per cent. upon the capital of the company. The tax is being made upon all persons or firms from outside the colony entering upon a contract to do certain works in New Zealand. The *New Zealand Times* states that there is a probability of the claim being contested on the ground that the New Zealand Government is levying the tax on the whole capital of the company, including that part employed in the progress of works at Durban, Malta, and other parts of the world. This, they claim, does not represent the standing capital of the company, and it is not a fair computation upon which to base such a claim. All the papers in connection with the demand have been forwarded to the head office of the firm in London for their decision. It is understood the contractors for the Auckland tramways (Messrs. White and Co.) are also making a request for a readjustment of their claim on similar grounds.

Norwich.—At its last meeting the Town Council considered the recommendation of the General Purposes Committee that the vacant land at Orford-place be purchased from the New General Traction Company, Limited, and the Norwich Electric Tramways Company for £2,000, the Corporation consenting to the company advertising on the tramway cars during the unexpired portion of the term of 50 years specified in Section 40 of the Norwich Electric Tramways Act, 1897, the Norwich Electric Tramways Company paying to the Corporation 25 per cent. of the gross receipts receivable in respect of such advertisements up to £600, and half of any such gross receipts over and above £600. In the event of the Corporation desiring to purchase the undertaking of the Norwich Electric Tramways Company, on giving notice of such of their intention, the receipts in respect of advertisements are not to be taken into account in ascertaining the then value of the undertaking. An amendment was moved that the term of the arrangement in regard to advertising should be restricted to 10 years, and subject to this the proposition was adopted.

Tipton.—At the meeting of the District Council a letter was read from the South Staffordshire Tramway (Lessee) Company stating that they had received a report from their mining engineer in reference to the subsidences of the road from Dudley to Wednesbury, which was of an unfavourable character. They called attention to the fact that when the Bloomfield Ironworks were offered for sale reference was made to the mining rights, and that if the new owners availed themselves of these rights further subsidences would take place. In the event of the electrification of the line being proceeded with, the deflections of the line would cause a leakage of electricity at the joints. Under the circumstances, the directors of the company were not able to proceed with the electrification of the line as requested by the committee. A further communication was received from the company inviting a deputation from the public authorities concerned to meet representatives of the company at Birmingham. The opinion was expressed that the company were endeavouring to evade their responsibilities, and it was resolved to take immediate action for a conference between the local authorities.

Aston.—The official inspection of the first completed length of the Aston tramways from the city boundary to Aston Cross was held on the 22nd ult. by Colonel Yorke on behalf of the Board of Trade. There were also present Mr. Trotter, electrical expert to the Board of Trade; the Mayor of Aston; Mr. Ballard, borough electrical engineer; Mr. Robert Green, consulting tramway engineer to the Council, and many others. The City of Birmingham Tramways Company was represented by Messrs. Connaty, Barling, R. H. Dickinson, and Pinkerton. A special car had been provided for the trial trip, and the inspection passed off without a hitch of any sort. On the following day an inspection was held of the Cotteridge section, which is leased to the British Electric Traction Company. From the point whence it leaves the Bristol-road line to the terminus, the new branch measures three miles, and is a single line with occasional loop crossings. Provision is made at the depôt for eight cars, and the total cost of constructing the line has been between £30,000 and £40,000. The lease granted to the company will expire at the same time as that for the Bristol-road route in 1911. The trial trip passed off smoothly, and Colonel Yorke expressed his satisfaction with the arrangements generally.

North-Eastern Railway.—Commencing to-day, a complete service of electric trains is to be run on the 37 miles of railway in the neighbourhood of Newcastle, upon the conversion of which from steam to electric traction the North-Eastern Railway Company have been engaged for the past 18 months. Sir George Gibb has thus fulfilled the promise he gave when the first section of these lines was opened for electric working that the whole work should be completed by June 30. In the time-tables of the company for July to September, which have just been published, 4½ pages are occupied by the electric trains. There is to be a circular service running every half hour between Newcastle (Central) and Newcastle (New Bridge-street) *via* Wallsend, Tynemouth, and Monkseaton, in addition to the local services between the Central Station, Newcastle, and Monkseaton, and between Benton and New Bridge-street, Newcastle. Then hourly trains are to be run by electricity between Newcastle (Central) and Tynemouth over the Riverside branch, and, further, there is to be a service of express electric trains between Newcastle and Monkseaton, Whitley Bay, and Tynemouth *via* Backworth, covering the journey to the coast in 20 minutes. Doubtless the trains will be made more frequent as matters progress. The electrification has been accomplished with a celerity that reflects great credit upon the company and the contractors.

Newcastle.—A deputation consisting of the members for Newcastle-on-Tyne and several parliamentary friends who support their views had an interview with the President of the Board of Trade and Mr. Bonar Law on the inter-running question, and expressed the opinion that compulsory running powers were undesirable. Mr. Gerald Balfour made a non-committal reply, and it is understood that the Government will maintain a neutral attitude. A number of new double-decker cars have been placed on the Osborne-road and Elswick sections of the Corporation electric tramway system. The inside arrangement is altogether different from the older cars, the garden seats of the larger bogie cars being adopted. The seats are placed four single at each entrance to the car, and eight double in the body of the coach, this arrangement affording better facilities for ingress and egress. Ten

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passengers are also allowed to stand inside. Outside 34 passengers can be seated, the cars being constructed to carry 68 persons. The protecting rail round the top of the car has been raised considerably. During race week the Newcastle tramcars carried 990,067 passengers, ran 94,190 miles, and earned £4,988 in fares, the average receipts per car mile being 12·71d. These returns show an increase on the returns of race week last year of 117,602 passengers, 9,120 miles, £656 in fares, and ·49d. per car mile. A new record for one week's traffic is thus established.

Manchester.—The report for the year ended March 25 shows a total revenue of £611,881. When the last annual report (March, 1903) was presented the routes open for traffic aggregated nearly 78 miles of single track. During the past 12 months, however, an additional length of nearly 60 miles has been opened, thus bringing the aggregate length of single track to about 138 miles (137 miles 1,602 yards). The working expenses were £392,504. This left a balance which, with bank interest, make a total profit of £222,456, against £126,566 last year. A sum of £50,000 was paid in relief of the rates, £52,000 for interest on mortgage debt, £27,000 for redemption of debt, £70,000 went to reserve, renewals, and depreciation, £20,000 in rent charges, and £2 012 for street improvements round the infirmary. In the year 1903-4 the cost of electrical energy per car per mile was 1·84d., as against 1·94d. in 1902-3; and the salaries, wages of drivers, guards, and traffic staff 2·35d., as compared with 2·27d. in the previous year. The total traffic expenses were 3·41d. per car mile, against 3·53d. in 1902-3, and the total management expenses ·67d., against ·75d. Repairs and maintenance cost ·86d. per car mile, as compared with ·73d. in the previous 12 months. The total operating expenses were 6·78d. per car mile last year, compared with 6·95d. in 1902-3. The total number of passengers was 120,772,368. The average traffic revenue per car mile was 10·52d., the average traffic revenue per mile of single track £4,468, and the average total revenue per car mile 10·67d. The working expense per car mile, excluding power cost, was 4·94d., while including power cost it was 6·78d. The average fare paid per passenger was 1·2d., the average number of passengers per car mile was nine, and the average number of journeys per head of the population per annum was 161. The electrical energy used amounted to 16,815,764 units, the number of units per car mile being 1·23. The percentage of working expenses to receipts was 64. The total borrowing powers of the department stand at £1,805,500. Of this sum £1,505 668 has been taken up. The gross capital expenditure to date is £1,485,162.

Aberdeen.—The official statement of the Corporation tramway accounts has just been issued, and shows highly favourable results. The revenue amounts to £64,071. 9s. 9d., as compared with £50,986. 0s. 7d., an increase of £14,085. 9s. 2d. over the revenue of the previous year. The total is made up thus: passenger fares, £63.246. 2s. 8d., representing 15,538,167 passengers, as against 12,152,774 passengers last year; advertising on cars, £552; and rents and miscellaneous receipts, £273. 7s. 1d. The average income per mile was 11·14d. The working expenses total £38 997. 0s. 3d., compared with £27,571. 4s. 6d. last year, leaving a profit on the actual working of £25,074. 9s. 6d. to be carried to the net revenue account. The working expenses include: traffic expenses, £16,810. 11s. 7d. (2·929d. per mile); electric current, £9,626. 9s. 6d. (1·675d. per mile); maintenance and repairs, £6,677. 13s. 8d. (1·162d. per mile); general charges, £3,939. 18s. 7d. (·680d. per mile); and depreciation on cars, plant, office furniture, and buildings, £1,942. 6s. 11d. (·338d. per mile). The average working expenses per mile work out at 6·78d. The balance of £25,074d. 9s. 6d., carried to net revenue account, is disposed of thus: interest on mortgages and loans, bank interest, and commissions and stamp duty, £9,449. 13s. 11d. (last year £7,666. 8s. 8d.); amount written off preliminary and parliamentary expenses, £889. 7s. 6d. (last year, £734. 3s. 4d.); carried to credit of sinking fund, £2,396. 8s. 10d. (last year, £1,884. 5s. 2d.); carried to credit of renewal account, £8,000 (last year £8,458. 18s. 9d.); capital account written off value of buildings, £4 288. 19s. 3d. The length of the system is: double track, 11 miles 3 furlongs 114 yards; single track, 2 miles 5 furlongs 140 yards; length of street in which tramways are laid, 14 miles 1 furlong 34 yards; total length of single track, 25 miles 4 furlongs 148 yards; depôt lines, 7 yards; crossings and sidings, 151 yards. The best week was that ending July 25 last, when £1,597. 7s. 6d. was drawn, representing 356,810 passengers. In the previous year the high-water mark was reached in the week during which the Highland and Agricultural Society show was held on the Links, when £1,647 16s. 1d. was drawn, representing 380,958 passengers carried. The Corporation have resolved to run, as an experiment, a service of cars for the convenience of workmen in the early morning, the fare to be 1d. on each route, except where the ½d. rate at present exists. In order to meet the convenience of the public three cars were run on Sunday by the Suburban Tramways Company on the new route between Mannofield and Bieldside, one of them being provided with the new covered top. The service was one of 20 minutes, starting from Bieldside at 10 o'clock and stopping at 10 o'clock at night. Two of the cars were run all the way between Castle-street and Bieldside, and the third was kept between Mannofield and Bieldside, being fed by the Corporation cars. The service was popular beyond all expectation, and thousands of intending passengers could not be accommodated. A time-table will be issued by the company this week.

London County Council.—The motion, of which notice had been given, to refer to the Improvements Committee a proposal for the acquisition by the Council of Hungerford Bridge and Charing Cross railway station, and constructing a new road bridge with a double tramway line, has been withdrawn. Upon the recommendation of the Highways Committee the Council have decided to make application to Parliament in the next session for powers to enable the Council to construct tramways from the present terminus in Westminster Bridge-road across Westminster Bridge and along the Victoria-embankment, and the portion of the subway authorised by the Council's Act of 1902, from the Victoria-embankment to the north side of the Strand, with a connection between the proposed tramways and the tramways in Lambeth Palace-road. The reconstruction for electric traction of several further routes has now been completed, comprising those from the Elephant and Castle to St. George's Church and Old Kent-road several in and around Southwark, and one from Grange-road to New Kent-road. Some additional sections authorised by the Council's Act of 1901 have also been constructed, and have been certified as satisfactory by the Board of Trade. The report presented to the Council on Tuesday comments upon the disparity between the amount (£91,363) awarded by the arbitrator to the London, Deptford, and Greenwich Tramways Company, and the value of the undertaking as estimated by the Council's witnesses. The Council put the figure at £53,329. A vote of £95,000 has been made to cover the cost of acquisition. The company desire that the Council shall take over the service at as early a date as possible, and the Highways Committee recommend that they be authorised to make all necessary arrangements for this purpose. The Camberwell Borough Council have agreed to petition the House of Lords not to make any alterations in regard to tramways Nos. 4 and 10 in the County Council's Bill now before a committee of the House, the London, Camberwell, and Dulwich Tramways Company having lodged an objection to same. The County Council having enquired whether the Camberwell Borough Council would contribute a third of the cost of certain street widenings in connection with the construction of the County Council's tramway from Lordship-lane to Stuart-road, a recommendation was submitted at Wednesday's meeting of the Borough Council that the suggestion should be acquiesced in. The Council has adopted the recommendation of the Highways Committee that the underground conduit system of electrical traction, approved by the Council on Nov. 10 and Dec. 1, 1903, and on Feb. 23, 1904, for adoption for the reconstruction of the first sections of the Council's (Northern) tramways, and for the construction of certain new lines in connection therewith, be modified so as to provide for the use of a conduit slot 1in. instead of ¾in. in width. Application is being made to the Board of Trade for approval. The receipts for the four weeks ended June 18 amount to £12,488, against £8,596 last year, and for the period April 1 to June 18 the total is £130,202, against £108,071.

LIGHTING AND GENERAL.

Ellon.—The cost of installation of the electric light into the burgh is estimated at £2,950.

Hanley.—Sanction has been received to the borrowing of £5,800 for the purposes of electric lighting.

Portsmouth Telephones.—The subscribers connected to the Corporation exchange on June 16 totalled 1,761.

Wrexham.—Sanction has been received to the borrowing of £5,600 for extension of electric lighting cables and plant.

Annfield Plain.—The Urban District Council are corresponding with the Northern Counties Electricity Supply Company, Limited.

Holyhead.—Application is to be made for sanction to borrow an additional £1,000 for the extension of mains and sources of electric light.

Beckenham.—The consideration of the proposals for the extension of the electric lighting undertaking has been adjourned for three months.

Maskelyne Wireless Telegraph.—The De Forest Wireless Syndicate has acquired all the Maskelyne patents in respect to wireless telegraphy.

Tewkesbury.—The Chepstow and Rose Electricity Company intend to apply for a provisional order for the district, including the borough.

Erith.—Application is to be made for sanction to the borrowing by the Council of the further sum of £2,500 for extensions to the electricity supply works.

Poplar.—Cotton-street and return to Bow-lane is to be lighted by five arc lamps, and the necessary mains and also distributors are to be laid, at an estimated cost of £388.

Eastern Extension Australasia and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share, tax free, payable on the 15th inst.

Epsom.—The Urban District Council have agreed not to reduce the price of current to private consumers until that consumption, which stood at present at 5,548 8-c.p., reached an equivalent of 7,000 8-c.p.

Hackney.—From Jan. 1 next the charges for current will be as follows: for an hour's use per day, 7d. per unit for lighting and 3d. for power; for three hours, 3d. and 2d.; and for six hours, 2d. and 1½d.

Caerphilly.—The Barry Railway Company have deposited in the Private Bill Office of the House of Commons a requisition for leave to withdraw their opposition to the Caerphilly electric lighting provisional order.

Ware.—The Urban District Council's draft agreement with the North Metropolitan Electricity Company for the taking over and working of the Council's electric lighting order has been approved by the company.

Sale of Plant.—The Council of Exeter have for disposal various plant. Particulars of this sale and of another, concerning an electric dynamo, switchboard, etc., at the Glanne Wells, Builth, will be found in another column.

City and Guilds of London Institute.—Particulars of session 1904-5 of the courses of instruction at the institute's central technical college (Exhibition-road) and at technical college (Finsbury) will be found in another column.

City of London Electric Lighting Co.—The following dividends have been declared on account of the distribution for the year 1904:

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on the preference shares 6s. per share, and on the company's ordinary shares 5s. per share, less tax.

Southend.—Cables are to be laid in Station-road and Chalkwell-avenue. During the month 19 consumers, with the equivalent of 1,068 lamps, have been connected to the mains, bringing the total number of lamps connected up to 37,201.

Refuse Removal.—Matthews and Yates, Limited, ventilating heating electrical engineers, of Cyclone Works, Swinton, are manufacturing a cyclone collecting plant for the car building sheds of the Brush Electrical Engineering Company, Limited, Loughborough.

Keighley.—The electricity sold during May amounted to 11,315 units, an increase of 2,219 units upon May, 1903, and there was also an increase of 42,757 units, or 32·7 per cent., in electricity sold from July 1, 1903, to May 31, 1904, upon the corresponding period 1902 3.

Swansea Telephones.—The Municipal Telephones Committee were on Monday considering the advice to apply for a mandamus to compel the National Telephone Company to grant intercommunication. After various points had been discussed the meeting decided to adjourn for a week.

Gillingham.—The last report of the engineer showed that 227 8-c.p. lamps, with three connections, had been connected to the mains since the last meeting of the committee, making a total of 10,730 8-c.p. lamps with 185 consumers connected. The laying of new mains is under consideration.

Stockwell.—At the recent festival of the Stockwell Orphanage Colonel Nisbet made an appeal for funds to provide an installation of electric light in the orphanage, which would, it was estimated, cost £1,400, but towards which £100 had been promised if the work were completed during the autumn.

Gloucester.—An agreement has been entered into between the Standing Joint Committee and the city authority in respect of lighting the shire hall with electricity. The city authorities will pay £100 towards the expenses. The Highways Committee have decided to appoint a consulting electrical engineer and obtain tenders for the work.

York.—The extensions at the electric lighting station are now almost completed, and it will be formally opened on the afternoon of July 18 It has become necessary to extend the mains throughout Coney-street and Spurriergate in consequence of the heavy demand for lighting and power purposes. The estimated cost of the work is £275.

London County Council.—On Tuesday tenders were received for the installation of electric light at the Poplar Technical Institute. It was agreed to lend the Fulham Borough Council £25,000 for electric light installation, and the Hampstead Borough Council £4,300 for electric light meters. Several notices of intention to lay mains were agreed to.

A.B.P. Accumulators. — The A.B.P. Accumulator Company report that they have just completed the erection of a battery, consisting of 256 cells, at the Leek electricity generating station, also 250 cells of their 23-plate type at the Corporation power station, Northampton. They have also delivered a complete battery of 58 27-plate cells to Constantinople.

Gravesend —The Town Council are about to extend their mains to the Milton Ironworks at a cost of £180. Applications have been received from intending consumers in Rosherville parish, and it has been arranged for a deputation from the Northfleet Council to confer with the Electric Committee on the subject of the extension of the Gravesend electric lighting order.

Bo'ness.—The Scottish Secretary has reversed his former decision, and has now sanctioned the loan of £25,000 for the proposed electric lighting of the burgh. The contractors provide, erect, and fit up the installation for the lighting of the whole of the burgh, the Town Council paying 2½d. per unit for public lighting. The contractors are bound to pay 6 per cent. on the capital expenditure.

Chertsey.—The Board of Trade having written to the Urban District Council in reference to the Staines, Egham, and Chertsey electric lighting order, and enclosing correspondence between the department and the Thames Valley Electric Supply Company, Limited, it has been decided to intimate to the Board that the Council are willing to support them in revoking the order.

"Malite" Fire-Resisting Cable.—The makers, Messrs. Johnson and Phillips' Electric Cable Works, Old Charlton, inform us that their Patent No. 24,755, dated as far back as Nov. 11. 1902, gives them the right of finishing these cables with flat leather strip braided around the core. This arrangement makes an extremely safe and neat design for car-shed flexibles and connections to mining plant.

Sunderland.—The Corporation Electricity Committee, which was muleted in costs owing to a misunderstanding, which involved their non-appearance before a Parliamentary Select Committee in connection with a petition against the Rural District Lighting Bill, have decided to protest against the order of the Select Committee as to costs. They contend that the committee had no power to order them to pay costs.

Aberdare.—The District Council recently decided to consider the destructor, electric lighting, and electric tramway as one scheme, and the surveyor was instructed to report thereon. At the June meeting it was resolved to allow the electric lighting scheme to stand over, and to obtain the report of expert engineers on the tramway and refuse destructor, and Messrs. Medhurst and Lloyd will be asked to report thereon.

Carnarvon.—The Council are about to purchase a site in Balaclava-road for the erection of electric light works at £1 000. The agreement with the National Construction Company is to be altered so that the maximum price to be charged should be 5d. per unit instead of 6d., and that the period for which the works should be maintained by the construction company be extended from 20 to 25 years. Mr. Price White, electrical engineer, Bangor, has been appointed engineer to supervise the work.

Holiday Sailings.—Messrs. J. and D. Robinson, Limited, 48, Wellington-street, Leeds, have again, in conjunction with Mr. Effingham Wilson, 11, Royal-exchange, E.C., issued "Robinson's Handbook," for holiday makers in all parts of the United Kingdom It is a most complete record and gives all the information required by the intending tourist from port to port in England, or thence to foreign ports, with the railway connections, etc.

Clyde Valley Electric Power.—The Clyde Valley Electrical Power Company's provisional orders in respect of the burgh of Milngarvie and portions of the parishes of Old and New Kilpatrick, in the county of Dumbarton, and in respect to portions of the parishes of Glasgow and Old Monkland, in the county of Lanark, have been granted. The Board of Trade have decided to dispense with the consent of the respective county councils.

Islington.—The electrical engineer has found that a certain amount of wear is taking place on the low-pressure pistons of the three 1,000-h.p. engines, and as this tends to reduce the efficiency of the engines by allowing steam leakage, his suggestion that tail rods be placed on the ends of the cylinders for the purpose of supporting the heavy pistons, and thereby preventing the wear, has been adopted. The estimated cost of the work is £100 per engine.

Swansea.—A notice has been issued by the electricity department of the Corporation in connection with the forthcoming Royal visit, informing persons who apply for a supply of electrical energy for illumination purposes on July 19, 20, and 21, 1904, that from 6 p.m. on July 19, 1904, the demand indicators installed will be "short-circuited," and that current will be supplied at a flat rate of 2d. per Board of Trade unit as measured by the meter fixed by the Corporation.

Stock Exchange.—The Stock Exchange Committee have ordered British Westinghouse Electric and Manufacturing Company's further issue of £116,353 4 per cent. mortgage debenture stock (redeemable) to be quoted in the official list. Application has been made to the committee to appoint a special settling day in Rhodes Electrical Manufacturing Company's 6,135 ordinary shares of £1 each, fully paid, Nos. 35,001 to 41,000 and 43,101 to 43,235; and 33,000 vendors' ordinary shares of £1 each, fully paid, Nos. 5,001 to 35,000, 41,001 to 43,100, and 43,236 to 44,135.

Swindon.—At the last Council meeting a report was read from the electrical engineer with regard to the extensions which would be required to the generating station in order to meet the demands for current for lighting and power purposes (other than tramways) for the autumn of 1905. Mr. Griffin was instructed to prepare plans and estimates of the cost (and so far as relates to the buildings in conjunction with the borough surveyor) of the required extensions, so as to provide for the estimated increased demand for the autumn of 1905, and also for laying the additional cables mentioned.

Long-Distance Telephone.—Telephonic communication will be opened between Manchester, Liverpool, Leeds, Hull, Wakefield, etc., and the chief exchange at Brussels to-day. The charge will be 8s. for a period of three minutes. Not more than two consecutive periods will be allowed to the same subscriber if other applications are on hand. The service, it should be understood, will be available only from call offices of the Post Office, and by the renters of telephone lines provided by the Postmaster-General. Double periods will be allowed at night on reduced terms to regular subscribers.

Removals.—Mr. A. R. Bennett, M.I.E.E., has removed from 66, Renfield street, Glasgow, to Queen Anne's-chambers, Broadway, S.W., where he will continue his practice as a consulting telephone and general electrical engineer. Mr. Walter P. Adams, M.I.E.E., of 35, Queen Victoria-street, E.C., has removed to new offices at 28, Victoria-street, Westminster, S.W. Saxby and Farmer, Limited, have removed their head office from Kilburn to 53, Victoria-street, S.W. Messrs. S. Parsons and Co. have removed to larger premises at Horton Ironworks, Beckside-road, Bradford. They have also opened a town showroom at 7, Aldermanbury.

Inquest.—Mr. R. A. H. Tovey, the Doncaster borough coroner, held an enquiry on Saturday into the death of John William Hankinson, of 8, West-street, electric lamp cleaner and motor attendant in the boiler shop at the Great Northern Plant Works, which took place in the infirmary on Friday. Mr. Phillips, assistant manager at the works, represented the railway company, and Mr. Jos. Roddis (from the offices of Mr. Gichard, of Rotherham) represented the widow. Mr. Joshua Dodgson, factory inspector, was present, and occupied a seat by the side of the coroner. After hearing the evidence, the coroner said that there was not the slightest evidence to show that the deceased was actually cleaning the machinery when the accident happened. It was one of those unfortunate accidents which would happen. One of the jurymen had suggested that the belt and pulley might have been protected. They had heard the questions put by the Government inspector, and they might take it for granted that there had been no neglect, or the inspector would have seen to it. He thought they might assume that everything had been done which the law required for the protection of this machinery. It was a case which seemed to resolve itself in effect to some thoughtlessness or forgetfulness on the part of the deceased. They could not but come to the conclusion that it was a pure accident. The jury retired and were absent nearly half an hour. Their verdict was "Accidental death, caused by the pulley and belt not being properly protected." Mr. Phillips said he would like, on behalf of himself and the officials, to express their sympathy with the widow and children in their sad bereavement. It was a very regrettable affair and particularly painful. The Coroner: I am sure the jury will concur in that, as I do. These things will happen, and there does not appear to have been anybody to blame. The jury have added a rider. It is their rider, not mine,

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Sunday Telephones.—At the last meeting of the Newport Chamber of Commerce the president alluded to the want of facilities for the public for using telephone call offices on Sundays. The matter had come under his personal consideration at Bristol a little while ago, when he found that the main office of the National Telephone Company was closed. He stated that since he had complained of that the main office had been opened on Sundays, and he understood that the telephone company were ready to open an office at Newport on Sundays if the site for such office could be settled.

Retford.—A committee has been appointed with power to employ an expert in order to present an electric lighting scheme to the Town Council. It is estimated that to begin with they would have to provide for about 2,000 lights. Public lighting is not proposed at present. A consumption of about 105,000 units for the first year is anticipated, which, at 4d. per unit, would be an income of over £1 700. A system to cover about five miles is estimated to cost £3 000. This would require two or three gas-engines of 150-h.p. in a building which would cost not more than £800. Altogether it is thought that the whole could be carried out for an outlay of £8,000.

Persian Telegraphs.—The telegraph line is completed as far as Kerman. Finally, it will connect direct with India, and besides relieving the heavy pressure on the cable, will, it is thought, prove cheaper to maintain. It will also produce various incidental improvements along its course. Progress in the first part was at the rate of 15 miles per week, but the line is now proceeding at 20 miles per week, and no fanaticism or hostility has been aroused. The line is expected to be complete by the end of this summer. It costs £130 per mile. The wire has been supplied by Messrs. Docman, Long, and Co., of Middlesbrough, and the posts by Messrs. Siemens Bros.

Pontypool.—The Urban District Council recently asked the Pontypool Electric Light Company for permission to fix a gas bracket on a company's standard. This the company declined, but made an offer, which has been accepted, to the effect that if the Council would bear the cost of fixing a lamp, bracket, and fittings, to be supplied by the company, and find the renewals that would become necessary from time to time, the company would find the necessary energy to supply a lamp of 30 c.p., to be switched on from the time the other arcs are switched off to sunrise, for a nominal consideration of 15s. per annum; or they would give a small arc of about 200 c.p. on the same terms for £3 per annum.

Derby.—The National Telephone Company are now transferring the wires from overhead to underground. The town has been divided into over 40 areas, in each of which is to be fixed a distributing point. From the exchange to these distributing points the wires will be placed underground. At each distributing point a special post will be fixed, to which, by means of overhead wires, the subscribers of that particular area will be connected. As the areas are not large, only one span of wire will be necessary between each building supplied and the distributing point. This will very considerably reduce the number and length of overhead wires, and as these remaining will be very short, there will be little possibility of breakage.

St. Marylebone.—The Borough Council have adopted a report of the Electric Supply Committee recommending the Council to empower them to enter into an agreement with the Metropolitan Company to supply electricity until March 31, 1905, and to entirely cease not later than March 31, 1906. The company were to take the revenue and pay to the Council a sum in respect of the interest on the amount and the capital sums payable by the Council to the company under the award, such interest to range from 4 to 3 per cent. The Council were to have complete control over capital expenditure, and the charges were to remain the same. Councillor Debenham remarked as soon as they completed the purchase it would be necessary to put in fresh engines and take over the other responsibilities.

Bury.—The charges for current have been fixed as follows: Lighting—places of worship, offices, banks, workshops, warehouses, public halls, and other short hours unclassified consumers, 5d. per unit flat rate instead of 6d., and 3d. per unit on the maximum demand system; shops, 4½d. per unit; hotels, public-houses, private houses, and other unclassified consumers, 6d. per unit. Any consumer included under these classes whose average account on the maximum demand system this year is lower than it would be under the proposed flat rate, is to have the option of continuing under the maximum demand system. For motor power—the initial price of 3d. per unit is to be reduced to 2½d. for the use of the maximum demand for an average of one hour per day or 1,000 units per quarter, and all additional units to be 1d. per unit as at present.

Hammersmith.—The last report of the Electricity and Lighting Committee shows that the premises of 12 additional consumers, representing a maximum of 388 8-c.p. lamps, have been connected to the mains, that seven consumers have been disconnected, and that the present number of consumers taking current from the mains is 1,482. It has been decided to lay a new main in continuation of that in Great Church-lane, at an estimated cost of £127. We deal elsewhere with the tenders for supplying the additional plant required in connection with the extension of the electric lighting installation. The tenders include the supply of two 1,500-kw. generating sets. The Guardians have appointed Mr. J. S. Enright, 68, Lincoln's-inn-fields, W.C., as electrical engineer to prepare specifications in connection with, and to superintend the carrying out of, the electric installations at the workhouse and infirmary buildings now in course of erection at Wormwood Scrubs, Shepherd's Bush, W.

Strike of Telephone Operators.—The strike of telephone operators engaged at the Holborn Exchange of the National Telephone Company was brought to a satisfactory conclusion on Monday, after a conference between three representatives of the girls and the manager, Mr. E. L. Gaine, and several of the officials of the company, at Telephone House, Victoria-embankment. The operators laid before Mr. Gaine their grievances, especially with regard to the extra hours of work they had recently been called upon to undertake through the introduction of a new schedule of duty. Mr. Gaine pointed out that no duty had been imposed upon them in excess of their contract with the company, but he thought that some of the hours of duty were unduly long and should be modified, and gave instructions for new time-tables of duty to be prepared accordingly. In consequence the operators will now be engaged for 8½ hours per day from Monday to Friday, and on Saturday about six hours, whereas under the schedule to which the operators objected the hours were nine, and in some cases ten, each day. One hour will be allowed for dinner and tea inclusive.

Grimsby.—The electrical engineer's last report contains the following: "With reference to the flame arc lamps recently tested, I have to report that they proved satisfactory. Comparing them with the ordinary 10-ampere street arc lamps, the chief points I noticed were: (1) That they gave from two to three times as much light. (2) That the annual cost of running, including the cost of current and carbons, but excluding trimming, repairs, and interest on capital, would be about £20. 19s. 6d. per lamp for 3,600 hours, as compared with £14. 15s. 4d. The cost of the special carbons required is five times as much as the cost of ordinary carbons. (3) The lamps are not quite steady, they feed irregularly, and this causes a flickering in the light. (4) The cost of the lamps only without any accessories is about £8. 10s. each, as compared with £4. 10s. (5) If a smaller lamp were used, the annual cost of running might be reduced to about £14, and the light would, I think, be greater than it is at present. To alter the existing lighting would be a serious expense, as all the existing lamps would have to be scrapped, and some of the accessories would have to be altered. The capital cost of the alteration would be from £10 to £12 per lamp. I would suggest, however, that when any extension to the public lighting is proposed this matter be further considered."

Curtis Turbines Supplanting other Apparatus in St. Louis, U.S.A.—The Union Electric Light and Power Company of St. Louis, which is a consolidation of the Missouri-Edison Electric Company, the Imperial Electric Light, and the Citizens' Electric Light and Power Company are building a large power station on the Mississippi River in North St. Louis. This power station when completed will supply all of their demands, shutting down three existing power-houses with miscellaneous types of apparatus. This power station will have installed therein four 5,000-kw., and two 2,000-kw., 25-cycle, 6,600-volt alternators, direct connected to Curtis turbines. In several sub-stations throughout the city motor-generators will be used for distributing direct current on 110 and 220 volt systems. The power-station is being designed with a view of securing the highest possible economy of operation. Being located on the river front and also having railway switching facilities, coal may be received by barges and by rail. The two 2,000-kw. turbines will be operated with Wheeler condensers, the four 5,000-k.w. turbines with Worthington condensers. The Union Company is to furnish the St. Louis Transit Company with 9,000 kw. continuously, and the St. Louis Transit Company is now installing two sub-stations. Sub-station No. 1 will have seven 1,000-kw. converters, sub station No. 2 will have two 1,000-kw. converters. The distribution mains to the Transit Company's power stations will be underground.

Shipley.—The rapid progress of the District Council's electricity department has made it necessary to almost double the station. In the year ended March 31, 1903, 470,530 units were generated, of which 169,294 units were required for traction and 90,780 units for private lighting and power purposes, the remainder being used for public lighting, the lighting of the works, and for motive power required at the sewage works. In the year ended March 31 last 926,244 units of current were generated, of which 362,411 units were for traction and 190,115 for private lighting and power purposes. The output has thus nearly been doubled within one year, and the total income has grown in the same proportion—*i.e.*, from £2,725 to £5,210. The loss in 1903 of £446 has fallen to £125. To meet the growing demand contracts have been let for an additional 300-h.p. turbine and dynamo, and the switchboard is to be extended to provide for three additional generators. Another boiler, superheater, and mechanical stoker, and other necessary apparatus are also about to be added, which will increase the producing power of the station by 60 per cent. The extensions at Dockfield have just been opened, and comprise a building covering 418 square yards. There are new offices, battery, storage, and testing rooms. The building has been erected from the plans of Mr. Sam Bradley by Messrs. Hartley and Kemplay (masons), and Mr. Joshua Hobson (joiner), the other contractors being Mr. Samuel Rushworth (plumber), Mr. W. Holmes (plasterer), Mr. T. Thornton (slater), and Mr. H. Hirst (painter).

London Gazette.—The first meeting in the estate of Henry Binks, electrical engineer, carrying on business at 34, Leaderhall-street, London, and residing at 4, Highbury-crescent, Highbury, Middlesex, will be held at 11 a.m. on July 7 at Bankruptcy-buildings, Carey-street, London, W.C. The public examination in the estate of Carl Vigant Tyge de Falbe (lately carrying on business as the Electrical and General Contracting Company), now residing at 1, Penywern-road, Earl's Court, and lately trading at 17, Shaftesbury-avenue, London, will be resumed at 11.30 a.m. on July 20 at Bankruptcy-buildings, Carey-street, W.C. A first and final dividend of 2s. 6½d. in the £ has been declared in the estate of Gilbert Jackson and David Smith (trading as Jackson and Smith), electrical engineers, 6, Annes-well-street, Carlisle, now payable at the Official Receiver's Office, 34, Fisher-street, Carlisle. The partnership between Henry Turner and Charles Richard Douglas Bearcroft, electrical engineers, 15, New Broad-street, London, E.C. (trading as H. Turner and Co.), has been dissolved by mutual consent. The Reliance Electric Company, Limited, will be wound up on account of liabilities. Mr. E. W. Bundy, 35, Philips Park-road, Bradford, Manchester, has been appointed liquidator. The final meeting of the Blake-Morscher Electrical Ore Separator Syndicate, Limited, will be held at 20, Copthall-

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avenue, London, on July 26 at 3 p.m. Royal assent has been given to the Electric Lighting Orders Confirmation (No. 1) Act, 1904; Govan Electric Lighting (Further Powers) Act, 1904; Chesterfield Corporation Tramways and Improvements Act, 1904; St. Marylebone Electric Lighting Act, 1904.

Newcastle.—With regard to the opening of the electric light station, mentioned in our last issue, we cull from the *Staffs Advertiser* as follows: "The new works have been erected on land adjoining the gasworks. The buildings have been put up by Mr. S. Wilton, jun., of Newcastle, and they comprise an engine-room 50ft. square—a lofty apartment, the walls of which are entirely lined with glazed bricks—and a battery room 50ft. by 12ft. The machinery comprises two 60-h.p. gas-engines, made by Messrs. Andrew and Co., Limited, Stockport, rope driven, with two 30-kw. dynamos by the Electric Construction Company, Bushbury, Wolverhampton, and a switchboard by Messrs. Crompton and Co., London, arranged for a three-wire continuous current supplying 230 volts pressure to consumers. The board is arranged for running the machines on the town, together with a storage battery for the same when required. Automatic circuit breakers are provided. The battery, constructed by the Electric Power Storage Company, London, comprises 130 cells, arranged for a 230-volt supply, and has a capacity for supplying about 200 8-c.p. lights for eight or nine hours. The battery is provided with a switch on the board by which the supply is regulated. The cables were supplied by Callender's Cable Company, London. A feeder, consisting of three cables, carries the total current required to a feeder pillar in the centre of the town, from which distributing cables are taken through distributing pillars over the compulsory area. These pillars are so arranged that any section of the town can be cut off independently. In the engine-room are a five-ton crane over the engine beds, and a two-ton crane over the dynamo beds. When the supply was first turned on a month or two ago about 430 8 c.p. lamps were connected up, and it was considered a very good start, but so rapid has been the extension that the total capacity of the works is already almost exhausted, and nearly 2,000 8-c.p. lamps are now connected. It is intended to supply current for power as well as lighting purposes, if required. The price charged for the light at present is 6d. per unit. The electrical engineer in charge of the works is Mr. J. F. Shoolbred, formerly of the Stockport electric light station.

Coventry.—The Electric Light Committee's annual report states that the capital expended during the year has been £16,758, bringing the total expenditure to date up to £119,470. The amount raised on loan is £93,474, and £12,000 has been received on temporary loan, while the receipts on various accounts have amounted to £1,543. The balance of £26,011 has not yet been raised. The total capital sanctioned is £110,485. The amount of capital repaid is £788, and the sinking fund amounts to £9,231. During the year the number of consumers has increased from 449 to 536, and the equivalent of lamps connected from 39,605 (8 c.p.) to 53,746. Further connections are being made. The number of units sold has increased from 566,731 to 920,192, and the revenue from sale of current and meter rental from £8,076 to £10,844. The increase in units sold to private consumers has been from 504,218 to 857,242, and the revenue from this source is £9,581, against £7,057. The working expenses are £4,598, as against £3,691 in the previous year. The profit on working is therefore £6,245. 11s. 9½d., against £4 385. 2s. 10½d. last year. The capital charges amount to £5,470. 0s. 3d. The net profit therefore is £775. 11s. 6½d., as against a loss of £189. 2s. 3½d. last year and £1,807. 19s. 7½d. the year before. The committee recommend that the balance of profit, £775. 11s. 6½d., be carried forward to next year's account. The sale of current shows a profit of ¼d. per unit, against a loss in every previous year, varying from 8d. per unit in the first year to ·08d. in 1903. Coal cost last year £1,461, which was an increase of £376 on the previous year, when the cost was £1,085. The manager in his report states: "During the year we have connected 87 consumers, which are represented by 4,871 lamps and 309 h.p. of motors. We have laid 6¼ miles of mains, besides 4¼ miles of spare pipes." The total number of lamps connected at the end of the year, including motors, was 53,746, and the number of lamps which were connected at the end of 1903 was 39,605, showing a total increased communication of 14,141. The cost of manufacturing current amounted to only 41 per cent. of the revenue, against 45·7 last year. The station costs having been reduced to the very low price of 1·15d. per unit, Mr. Jeckell in his report said: "With regard to the cost of manufacture at the works, though it was very low for the last year, it has been reduced still further—viz., it has been reduced from 1·513d. per unit to 1·159d. per unit."

PROVISIONAL PATENTS, 1904.

JUNE 20.

13902. Improvements in terminating insulators. William Aitken, care of British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool.

13903. Improvements in means for producing electric arcs from alternating currents also applicable for rectifying alternating currents. Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 20, 1903, being date of application in United States.) (Complete specification.)

13925. Improvements in electric arc lamps. George Willis Matthew, 22, Southampton-buildings, Chancery-lane, London.

13927. An improved system and apparatus for electrically operating bulkhead doors, hatches, or the like. Allen Parry Jones, 55, Chancery-lane, London. (Long Arm System Company, United States.)

13928. Improvements in automatic electric cut-out mechanism. Allen Parry Jones, 55, Chancery-lane, London. (The Long Arm System Company, United States.)

13933. Improvements in or relating to storage battery separators. Alfred Julius Boult, 111, Hatton-garden, London. (Norman Dodge, United States.) (Complete specification.)

13937. Improved system of installation of electric apparatus for traction in mines or other places containing explosive gas. Edgard François Joseph Modesse, 111, Hatton-garden, London. (Complete specification.)

13945. Improvements in power transmitting devices. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (Electric and Train Lighting Syndicate, Limited, Canada.)

13947. Improved construction of electric tumbler switch. George Smith, 173, Fleet-street, London.

13952. Apparatus operating with automatic regulation for submitting gases and vapours to the action of the electric arc. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société Anonyme d'Etudes Electro-Chimiques, Switzerland.)

13979. Improvements in electric lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (General Electric Company, United States.)

13984. An improvement in electric fuseboards and fuses. George Mark Pinkerton, 10, Camomile-street, Bishopsgate-street Within, London.

JUNE 21.

14020. Improvements in electrostatic apparatus for measuring electrical potential differences. Edgar Walford Marchant and Gladstone Walter Worrall, The University of Liverpool. (Complete specification.)

14032. Improvements in miners' and other portable electric lamps. William Edwin Gray, 53, Bayham-place, London.

14058. Improvements in solutions for the electro-deposition of metal. Louis Potthoff, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14059. Improvements in apparatus for electro-galvanising. Louis Potthoff, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14066. Improvements in conductor and collector devices for electric railways and tramways. André Bolzano, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14066. An improved high-voltage battery. Lionel de Gournay, 40, Chancery-lane, London. (Complete specification.)

14071. Improvements in raising and lowering of arc lamps. Herbert Henry Berry and Ernest Skinner, 78, Upper Thames-street, London.

14072. Improvements in the transmission of vibrating or wave-sounds, messages, signals, and the like. Robert James White, 28, St. John's-park, Holloway, London.

JUNE 22.

14097. Improved box and lid for electric accumulators on board ships, motorcars, and the like. Arthur Albert Smethurst and Thomas Henry Bishop, 44, Lodge-road, Southampton.

14105. Improvements in and relating to electric cells. Ernst Wichmann, 112, Potsdamerstrasse, Berlin, Germany. (Complete specification.)

14111. A self-locking contact maker. Joseph Henry Golding, Amhurst Electrical Works, Garnham-street, Stoke Newington, London.

14117. Improved form of protected conductor rail for electric railways. Richard Owen Sullivan, 170, Portland-road, Jesmond, Newcastle-upon-Tyne.

14128. Improved method of preliminary treatment for accumulator plates. Henry Leitner, Lynton, Dartnell Park, Byfleet, Surrey.

14135. Improvements in or relating to apparatus for supplying current to electrically-propelled vehicles and the like. Torius Larssen Kolkin, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

14136. Improvements in brush-holders for electrical machines. William Horace Foot, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 24, 1903, being date of application in United States.) (Complete specification.)

14139. Improvements in and connected with arc lamps. Francois de Zea Bermudez, 33, Cannon-street, London.

14145. Improvements in or connected with telephonic instruments. Charles William Fisher, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14147. Improvements in and relating to the electrolytic deposition of metals. Sherard Osborn Cowper-Coles and The Metals Corporation, Limited, 70, Chancery-lane, London.

14148. Improvements in vapour electric lamps. Osias Otto Kruh, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 22, 1903, being date of application in United States.) (Complete specification.)

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14166. Improvements in or relating to electric clocks and electromotive apparatus thereof, and for other purposes. Sebastian Palmer, Palace-chambers, Westminster, London. (Complete specification.)

14163. Improvements in movable overhead frogs or switches and section insulators for electric railways and tramways. Charles Hesterton Merz and Sydney George Redman, Norfolk House, Norfolk-street, Strand, London.

JUNE 23.

14170. Improvements in electrical accumulators. Thomas Rigg, 5, Corporation-street, Birmingham.

14176. Improvements connected with electrical collector rails. Thomas Francis Jones, 9, Tempest Hey, Liverpool.

14195. Improvements in electric conductors for tramways worked on the conduit system. Wilfrid John Aris Watkins, 106, Chichele-road, Cricklewood, London.

14196. Improvements in electrodes for arc lighting. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14221. Improvements in and relating to galvanic batteries. Reinhold Dréibholz, 6, Lord-street, Liverpool. (Complete specification.)

14231. Improvements in electric sparking plugs for internal-combustion motors. Hippolyte Joseph Le Force, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 24, 1903, being date of application in France.) (Complete specification.)

14239. Improvements in or relating to electric traction engines. Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

14250. Improvements in dynamo-electric machines and the like. Ludwig Torda, 40, Chancery-lane, London.

JUNE 25.

14281. Improvements in the method of and means employed for supporting and connecting the trolley wires of overhead electric systems and in the method of insulating such connections. James Haydock and Thomas Smith Jones, Penny Bank-chambers, Halifax.

14294. An improvement connected with the "live rails" of electric railways. Thomas Massey Lynch, 15, Water-street, Liverpool.

14300. Improved arrangement of plant for generating stations. Bernard Mervyn Drake and Drake and Gorham, Limited, 66, Victoria-street, Westminster.

14326. Improvements in and relating to the generation of electricity. William Strickland, 70, Chancery-lane, London.

14250. Electrically-operated signalling and braking devices for railway trains. Peter Krause, 65, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 14, 1904.

1903.

11760. Electrical switch apparatus. Jones.

13741. Dynamo-electric machinery. Midgley and Wright.

13746. Method for operating signals on electric railways. Young.

13822. Dynamo brushes. Siebers.

14173. Breaking and controlling electric circuits. Le Tall. (Cooper Hewitt Electric Company.)

16534. Secondary galvanic batteries. Schneider and Beissbarth.

18253. Magnetic controlling devices. Carolan. (General Electric Company.)

18343. Electric vapour lamps. Carolan. (General Electric Company.)

18344. Electric lamps. Carolan. (General Electric Company.)

19366. Process relating to the reducing of metallic compounds and the fusing of metals, in particular of nickel and iron in the electric furnace. Abel. (Siemens und Halske Aktiengesellschaft,)

26850. Selective signalling systems. Fairweather. (Stromber Carlson Telephone Manufacturing Company.)

26851. Central telephone exchange apparatus and connection. Fairweather. (Stromberg Carlson Telephone Manufacturing Company.)

1904.

2008. Electric induction motor meters. Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz. (Date applied for under International Convention, Feb. 26, 1903.)

3221. Electric telegraph apparatus. Brown and Hardie.

3692. Electric bells or gongs. Heyes and Heyes.

4567. Electric controllers. Eastwood.

7224. Cluster sockets for electric lamps. Fairweather. (Benjamin Electric Manufacturing Company.)

9647. Electromagnetic machines for igniting in explosion motors. Pichard and Meunier.

9375. Electrical resistances. Vedovell (nee Del Castello). (Date applied for under International Convention, Oct. 19, 1903.)

9950. Collector rings of alternating-current generators and motors. Kandó.

10171. Electric converters. Müller.

10623. Automatic trolley controlling devices for electric tramcars and the like. Nichols.

10986. Printing telegraphs. Sheehy.

11525. Magnetic compasses. Lilley.

11568. Electric current switches. Hall and Hackblock.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-5⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	101-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	3¼-3⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	87-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1
—— Non. Cum., 6 per cent. Pref.	2	..	¾-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	94-98
—— 4½ per cent. 2nd Debenture Stock	100	..	73-78
Callender's Cable, Debentures	100	..	104-108
—— Ordinary	5	..	9¼-10¼
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	5	..	1¾-2¼
—— 5 per cent. Debentures	100	..	95-98
Edison and Swan United, "A" Shares, 1-99,261	5	..	2-2⅛
—— "A" Shares, 01-017,139	5	..	1-1⅛
—— 5 per cent. Debentures	100	..	75-79
—— 4 per cent. Deb. Stock, Red.	100	..	73-78
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1⅜-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-9⅞
—— 4 per cent. 1st Mort. Deb. Stock	100	..	93-98
W. T. Henley's Telegraph Works, Ordinary	5	..	11¼-12¼
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	19-20
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	36-39
—— 5 per cent. Bonds	100	..	101-104
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅞-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	120-125
Bournemouth and Poole, Ordinary	10	..	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	10⅜-11¼
—— 7 per cent. Preference	5	..	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	7-7¼
—— Nos. 20,001-30,000	5	..	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-108
Charing Cross and Strand, Nos. 1-70,000	5	..	7¼-8
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	102-104
Chelsea Electricity Supply	5	..	6¼-6⅜
—— 4½ per cent. Debentures	100	..	107-110
City of London, Ordinary	10	..	11-11¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London Electric Supply, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	105-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5¼-5⅜
—— 6 per cent. Cum. Pref.	5	..	5¼-5⅜
—— 4½ per cent. First Mort. Deb.	100	..	105-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	..	90-95
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	12-13
—— per cent. Debenture Stock Red	100	..	102-105
Kensington and Knightsbridge and Notting Hill	100	..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	5	..	14-14¼
—— 6 per cent. Pref.	5	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	93-96
Metropolitan Ordinary	10	..	19¼-20¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 3½ per cent. Mortgage Debenture, Red.	100	..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	..	100-103
Notting Hill Electric Lighting	10	..	13¾-14¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98-101
Oxford Electric, Ordinary, 1-96 and 4,[illegible]-14,510	5	..	5¼-6
—— 4 per cent. Debenture Stock	100	..	98-101
Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ltd., ord., 1-12,000	5	..	2⅝-3¼
—— 4 per cent. Debenture Stock	100	..	86-90
South London, Ordinary		..	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-80,080	5	..	14¼-15¼
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	8	..	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4¼-5
Westminster, Ordinary	5	..	13¼-13¾
—— 5 per cent. Cum. Pref., 110,101-138,851	5	..	6¼-6⅝

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 —	90-95
—— 4 per cent. Pref.	100 —	101-104
—— ,, deferred	100 —	79-82
—— 4 p.c. Deb. Stock (Prov. Scrips Certs., fully paid).	100 —	113-116
City and South London, Consolidated Ordinary	100 —	46-49
—— 4 per cent. Debenture Stock	100 —	106-109
—— 5 per cent. Pref. Stock '91	100 —	123-126
—— ,, ,, ,, '96	100 —	120-123
—— ,, ,, ,, '01	100 —	115-122
Liverpool Overhead, 5 per cent. Pref.	10 —	10-10½
—— Ordinary, 1-50,000	10 —	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	99-101
Waterloo and City, Ordinary	100 —	89-92
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 —	5-5½
—— Permanent 5 per cent. Debenture Stock, 1888	100 —	132-137
Blackpool and Fleetwood Tramroad	10 —	13¾-15¾
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 —	3¼-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 —	3¾-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 —	98-103
British Columbia Electric Railway Co., Ord. Def.	100 —	100-103
—— Ord Pref.	100 ..	98-101
—— Non-Cum. 5 per cent. Pref.	10 —	10½-10¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 —	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	98-101
British Electric Traction Ord. 1-500,000 & 60,001-80,000	10 —	9½-10
—— 6 per cent. Cm. Pf., 80,001-60,000	10 —	10¾-11¼
—— 5 per cent. Perpetual Debenture Stock	100 —	116-118
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2¾-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,600	5 —	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 —	107-110
—— Prov. Cert., all paid	100 —	103-106
Cape Electric Tramways, Nos. 1-480,000	1 —	1¼-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 —	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-5,000 (1917)	100 —	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 —	100-103

Name.	Amount paid.	Last price
	£	£
Cork Electric Tramways and Lighting Co., Ordinary	10 —	9½-10
—— 5 per cent. Cum. Pref.	10 —	11-12
—— 4 per cent. Debentures	100 —	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways Ordinary	all —	18 19
—— 6 per cent. Cum. Pref.	all —	14-14½
—— 4½ per cent. Deb Stock	100 —	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 —	3¼-4
—— 4 per cent. Debenture Stock	100 —	90-93
Kidderminster and District Lighting and Traction, Pref.	5 —	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	11-11¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	104-106
Metropolitan Electric Trams., Deferred 1,000 001-1,514,016	1 —	¼-¾
—— 5 per cent. Cum. Pref., 500,001-814,016	1 —	¾-1
New General Traction, Ordinary	5 —	¼
—— 6 per cent. Cum. Pref.	5 —	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 —	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	12-12½
—— 6 per cent. Cum. Pref.	10 —	9¾ 9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 —	101-104
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 —	9-10
—— 4½ per cent. Debenture Stock	100 —	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference	1 —	1
—— £528,0 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.
Telephones.—		
National Telephone, Preferred	100 —	104-106
—— Deferred Stock	100 —	86-87
—— 6 per cent. Cum. First Pref.	10 —	11-13
—— 6 per cent. Cum. Second Pref.	10 —	11-13
—— 6 per cent. Non. Cum. Third Pref.	5 —	5-5½
—— 5½ per cent. Deb. Stock, Red.	100 —	99-101
—— 4 per cent. Deb. Stock, Red.	100 —	103-106
Oriental Telephone and Electric Company	1 —	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June 26	1,534	1,247	+ 285	+ 1,155*h*	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 25	792	368	+ 24	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	,, 18	37	—	—	—	1½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 26	1,060	1,110	- 50	- 89	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 25	5,479	5,361	+ 118	+ 8,312	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 24	920	909	+ 11	+ 839	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 23	857	1,017	- 160	+ 531	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 23	690	684	+ 6	- 771	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 26	1,855	1,937	- 82	- 185	38	38	March 31*g*	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 22	1,050	932	+ 118	+ 756	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 18	4,671	3,485	+1,186	+ 9,174	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 26	979	947	+ 32	+ 52*h*	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 21	5,201	5,093	+ 108	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 25	986	792	+ 194	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 19	354	—	—	—	8½	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 25	2,035	2,060	+ 35	+ 934	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 25	201	221	- 20	+ 268	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 25	6,621	7,059	- 438	- 3,245*h*	6	6	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City & South London Railway	,, 26	2,552	2,444	+ 108	- 2,543*h*	6⅜	6⅜	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 23	535	566	- 31	- 834	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 24	225	231	- 9	- 131	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 25	251	267	- 16	- 253	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 19	129	126	+ 3	+ 210*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 21	4,274	4,174	+ 100	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 24	1,134	986	+ 148											
Dundee City Tramways	,, 22	851	867	- 16	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 25	781	804	- 23	+ 938	10·75	10·75	March 31*g*	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 25	14,279	13,973	+ 306	- 1,476*h*	124	124	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	,, 1	224	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 15	3,105	2,532	+ 573	+ 1,073	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 18	1,312	1,130	+ 182	—	34	34	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·32
Hull Corporation, E. S	,, 25	2,152	1,862	+ 290	+ 2,959	25	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 25	519	555	- 46	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 22	143	191	- 48	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 22	217	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 25	5,781	6,011	- 230	+ 4,361	77	77	March 25*g*	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 25	1,097	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 18	10,857	9,669	+1,188	+ 5,685	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 26	1,721	1,660	+ 61	+ 43*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	,, 18	12,488	8,596	+3,892	+22,131	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 25	207	—	—	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 25	12,112	12,269	- 157	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 25	116	70	+ 46	+ 650	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 25	4,983	4,332	+ 656	—	38½	38½	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 25	515	402	+ 113	+ 1,575	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 25	2,313	2,341	- 28	+ 2,170	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 20	131	150	- 19	—	4½	4½	March 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 23	494	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 27	4,060	4,159	- 99	+ 4,493	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 25	205	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 26	4,659	4,757	- 97	+ 1,916	53½	53½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 16	966	1,187	- 221	—	11	11	,, 31	35,874	9,084,522	752,814	0 946	11·436	3,760	—
Southend-on-Sea Corporation	,, 22	391	332	+ 59	+ 297	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 24	566	323	+ 243	+ 3,053	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 26	1,761	1,405	+ 44	+ 343	18·48	18·48	,, 31*g*	59,930	13,987,121	1,270,957	1 03	11·3	3,243	6·4
Wallasey U.D.C.	,, 25	766	738	+ 27	+ 415	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 23	1,132	—	—	—	1¾	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 22	618	447	+ 171	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Radium.—Prof. Geitel, of Wolfenbuttel, has just been successful, it it reported, in discovering comparatively large quantities of radium in the thermal mud used during the last few years at Baden-Baden for medicinal purposes.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, the Duke of Northumberland, K.G., president, in the chair. Viscountess Gort, Mr. M. H. Speilmann, and Mr. W. R. W. Sullivan were elected members.

Wireless Telegraphy.—It is reported that the Marconi system of wireless telegraphy is being introduced on board the Northern Lights Commissioners' steamer "May." The system is also being installed at the light-house on Inchkeith, chiefly as an experiment with a view to the introduction of it to other steamers and lighthouses under the control of the Commissioners.

The New Telegraphic Code.—The new code decided upon by the International Telegraph Convention last summer came into operation last Friday. Its advantage to concerns trading abroad is shown by the fact that the cost of cabling in cipher is reduced by something like one-half. Any pronounceable combination of 10 letters may now be employed, subject to the proviso that combinations formed by the union of two or more actual words are inadmissible. It is calculated that the enormous total of 20,000 million combinations can be used.

N-Rays.—A suggestion is advanced by M. Jean Becquerel that there are two elements in the N-rays, consisting of an undulatory movement propagating itself with the speed of light, and another mode of energy propagating itself more slowly. It will be remembered that M. Becquerel demonstrated that metals transparent to N-rays become opaque to them when their surface is subjected to the influence of chloroform or ether. M. Becquerel considers that it is the latter of the elements now attributed by him to the N-rays which is arrested by metals under the action of an anæsthetic.

Electrical Ore Finding.—The Daft and Williams electrical prospecting system, of the results accomplished by which we recently gave some particulars, is to be employed on some mines in the Coniston district, near Barrow-in-Furness. The experiments, which will be carried out entirely at the expense of the Electrical Ore Finding Company, are intended to prove whether it is worth while spending further capital upon what has hitherto been an unremunerative undertaking. Upon metalliferous lodes being located by the electric waves, a bore or shaft will be sunk to verify the indications. The results are expected to be ascertained definitely within a few days.

Atmospheric Pressure.—Now that the working of the Meteorological Office is under consideration, it is interesting to note the opinions recently expressed by an official of the Norwegian Meteorological Institute. He considers that too little attention has been paid to the electrical conditions of the atmosphere, and that such investigations as have been carried on in this sphere are impaired by the observations being generally made in the lowest strata of the atmosphere. He also remarks that the distribution of atmospheric pressure and temperature is often quite different from what might have been expected from the telegraphic reports of the previous day, leaving the impression that there are unknown factors in co-operation.

Electric Arcs between Mercury and Carbon.—In No. 10 of the *Physikalische Zeitschrift* Dr. L. Cassuto describes some experiments on electric arcs in mercury and carbon. From measurements of the electric tension and current intensity made with both directions of the current and with different electrode distances, it is inferred that for equal current intensities and equal electrode distances the electrode tension of the arc will be higher if the mercury be the cathode and the carbon the anode than in the opposite case. The sum of the anode and cathode tension falls is practically identical for both senses of the current, whereas the tension fall in the arc column is higher in the case of the mercury being cathode than *vice versâ*. These phenomena are accounted for as follows: The column of the electric arc between the mercury and carbon will show nearly throughout its length, irrespective of the direction of the current, the bluish light characteristic of mercury vapour, mercury being vaporised much more strongly than solid carbon. Now the vaporisation of a mercury anode is greater than that of a mercury cathode, the potential fall being higher in the former case. A mercury anode will therefore supply the electric arc column with more vapour than a mercury cathode. The potential fall in the arc column, however, depends on the amount of vapour derived from the electrodes, increasing as the latter decreases. The potential fall in the electric arc column must, therefore, be smaller in the case of a mercury anode than in that of a mercury cathode with less vaporisation.

Aerial Electricity.—Some particulars are given by the *Scientific American* of the growing use of windmills in the Western States for generating electricity in connection with agriculture. The question of utilising the wind for driving farm machines is of great importance to farmers in those regions, as there are no large streams for them to harness, while wind is abundant. The wind has now been harnessed for generating electricity for use generally on the farm. The earlier mills were employed experimentally to generate electricity for lighting the barns and homes, but their success stimulated some to more ambitious efforts. To-day a good many of them are being run to generate sufficient power to operate small motors. Several windmills are worked together on some farms to operate the generators, and in this way 10-h.p. motors are working in the field continually. Several motors of 2 h.p. and 3 h.p. are operated in the field, and better results are obtained in this way than by one large single motor. By distributing the windmills and motors in different parts of the farms, more favourable results are obtained than by any other method. Another example of the use of the windmill for generating electricity is provided by the village of Askov, in Denmark. The windmill can be supplemented by a small petrol engine in case of a period of quiet weather. There is storage capacity for four or five days, so the engine is seldom required—only about 30 days every year. An ingenious contrivance enables the speed of the dynamo to be controlled and regulated. From this station the whole village is supplied with light, and power is provided for industrial and agricultural purposes. A farm in the neighbourhood, about 80 acres in extent, has a private plant of the same type, from which illumination and also power for driving all the machinery is obtained. The whole of this latter installation, including windmill, dynamo, etc., cost only £230.

Disruptive Discharges at Very High Tensions.—According to a communication recently made before the French Academy of Sciences, Mr. de Kowalski has performed some experiments with three continuous-current machines of the Thury system, built by the Compagnie de l'Industrie Electrique et Mécanique, of Geneva, and capable of yielding a current intensity of one ampere under a maximum tension as high as 20,000 volts. By connecting these three machines in series potential differences as high as 70,000 volts could readily be obtained at the

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terminals of the machine. The results of de Kowalski's researches are as follows: (1) Continuous-current electric arcs at high tensions and small current intensities will, generally speaking, show the same behaviour as the alternating-current arc investigated by Messrs. Guye and Monasch. The author suggests a similar distinction between a stable and an unstable zone, while the critical zone observed by the above investigators with alternating arcs has not been found to exist in the present case. (2) In the stable zone, the ratio between the length of the arc, the potential fall, and the current intensity, appears to be expressed by a linear equation. (3) The limiting length of the stable arc depends on the current intensity and on the potential difference on the terminals of the machine, as may be inferred from the following figures:

V =	20,500	30,400	25,600	40,000	40,000	30,000
I =	0·023	0·024	0·031	0·032	0·08	0·04
δ =	1·45	3·48	1·82	5·15	7·60	4·70

In the above table V represents the potential difference at the terminals of the machine in volts; I the current intensity in amperes; δ the length of the stable arc in centimetres. (4) In the unstable zone the continuous-current arc shows an asymmetrical aspect, while being nearly fixed at the cathode it will tend successively and rather rapidly towards different points of the anode.

Calcium Carbide.—A patent has been granted in the United States to Mr. A. H. Cowles, of Cleveland, for a process intended for the continuous production of calcium carbide, which is maintained in a molten condition in order to remove it from the furnace. *Electrochemical Industry* of New York gives a description of the process. The charge is used as resistance conductor. The furnace used is illustrated in vertical central section in the accompanying

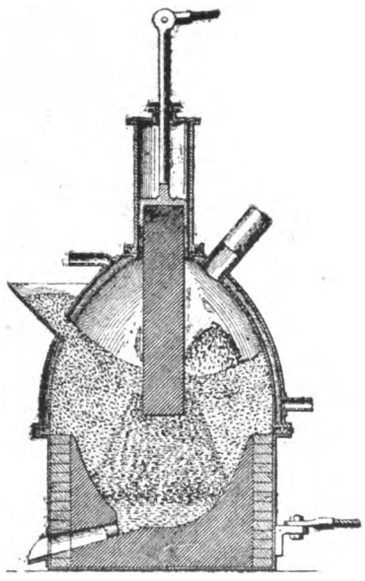

diagram. It has a solid carbon hearth surrounded by a layer of firebrick and a sheet-iron casing. A tapping-hole is provided, and a terminal, which connects the hearth with the source of electric current. An insulating ring of asbestos separates the hearth casing from a dome-shaped, water-jacketed, sheet-iron structure, with water inlet and outlet. A pipe for carrying off waste gases and charge openings are also provided. The other electrode is made of carbon and suspended vertically in the furnace. It is intended to produce superheated molten carbide, which means that the carbide has not only been produced and melted by the heat from the resistance conductor, but has also been raised to such a temperature that it will run through a tapping-hole without requiring an additional supply of heat.

Power Factor Regulation.—At a recent meeting of the American Institute of Electrical Engineers at Chicago Mr. B. G. Lamme was the contributor of a paper on "The Synchronous Motor for Regulation of Power Factor and Line Pressure." The conclusions of the paper, taken from an advance proof, are as follows: (1) A synchronous motor can be used to establish leading or lagging currents in its supply system by suitable field adjustment, and can thus affect or control power factor or phase relations of the current in the alternating-current system. (2) A synchronous motor will set up leading or lagging currents in its supply system if its field strength is held constant, and the pressure of the supply system is varied above or below that generated by the synchronous motor. Such leading or lagging currents in the supply system will tend to vary the pressure of the system. A synchronous motor can thus act as a regulator of the pressure of its supply system. (3) This regulating action is greatest with synchronous motors, which have the closest true inherent regulation (as indicated by high field magnetomotive force compared with the armature magnetomotive force) in distinction from machines which have close apparent regulation obtained by saturation of the magnetic circuit. (4) If the synchronous motor is used both for regulating the power factor for neutralising the effect of other apparatus on the circuit, and for regulating or steadying the pressure of the supply system, its normal capacity for regulating will be diminished. (5) The most suitable speeds for best electrical conditions will in general be considerably below highest possible speeds as limited by mechanical conditions. (6) Heavy dampers will increase the effectiveness of the regulating tendency. (7) If the synchronous motor can be used for power purposes as well as for regulation, its apparent capacity is increased. This is due to the fact that the regulation is obtained by means of a wattless component and the power from the energy component, and the algebraic sum of these two is greater than their resultant which fixes the current capacity of the machine. (8) Synchronous converters in general are not suited for regulating the pressure or controlling the power factor for an alternating-current system. (9) The cost of synchronous motors for regulating purposes will in general be lower than for alternating-current motors or generators of customary speeds, and will approach more nearly to turbo-generator practice.

The Disappearance of the Radioactivity Produced by Radium on Solid Bodies.—Messrs. P. Curie and J. Danne a short time ago investigated the law representing the disappearance of the radioactivity of a solid body which had been exposed to the radium emanation for a certain length of time. In a communication to the French Academy of Sciences they recorded graphically the results of their experiments by means of a set of curves where logarithms of the intensity of the radiation were plotted as ordinates and the time as abscissæ, being counted from the moment of the plate being withdrawn from the action of the emanation. It was shown that the intensity of radiation in terms of time is given by the difference of two exponential functions. These results, as pointed out in a recent note presented to the same academy, may be accounted for theoretically on the basis of Rutherford's views, supposing the emanation to act on the solid walls so as to give rise to the formation of a radioactive matter, B, disappearing spontaneously according to a simple exponential law with a coefficient, *b*. While disappearing this matter, B, would give rise to the formation of another radioactive substance, C, disappearing in turn according to another simple exponential law with the coefficient, *c*. Supposing both of these two substances to emit Becquerel rays, the above law could be readily accounted

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for. In the special case of the substance C radiating alone a remarkable coincidence would be obtained between the formula and the experimental results. According to the above, is would seem as though the substance B were devoid of any radioactivity, being converted into a substance, C, which alone would emit Becquerel rays. Now, in the case of *b* being superior to *c*, the inactive substance B would disappear more rapidly than the substance C; some hours after the beginning of the disactivation, the substance C would exist alone at the surface of the body. In the case, however, of *b* being smaller than *c*, the substance B would be destroyed more slowly than C. As, however, this substance gives rise to the formation of C, both substances would disappear at the same time during disactivation, the mixture existing up to the disappearance of any activity. In order to decide between these two hypotheses, other phenomena, such as, for instance, the distillation of the activity on the bodies being heated, will have to be resorted to. The authors have made some experiments in this line which are going to be published, and according to which the former hypothesis is the true one. According to this theory the inactive substance B is the one which disappears with the greater rapidity.

New Equipment for Fire Protection.—The Metropolitan West Side Elevated Railway Company, of Chicago, have recently installed a novel car equipment for fire protection at terminals and yards, of which some particulars are given in the *Street Railway Journal* of New York. It is composed of an outfit of large chemical extinguishers of the Nott Fire Engine Company's manufacture, which are housed in a fireproof car body. The car is 30ft. long and 8ft. wide, the house being 20ft. long and extending clear across the car, with a door at each end and a window on either side. The house is cased in corrugated iron, and the floor on the platform at each end is of ¼in. steel plate. In the car, at one side near the end, two duplicate horizontal pressure tanks are mounted side by side on the floor, occupying a space of 6ft. by 4ft. 6in., leaving a 3ft. passage. Through the centre of each tank from end to end runs a shaft, carrying two paddles, and terminating outside one end in a crank. In the top of each tank near the crank is a large hole, closed by a cap. Immediately under this hole the inside shaft and paddles are so bent and shaped as to form a cradle, in which the acid solder or jar is fixed while the whole shaft is rotated. This rotation of the shaft and paddles causes the acid to be spilt, and at the same time agitates the whole mixture, thus keeping up the pressure during the discharge. The water and soda are also introduced through this hole. Two 150ft. chemical hoses are provided, which can be worked singly or together from either tank, each hose line having a 250lb. pressure gauge mounted near its controlling valve. In the corner opposite the tanks stands an upright water-supply tank of 250 gallons capacity. The apparatus is operated by giving the crank a few swings and opening the valves. Only one tank is discharged at a time, the second one being reserved for discharge while the other is being refilled, thus maintaining a continuous stream. On the second pressure tank being put into action by turning its crank after the first one has been exhausted, the pressure rapidly rises, and the hose lines are cut off from the first tank and thrown on it instantly by the valves. The gas is then blown off from the empty tank by a drain valve and pipe, a fresh charge of soda is emptied into the cap-hole, a 3in. pipe with a gate-valve refills the tank with water from the supply tank, and after a few turns of the paddle crank, to stir the soda solution, the fresh acid-holder is set in, the cap screwed on, and the tank is ready for use again, the recharging being completed in four minutes. One tank will run seven minutes when supplying both hoses simultaneously at 150lb. pressure. The tests were so satisfactory that the Metropolitan Company is building four similar cars.

The Faraday Society.—In a paper on "The Hard and Soft States in Metals," read at a meeting of the Faraday Society, Mr. G. T. Beilby remarked that an exclusively crystalline theory of metal structure was insufficient to fully explain the wide range of phenomena associated, directly or indirectly, with the hard and soft states in metals. The author observed that the crystalline was not the only form of solid aggregate; the movement of the molecules in the liquid state may be so suddenly arrested that they have no time to fall into the regular formation of the crystalline state, so that the solid which results is amorphous, not crystalline. A suddenly congealed liquid may be likened to an instantaneous photograph of the rapidly moving molecules of the liquid state. As the result of the author's investigations, the view is advanced that the mechanical, electrical, optical, and thermo-chemical properties of metals, as well as the micro-structure, show that the two states are perfectly distinct phases, the soft phase, C, being crystalline and the hard phase, A, amorphous. The transformation of A into C is effected by heat, and takes place at a definite transition temperature. On either side of the transition point the various properties are characteristic and distinct; for instance, an E.M.F. of 120 microvolts may be developed in a thermo-junction of silver in the two phases. The E.M.F. falls to zero after the junction has been heated to 260deg. for a few seconds. The transformation from hard to soft is thermally irreversible, but is readily effected mechanically. This reverse transformation—soft to hard—takes place when the metal is deformed by overstrain, however slight. It takes place through an intermediate mobile phase, in which the molecules have a freedom analagous to that in the liquid phase. This freedom is produced by motion directly imparted to the molecules during the slipping of one portion of the material over another. The transformation C – M – A, while it occurs at every moving surface, does so as a rule in extremely thin layers. The layers of the hard phase which result supply a rigid casing for the unaltered crystalline elements, and thereby give a granular and cellular structure to metal which has been overstrained by having any kind of work done on it. The coexistence of the two phases in this way accounts, the author explained in conclusion, for the variety of structure which may be developed in malleable and ductile metals. The view was expressed by Dr. T. M. Lowry that the temperature which Mr. Beilby called the transition point was not a true transition point, such as exists, for example, in sulphur at 96deg. C., at which the rhombic passes into the monoclinic phase, but really the stability limit—*i.e.*, the temperature at which the mobility of the molecules enables a change which has been trying to take place all along to do so at a visible velocity.

Chemical Effects of Cathode Rays.—Dr. E. Bose, of Göttingen University, has for two years past made a close investigation of the simplest possible case of a chemical action of cathode rays, with a view to ascertaining whether or not the chemical conversion due to the rays is a purely electro-chemical phenomenon according to Faraday's law (see *Physikalische Zeitschrift* No. 12, June 15, 1904). A solution of caustic potash, saturated in the hot state, was exposed for a long time to the effect of cathode rays in a convenient outfit, allowing of an electrolyte surface of about 80 square inches being radiated upon intensely, when a reduction attended by the formation of hydrogen was noted. The amount of electricity absorbed

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by the electrolyte was measured with the aid of a hydrogen voltameter under reduced pressure, this electricity being drawn off through a platinum electrode sealed into the bottom of the testing tube. As the hydrogen present in the vacuum where the discharges took place was partly dissociated into hydrogen and oxygen, a mixture of hydrogen and oxygen, containing hydrogen in excess, was withdrawn by means of the mercury air-pump, and after the gases due to this dissociation were eliminated by an explosion, the hydrogen in excess could be measured, and its pure condition confirmed. Now, in the case of the chemical effect of the cathode rays following Faraday's law—*i.e.*, being a purely electro-chemical phenomenon—the amount of hydrogen derived from the vacuum should be strictly the same as that evolved in the voltameter. A high degree of accuracy was not to be anticipated on account of the smallness of the effects and amounts of electricity in question, but the invariable result of the experiments was in opposition to the above hypothesis, 10·30 and even more times the amount obtained in the voltameter being derived from the vacuum. There must therefore be, in addition to the electrochemical action, another chemical effect of cathode rays, due, obviously, to the kinetic energy of the cathode ray particles, this hypothesis being borne out by the theoretical considerations of the author. It is shown that in the most favourable case an amount of hydrogen even 1,600 times the electrochemical amount would be obtained, but it should be remembered that in most cases the greater part of the kinetic energy of the rays is simply transformed into heat. The author thinks his experiments are likely to bring about an agreement between existing divergent views as to the chemical or physical character of the effect exerted by cathode rays, as both kinds of effect seem to be present at the same time. Similar conditions will be met with in the case of Becquerel rays, though on account of the higher *fors viva* the dynamical effect is likely to prevail much more. On the other hand, passing to slower cathode rays, the dynamical-chemical effect should play a more and more secondary part, an effect of practically purely electrochemical character being eventually noted. The author opines even other forms of electrical discharges in gases to be likely to afford interesting material for the investigation of the electrochemical effects of electrons, allowing of a theory of electrochemistry without metallical electrodes being elaborated.

Incorporated Municipal Electrical Association. The annual general meeting of this institution, with which the convention terminated, was held at Derby on Saturday. The report showed that there had been a continued increase in the membership, which now aggregates 387. The balance-sheet, which showed a slight deficit, was adopted. In the course of the year the Parliamentary Committee dealt with a large number of enquiries from corporations and individual members upon various matters affecting municipal electrical undertakings, and gave careful consideration to the Supply of Electricity Bill, taking steps to ensure that the objections it had raised to several points in the Bill would receive attention. A case of drawing instruments was presented to Mr. Hedley Howard, of Manchester, for having won the associate's prize for a paper on "Steam-Turbines and their Efficiency Compared with Reciprocating Engines," the president remarking that the paper exhibited considerable ability and originality. The election of officers for the ensuing year resulted as follows: Mr. F. A. Newington (Edinburgh), president; Messrs. R. A. Chattock (Birmingham), and S. E. Fedden (Sheffield), vice-presidents. Council — Messrs. J. K. Brydges (Eastbourne), J. Christie (Brighton), A. S. Giles (Blackburn), H. Kilgour (Cheltenham), V. A. H. M'Cowen (Belfast), Councillor Panton (Bolton), H. F. Proctor (Bristol), Alderman J. P. Smith (Barrow-in-Furness), H. Talbot (Nottingham), Alderman Bruce (Sunderland), W. A. Chamen (Glasgow, past-president), S. L. Pearce (Manchester), Councillor Sinclair (Swansea), Bailie Willcock (Glasgow), and G. Wilkinson (Harrogate). The six last-named gentlemen are newly-elected members of the Council. Alderman G. Pearson (Bristol), Mr. J. H. Rider (London), and Mr. J. E. Edgcome (Kingston-on-Thames) were unanimously re-elected to the honorary positions of solicitor, treasurer, and secretary respectively. It was agreed to hold the next annual convention at Edinburgh, and Bailie Willcock (the chairman of the Glasgow Electricity Committee) invited the members to visit the latter place for an inspection of the extended generating stations and the turbine plant, which are expected to be completed by the date of the next convention. A resolution was passed at a special meeting amending the articles of association in regard to the qualifications for membership. The new articles read as follows: "Members.—10. Every member shall come within one of the following descriptions: (*a*) the member shall at the time of his election be the chief electrical engineer engaged on the permanent staff of an electrical undertaking owned by a local authority, or the chief assistant or head of any engineering department in connection with such an undertaking of an actual or constructing capacity of not less than 5,000 kw.; (*b*) the member shall be the committee appointed by a local authority to have control over a municipal electrical undertaking within the area of such local authority, and shall be represented as regards its qualification to vote by one member of such committee. Associate members.—11. Every associate member shall at the time of his election be an electrical engineer engaged on the permanent staff of a local authority in the capacity of assistant in a position of responsibility in connection with an undertaking having a plant capacity of at least 2,000 kw. Associates.—12. Every associate shall be an electrical engineer engaged on the permanent staff of a local authority in a position of responsibility in connection with an undertaking whose plant capacity does not exceed 2,000 kw." This resolution will be submitted for confirmation at a future meeting.

Tests of Cooper-Hewitt Mercury Vapour Lamp.—The *Electrical World* of New York describes some candle-power tests of a Cooper-Hewitt mercury vapour lamp of the type known commercially as Type H-4. The lamp, which is rated at three amperes and designed for a 110-volt circuit has a tube diameter of $1\frac{1}{16}$in. and a length of arc of 45·67in. The lamp was mounted at one end of a 5m. photometer bar and enclosed in a long wooden box at right angles with the axis of the photometer bar. At the middle of the box, in line with the axis of the bar, was a 2in. by 2in. opening. The box was well ventilated so as to give conditions as near normal as possible. The illumination from a 2in. length at the middle of the Cooper-Hewitt light was measured and the corresponding candle-power multiplied by the ratio 45·67/2, the length of the light-giving arc to the length of the tube used. The lamp and box were inclined to the horizontal plane through the axis of the photometer bar by an angle of 11deg. 20min. The lamp was compared with a standardised 32-c.p. incandescent lamp. The screen used was a Lummer-Brodhun. The balance point on the photometer bar could easily be located within 1cm., although the two sides of the screen showed a great contrast in colour. In the course of taking readings the screen was, of course, reversed, and the average reading taken. In the

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first of the accompanying diagrams Curve 1 represents the variation of candle-power and current; Curve 2 the variation of watts in lamp per candle-power; Curve 3 the variation of total watts per candle-power with current; Curve 4 the variation of current and volts across tube. In Fig. 2 Curve 5 represents the variation of candle-power and current; Curve 6 the variation of watts in lamp per candle-power and current; Curve 7 the variation of total watts per candle-power and current; and Curve 8 the variation of current and volts across the tube. The curves of Fig. 2 were taken when the lamp was new. The curves of Fig. 1 were taken after the lamp had been running about 24 hours. The reduction in candle-power noted is due to a coating, at first gray and afterward black, which gradually forms all over the inside of the tube. No life tests of the lamps were made, but of two lamps which had been run continuously, one burned out after 800 hours, and the other had not burned out after running 1,000 hours. The used-up lamp blackened somewhat similarly to an incandescent lamp. The immediate failure was due to the

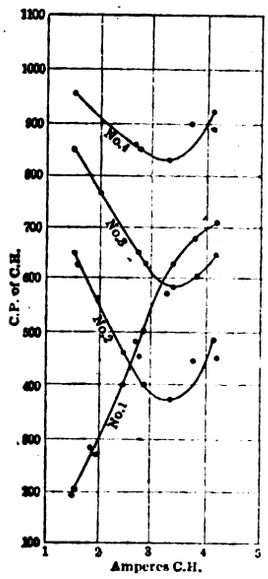


FIG. 1.

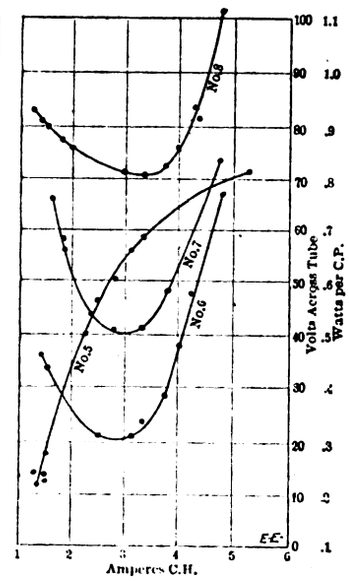


FIG. 2.

impairment of the vacuum, principally through leakage at the leading-in wires. For all curves the currents were read after the lamp had settled to steady temperature conditions, and the values used as abscissæ. All instruments were calibrated by means of standard cells and standard resistances. Curve 6 on Fig. 2 was obtained by multiplying volts across the tube by current and dividing by the candle-power corresponding to the current. It represents the watts per candle-power consumed by the lamp itself. Curve No. 7 was obtained by multiplying line volts (assumed constant at 110 volts) by current and dividing by corresponding candle-power.

The Rate Question.—A great deal of attention is being given in Germany to the question of rates of payment for electricity supply. Prof. Dr. Rasch discusses it in a recent issue of the *Electrotechnische Zeitschrift*. In his opinion the price per unit per annum, taking into account all concessions, should work out at the rate of

$$S = A + \frac{B}{T} + C \cdot n,$$

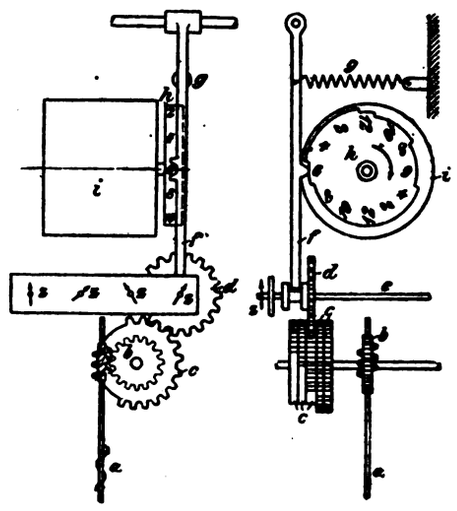
S representing the average price per unit, A B and C constants, T the mean demand $= \frac{\text{total annual consumption}}{\text{maximum demand}}$, and n the average load on the generating plant during the hours of demand. For example, suppose a consumer having a maximum demand of 2 kw. uses 200, 500, and 1,000 units at times when the load on the station plant is 100, 60, and 20 per cent. respectively. Then

$$n = \frac{200 \cdot 1 + 500 \cdot 0{\cdot}6 + 1{,}000 \cdot 0{\cdot}2}{1{,}700} = 0{\cdot}412.$$

and

$$T = \frac{1{,}700}{2} = 850.$$

The values for A B C need not be uniform for all consumers on a given supply. It may, of course, be advisable to give preferential rates to large consumers. The use to which the energy is put is of less importance than the time at which it is used. That this is now being recognised is proved by the introduction of the two-rate meter, which has already been adopted in some few instances. But while the institution of the two-rate system of payment marks an undoubted advance, it cannot be said to completely solve the question. Those who have recognised that it pays to sell current in the daytime at a cheaper rate than during the evening hours cannot deny that it could be supplied still cheaper during the night. If engineers have paused at the two-rate system it is not because it represents the acme of perfection, but rather that no cheap and reliable multi-rate meter has hitherto been obtainable. The author goes on to describe the Baumann multi-rate meter, which, in his opinion, fills the want. Accompanying are front and



side views of this meter. A motor, not shown, drives the toothed wheel, *b*, through the vertical spindle, *a*, the revolutions made by this wheel corresponding to the number of units consumed. Mounted on the same shaft with *b* are the toothed wheels, *c*, distinguished in that each has a different number of its teeth cut away, those remaining being arranged to coincide exactly, as shown, with the teeth of the companion wheels. Each of these wheels, in turn, serves to drive the gear wheel, *d*, the latter being mounted on the rectangular shaft, *e*, along whose axis it can be moved. This movement is effected through the lever, *f*, which is held in contact with the dial, *h*, of the clock, *i*, by means of the tension spring, *g*. By the movement of the dial, *h*, which occurs at intervals of an hour it follows that the gear wheel, *d*, will engage successively with the wheels, *c*, as the lever, *f*, is displaced by the steps provided round the circumference of the dial in question, a varying motion being thereby imparted to the rectangular shaft, *c*, and the attached hands, *z*. In other words the ratio of the gear through which motion is imparted to these hands is varied automatically with the time of day, hence also the price charged to the consumer for current, since the amount due from the consumer is indicated direct. A meter for, say, eight different rates costs little more than one for two rates. In conclusion, the author dilates upon the inherent possibilities of the system and points out its manifold advantages.

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THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

Twelfth Annual Meeting. — Cassel.

[FROM OUR SPECIAL CORRESPONDENT.]

(Continued from page 8.)

In regard to the standards for the use of electricity on ships which were approved by the meeting, as reported in the first instalment of this article, the desirability of the universal adoption of some such set of standards admits of no question. At the same time it is somewhat remarkable

Square—Old Cassel.

that it should have been left to Germany to take the lead in this matter, considering the preponderating interests of England afloat. It is, however, so far satisfactory that the importance of these standards has been practically recognised in England; the principal shipping companies having already signified their willingness to adopt them. The advantages to be derived cannot well be over-estimated. It was pointed out that their universal adoption would enable a uniform system of electricity supply to be introduced at the different ports of call throughout the world, thus enabling a ship in harbour to take a supply of current

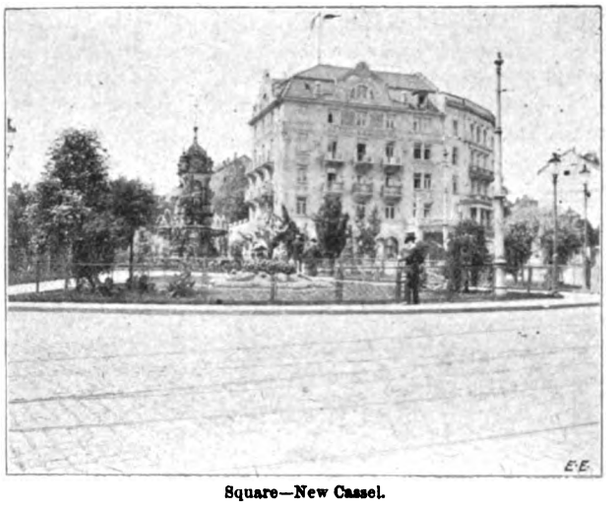
Street—Old Cassel.

from the shore station for power and lighting purposes, at a considerable saving in cost, not to mention the convenience of shutting down the ship's own plant. Moreover, the safety of ships would be increased not a little, since in the case of damage involving flooding of the boiler compartments, electric energy for driving pumps and auxiliary machines might be obtained from any steamship standing by. Or a stranded vessel might obtain current for lighting purposes in a similar manner, thereby enabling the salving of life and property by night.

Any one of the advantages enumerated is in itself sufficient justification for the introduction of these standards.

WAYLEAVES FOR TRANSMISSION LINES.

Three papers in all were contributed to the proceedings. One of these was read by Dr. Fick, of Berlin, and dealt with the question of wayleaves for power transmission lines. In the course of his remarks the author said that German legislation had maintained a wise reserve towards the new conditions which the growing importance of electricity had brought about. As a consequence, the development of the German electrical industry had hitherto been free and unhindered, while, on the other hand, that of England had been checked by the Electric Lighting Act of Aug. 18, 1882. In regard to transmission work, it was requisite that they should obtain that freedom of action so



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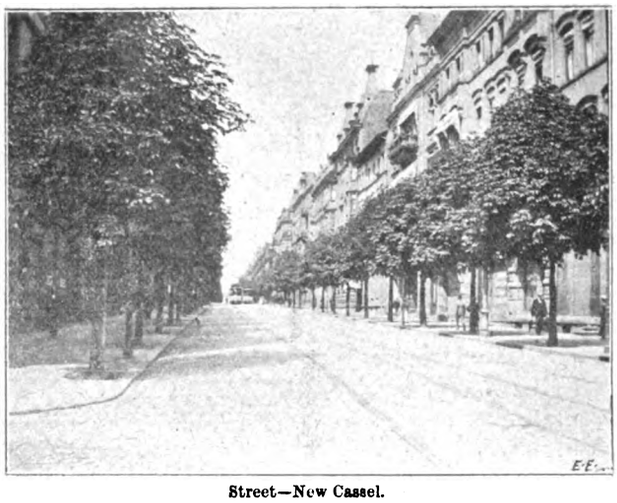
essential to the continued development of the electrical industry. Not only must it be acquired in the interests of the latter, but also in that of the whole community, if the possibilities of electric transmission were to be developed for the common good. Wayleaves were already provided for in the case of Government telegraphs. What they wanted was a similar right of way for their transmission lines, thereby enabling electrical energy to be distributed as an ordinary article of commerce. As the law stood to-day it might depend, in certain circumstances, on the mood of a single stubborn landowner whether



Street—New Cassel.

a community could be supplied with electrical energy from a central station. That was an impossible state of things, and must be rectified. Streets were poorly lighted; blacksmiths, joiners, locksmiths, glaziers, all suffered from the want of a suitable supply of energy for power purposes, while hundreds of others had to make shift with oil lamps or candles, as a source of artificial light, in dwellings and places where electric light might have been established to-day, had not the projected transmission line met with opposition from some obstinate landowner, who either absolutely refused right of way, or made an exorbitant demand for the concession, thereby wrecking the scheme. Even when consent was obtained, the landlord almost invariably reserved unto himself the right to withdraw the concession. Not until the principle

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of compulsory wayleaves for electric transmission lines was recognised and provided for by legislation could it be hoped that there would be any general development of the electrical industry by the erection of large works for the supply of electrical energy over wide areas. Legislation to the end in question would not only benefit already established undertakings, but also enable a large number of schemes to be carried out which were impossible now for economical reasons. In conclusion, the author hoped the Verband would do all in their power to promote the question.

In the course of the discusion which followed, it was suggested that wayleaves over public property should also be provided for by the law.

Subsequently, it was decided to appoint a special committee to deal with the question, its members to include some experts on cablelaying.

(To be continued.)

SOME NOTES ON TESTING.

BY C. H. R. T.

A good deal has been written at various times on the subject of testing, and the different tests to which dynamos and motors are usually subjected by manufacturers for the purpose of finding their efficiency, behaviour on load, etc., have many times been more or less fully described, but there are several simple little tests which are constantly made use of in the test-room, but which are never mentioned in articles and papers on the subject. Possibly it is owing to their simplicity that they are passed over, but as many of them come in very useful outside the test-room, and are not, in spite of their simplicity, too generally known among average engineers, it may be worth while mentioning a few which occur to the writer.

If a motor has to be tested, it is, of course, best to run it *as* a motor, but if current at the voltage for which the motor is designed is not available, it may be (and in practice often is) more convenient to run it as a dynamo. In the same way it may happen that no convenient means are to hand for mechanically driving a dynamo which has to be tested, whilst electrical power of the right voltage, by which it can be run as a motor is available. In the first case the motor is preferably run as a dynamo, at such a speed as to give the full voltage for which it is designed as a motor—and its speed will obviously be high. In order to find, from its behaviour as a dynamo, at what speed it will run as a motor on its proper volts, the following formula is used:

$$\frac{DS}{MS} = \frac{DV+LV}{MV-LV},$$

where DS = speed of machine running as a dynamo;
MS = speed at which machine will run as a motor on its proper volts (viz, MV);
DV = volts generated as a dynamo;
MV = volts for which machine is designed (as a motor);
LV = volts lost in armature and series field coils (if any).

In the second case, the dynamo under test is run as a motor on the voltage which it is designed to give as a dynamo, and its speed will, therefore, be low. In this case the same formula is, of course, applicable, the only difference being that the meaning of the symbols is slightly altered, they being now as follows:

DS = speed at which machine is designed to run (as a dynamo);
MS = speed machine runs at as a motor;
DV = volts machine will give as a dynamo at its correct speed (DS);
MV = volts on which machine is running as a motor;
LV = as before.

In both cases the resistance of the armature and series field coils, for calculating the lost volts, should be taken when the machine is hot after a run, but it is sometimes convenient to take a rough reading of the resistances before the run, in order to get at the size of pulleys, etc., required for the test.

Owing to the fact that when a motor is running as a dynamo, and *vice versâ*, either the speed or the volts (preferably the former) must differ somewhat from the speed or voltage for which the machine is designed, tests taken in this way are not absolutely reliable, but the error is usually very slight, and for most purposes negligable.

In compound motors and dynamos, it is often difficult to see which way the two coils on the bobbins are wound, and consequently they are often coupled up for testing with the series winding opposing the shunt. This, if at first overlooked, is generally noticed on starting up in the case of a motor, or in putting the load on in the case of a dynamo (or a motor which has started up all right). When, however, the amount of series compounding is comparatively small, a machine may often be started up and loaded without anything uncanny happening, and the high speed in the case of a motor, or low voltage in the case of a dynamo (neither being very marked), may be put down to faulty calculations on the part of the designer. If there is any doubt about the matter, a convenient and much-used way of satisfying oneself is to short-circuit the series winding for a few seconds, and observe the result on the load. In the case of a *dynamo*, the load—*i.e.*, external amperes—goes *up* if the series winding *opposes* the shunt, and it goes down if the machine is correctly coupled. In the case of a *motor*, the load—*i.e.*, the external amperes of the driven machine—goes *down* if the machine is *wrongly* coupled, and up if it is correct. The reason is obvious. The test is, of course, never required with heavily compounded machines, as the "nigger" will be discovered before getting much load on.

It is usual in manufacturing works to send machines in to be tested when they are in the rough state and not coupled up, in case any alterations are required in the windings. Although, therefore, a machine may have run correctly on test, it is not safe to send it away without a final inspection and coupling-up test by the test-room officials. These coupling-up tests are, of course, very simple, but mistakes are nevertheless sometimes made in carrying them out, and it may, therefore, be of some service to mention the points to be noticed. In these tests it is only necessary to run the machines round for a few seconds without any load, and the quickest and simplest way of doing this is to connect them up to an electrical supply and run them round as motors, even if they are going out as dynamos.

In the case of shunt and series motors these tests are very simple, as they should, of course, run in their proper direction if coupled up correctly. Compound motors should be run on the two windings separately—*i.e.*, the machine should be first run as a shunt motor, the series winding being short-circuited or cut out, and then as a series motor, the lead from the starter to the shunt terminal of the motor being left out. Both on the shunt and the series windings the machine will run in the proper direction if correctly coupled up.

In the case of dynamos a little more attention is required. Shunt dynamos, if correctly coupled up, will run as motors in their proper direction, but *series* dynamos will run in the *wrong* direction, or against the brushes. Compound dynamos will therefore run in their proper direction when running on the shunt winding only, and in the *wrong* direction on the *series* winding if correctly coupled up.

For these coupling-up tests it is most convenient to have supply mains of fairly low voltage—say, about 100 volts—laid on in a handy place so that all machines above that voltage may be run on them. Very low-voltage machines are scarce, and special arrangements must be made when they come along for their final test. In running, say, a 500-volt shunt machine on 100 volts, it will often require a push round by hand to start it, but once started, care must be taken that it does not attain a dangerous speed, owing to its weak field. The same also applies, of course, to running a series machine, or a compound machine with the shunt disconnected, on no load. If gauze brushes are fitted on a series or compound dynamo, it is advisable to only let the armature make one or two turns, or even only part of a turn, in the wrong direction, as otherwise the brushes may be damaged.

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When running shunt or compound dynamos as motors, one end of the shunt-winding must, as a rule, be temporarily disconnected from a main terminal, in order to connect it up to the "shunt" terminal of the motor-starter; but this temporary alteration to the final coupling up of the dynamo cannot, of course, affect the direction of rotation. In many cases provision is made on the dynamo for the insertion of a regulating rheostat in the shunt circuit, and then no alteration whatever has to be made in the connections when making the final test.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Ninth Annual Convention.

(Continued from page 16.)

Commercial Practicability of Electric Traction by Surface Contacts.

BY C. E. C. SHAWFIELD, A.M.I.E.E., M.I.MECH.E., BOROUGH ELECTRICAL AND TRAMWAY ENGINEER, WOLVERHAMPTON.

(Concluded.)

In the case of the Lorain system as installed at Wolverhampton, the current required for the operation of the circuit-closing mechanism in the track equipment, which is in this case the energy required for the excitation of the magnets, represents a power consumption of 670 watts per hour, which is equivalent, under ordinary conditions of service, to ·11 unit per car mile. The additional energy required to propel the cars owing to the extra weight carried must, of course, vary in different localities, being obviously more in a hilly district than in a flat. It would also be affected to a certain extent by the type of rolling-stock in use and the distance apart of the stopping places. It is therefore impossible to give a general estimate as to the additional energy consumed under this heading. In Wolverhampton the routes at present in operation include some rather severe gradients, and owing to the fact that a large proportion of the road surfaces in the vicinity of the routes are macadamised, the track is always very muddy and greasy in wet weather, and correspondingly dusty in dry weather. The tendency is therefore for the current consumption per car mile to be rather heavy, the average during the past 12 months being 1·49 units. The average total weight of a single-truck double-deck car, together with driver and conductor and an average number of passengers, but *exclusive* of Lorain equipment, is 8¾ tons. To this must be added the weight of the magnets, collecting skate, battery, cables, and connections of the surface-contact apparatus, amounting in all to one ton. The steepest gradient has a rise of 1 in 17, and there are a number of sharp curves varying from 40ft. to 37ft. 6in. radius. Under these conditions the author has calculated that the additional current consumption due to the weight of the Lorain equipment is approximately equal to ·13 unit per car mile. The *total* additional current consumption to be debited against the surface-contact system is in this case ·24 unit per car mile, or approximately 19 per cent. in excess of what would have been required by the overhead system.

Cost of Installation.

Although perhaps not of such vital importance as the cost of operation, yet nevertheless the capital cost of installation must weigh heavily in considering the merits of any system, and it is obvious, therefore, that any system of electric traction which desires to enter into competition with the overhead trolley system must be capable of being installed at a cost not very much in excess of the latter. It is very difficult, if not impossible, to give a general figure for the difference in first cost of the overhead system and the surface-contact system, owing to the fact that whilst the cost of the former is practically the same for either double or single track, the cost of the electrical equipment of the latter is obviously twice as much for double track as for single. Consequently the amount of the extra cost of installing a surface-contact system necessarily depends upon the proportion of double to single track on the routes concerned. Speaking generally, however, it may be taken that first-class overhead construction costs from £1,500 to £2,000 *per mile of route*, whether double or single, whereas the cost of the surface-contact system will be from £2,000 to £2,500 *per mile of single track.*

Disfigurement of Streets and Obstruction to Traffic.

It seems at the present time to be almost an article of faith amongst those in charge of the promotion of tramway schemes that the adoption of electric traction must of necessity involve the disfigurement of the streets, either by the erection of tramway poles and overhead wires or by the construction of an open slot between the centre of each track. It is true that great progress has been made in the direction of rendering modern overhead construction less unsightly and obtrusive than was the case formerly, but, nevertheless, it must be generally admitted that the introduction of the overhead system into towns like Manchester and Liverpool has to a very large extent spoilt the appearance of some of the finest streets and buildings in those cities. One has only to compare the present appearance of St. George's-square, Liverpool, or Piccadilly, Manchester, with what it was before the introduction of electric traction to realise the great disfigurement due to the erection of poles and wires along these fine thoroughfares. The author was speaking not very long ago to a Liverpool photographer, who informed him that at the present time it is practically impossible to get a satisfactory photograph of St. George's Hall from any point of the compass owing to the interposition of the network of overhead wires. Where centre-pole construction is in use, there is, in addition to the unsightliness involved, another very serious objection—namely, the obstruction to traffic. There can be no doubt whatever that the introduction of centre poles into a street of average width very largely reduces the accommodation for vehicular traffic, and materially adds to the congestion of the already overcrowded streets in many of our large towns. Where side-pole construction is adopted, this inconvenience is not so marked, although the presence of a large iron pole with massive base every 40 yards along the side walk is not by any means conducive to the comfort and convenience of pedestrians.

It is claimed for the surface-contact system that it offers less impediment to the free use of the streets and side walks than any other system of electric traction in which the energy for the propulsion of the cars is collected from an external source, and the experience of the author in connection with the Wolverhampton tramways leads him to believe that this claim is justified. It was anticipated when the system was first installed that trouble would be experienced through the metallic studs between the rails projecting above the normal level of the paving, proving a source of danger to the ordinary street traffic and to horses in particular, and that considerable expense would be occasioned through the extra wear and tear of the paving surrounding the studs. During the 2½ years that the system has been in operation no complaint of any kind has been received as to any obstruction or inconvenience to traffic having been caused by the iron top plates in the street surface, and, so far as the author is aware, no accident of any kind has ever been attributed to them. There is, moreover, no indication of any abnormal wear of the paving surrounding the studs, neither wood nor granite paving in the immediate vicinity of the metal top plates appearing to wear any faster than at any other parts of the track. On the score of appearance it may fairly be said that the surface-contact system is the least conspicuous and the least objectionable of any system of electrical traction; in fact, it is the author's experience that unless the track is abnormally clean and free from dirt it is very difficult to distinguish the studs from the remainder of the paving. During dusty or muddy weather it needs a close examination of the track to detect the exact whereabouts of the metal top plates, and probably owing to this reason a very large proportion of visitors to the town go away with the impression that the electric energy for the propulsion of the cars is carried in storage batteries on the cars themselves. There can be very little doubt that from the point of view of the property owner in good residential districts, the surface-contact system is distinctly preferable to the overhead system, as it is much less likely to cause depreciation in the value of the property adjoining the tramway routes. To illustrate certain points raised on this question of disfigurement of streets and obstruction to traffic, the author hopes to be able to exhibit several lantern slides of streets in Wolverhampton where the Lorain surface-contact system is in use, and of similar streets in other towns where the overhead system is installed.

In considering the results achieved at Wolverhampton in the operation of tramways by a surface-contact system, it should be borne in mind that in many respects the local conditions at Wolverhampton are probably more unfavourable to the successful operation of a surface-contact system than in almost any other town in the United Kingdom. Owing to the large number of factories in the town engaged in the production of stamped steel and iron articles, a very large quantity of scrap iron of all sorts and sizes is produced and has to be carted away from the various works. This scrap iron is usually very carelessly heaped in open carts, with the result that a considerable percentage of each load is scattered in the streets, and it unfortunately happens that the principal repositories for scrap iron are situated on the busiest tramway routes. As previously explained the presence of this scrap iron constitutes the most serious difficulty the system has had to contend with. The heavy rainfall of the last two years, in conjunction with the very general use of macadam in the majority of the streets in the town, has resulted in a clean track being a luxury but rarely attained, the track being usually covered with a sticky mud, which an hour or two's wind and sun speedily converted into equally objectionable dust. It should be pointed out, moreover,

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that in Wolverhampton the track is laid to a 3ft. 6in. gauge, and consequently the space available between the rails and between the side frames of the trucks for the reception of the surface-contact apparatus is comparatively limited, and the author believes that with the standard 4ft. 8½in. gauge many of the troubles experienced with the upkeep of the magnet and collecting skates would largely, if not entirely, disappear, and the arrangement of the track equipment at points, crossings, and other special track work would be considerably simplified.

The conclusions arrived at in the foregoing paper may be briefly summarised as follows: A well designed and carefully installed surface-contact system is superior to the overhead trolley system in respect of the questions of safety, reliability, disfigurement of streets, and obstruction to traffic. The overhead system is considerably cheaper both as regards the capital cost of installation and the annual cost of operation and maintenance. For tramway systems where low initial cost and low annual charges are the first consideration, and especially for light railways in thinly-populated districts, the overhead system is to be preferred. In many of our larger towns, and especially at watering places and other pleasure resorts, the surface-contact system has many claims for serious consideration in preference to the overhead trolley system. The author has made no attempt to treat this subject at all fully in the limited scope available in a paper of this discription, his object being merely to provide a basis for discussion of a subject which has previously been brought very little before the notice of tramway engineers as a body.

Discussion.

Mr. J. H. Rider, of the London County Council, opened the discussion, and congratulated the association on having such an excellent paper from Mr. Shawfield. Wolverhampton was the only town in the British Isles which had a surface-contact system of electric traction, and Mr. Shawfield was the only engineer who was able to give them his experience of working such a system. He asked the author how he arranged his car-sheds, as he did not see that there could be the pits which were required below all the tracks for inspection purposes. As regarded safety, which was the all important question, Table I. showed that there were on the average 21 studs alive per mile of roadway per annum. No system of overhead construction would be permitted with such a record. With respect to the trouble from scrap iron on the track he thought that Wolverhampton was the last place in which to try a surface-contact system. A parallel case was that of the first conduit line at Blackpool. The local conditions interfered with the working and threw back the development of the conduit system in other places. He then quoted the following extract from the paper: "The author has on more than one occasion watched a pedestrian step on a box which he has known to be alive at a pressure of 500 volts, as recorded by a Weston voltmeter, but in all cases the individual was apparently quite unaware of the fact." A little farther on the author stated that with falling trolley wires and lines and "live" tramway poles occurring frequently on the overhead system, the absence of injury to human beings and animals appeared "to be largely due to the beneficent interposing of providence." Mr. Rider thought that providence was a new name for a thick and dry leather sole, but he did not fancy a system which made the engineer so careless as to stand and watch pedestrians stepping on a live track. The author's comparisons of the overhead system and the surface-contact system were not fair, because there were 100 overhead lines to only a few equipped on the surface-contact system. Without doubt, trolley poles and the tramway poles in the streets should always be earthed up, but this could not be done with the studs of the surface-contact system, and there was absolutely nothing to show whether they were alive. Referring to the effect of a breakdown on one stud, Mr. Rider proceeded to argue that this would cause the current to be interrupted at the carbon contact in the previous switch, and that in consequence there was more chance of studs being left alive. He said that the author's remarks on the faults of overhead system were only applicable to cases of very bad design, he knew of no case where single insulation of the overhead wires was used. It seemed to the speaker that the heavy skates under the car hampered access to the motors. He concluded his remarks by repeating a conversation he had recently had with a Wolverhampton gentleman. This gentleman said that he was very pleased with the tramway system, and that they had the quickest service he knew of. It was due to the fact that the horses and carts always kept off the tracks.

Mr. Wedmore, of the Lorain Company, who spoke next, said that they preferred to try their system under the worst possible conditions, as if it was successful in Wolverhampton it would be much more successful in other towns where the conditions were better. He thought that the scrap iron which had caused trouble in Wolverhampton would also have seriously upset the conduit system of the London County Council. Wolverhampton had the only commercial system of electric traction by surface contact, and Mr. Wedmore proceeded to review the troubles which had prevented the continuation of the use of rival systems in other places. Mr. Rider was wrong in his supposition that the armature might be held up by friction, as the design of the apparatus absolutely prevented any friction between the carbon contacts. With respect to the weight of one ton of the magnet and skate, this compared with the half-ton of the plough on the conduit system. He had calculated that the extra electric energy required for moving this extra one ton per car was more than was required to excite the magnet.

Mr. Raphael commented on the lantern slides of overhead work which had been found on the screen. His experience of photographs of overhead construction was that the wires were difficult to see, and they always had to be thickened up before they could be used for reproduction purposes. He had never seen, however, a case in which this thickening up had exaggerated the appearance of the overhead wires as much as in the author's lantern slides. (N.B.—This invisibility of overhead wires in photographs is due to an halation effect with which all amateur photographers are conversant.—Editor *E E.*)

Mr. J. F. C. Snell (of Sunderland) confined his remarks to questions to which he would like further information. For instance, he wished to know the average leakage and how this complied with the Board of Trade requirements; how long it took to place a defective box, and whether they had trouble with horses sliding on the studs. If Mr. Rider's story was a true one, he congratulated Mr. Shawfield on being able to keep horses off the track. At Sunderland they had to bear on the average an expense of about £50 per annum per mile for repaving the tracks owing to wear. This was out of a total of £74 per annum per mile. If Mr. Shawfield with the surface-contact system was able to reduce this charge, it would go towards the extra capital charges on the cost of the system.

Mr. Stanley Clegg (Lincoln) was interested in the paper because they had practically decided to use the surface-contact system in the city of Lincoln. They were inclined to favour the Griffiths-Bedell system. He would like to know what was the drop in volts between the live cable and the motor terminal. He thought that Mr. Rider was wrong in his remarks as to the effect of a faulty stud, as all the arcing would take place at the road surface and not in the switch. The author in Table IV. had given the cost of repairs and maintenance of the track equipment at £21. 6s. per mile of single track. He had recently obtained from 30 different towns this cost for the overhead equipment, and the replies ranged from £5 to £95 per mile.

Mr. G. E. C. Shawfield, in reply, said that in their new car depôt they were having inspection pits under all the tracks. They found the best way of moving the cars in the shed was by means of a wandering lead. They had not had any extra labour in consequence of the increased difficulty of inspecting the motors and gearing under the car. The 119 studs which had been found alive in the course of a year rather exaggerated the matter, as although they were alive a shock could not be got from them for reasons explained in the paper. He thought that Wolverhampton was the best town in which to try the system. The studs were only found alive after a short-circuit, usually due to scrap iron, had occurred on the street surface. The small boys with bare feet made a practice of investigating the studs whenever they saw the flash under the car, in order that they might run to the power station and claim a small reward for reporting the live studs. In the same way the conductor, after a short had occurred,

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always went to feel the studs to see if they were alive, and in no cases had accidents occurred from this practice. He would inform Mr. Rider that, from his (Mr. Shawfield's) experience, the British Electric Traction Company used single insulation on the majority of their overhead work. Mr. Rider was wrong in his supposition that with one defective stud the current would be broken at the carbon contacts of the switch. The magnets held up the contact in this case until the circuit was broken at the street surface. He knew of 50 miles of track owned by the British Electric Company on which the troubles from this system mentioned in his paper obtained. In reply to Mr. Snell, he said that in dry weather the leakage current per car was inappreciable. In extremely wet weather, again, it was not more than one-tenth of an ampere. When the streets were extremely muddy, it was anything from 1 to 1½ amperes. The average leakage over the year worked out at about 0·008 of a unit per car mile. They could remove a box easily in 15 minutes and replace it with a new one; he could do it in 10 minutes. There was no need, however, to replace these boxes in the daytime, as the leakage was so small that they could be left in until the night. In the course of 2½ years they had had no accidents from horses or pedestrians sliding on studs.

The Organisation and Management of a Central-Station Meter Department.

BY A. J. CRIDGE, SHEFFIELD.

The object of this paper is to outline some of the methods adopted in the equipment, maintenance, and working of a meter department in connection with an electricity supply undertaking. In small stations it is usual for the mains engineer to take charge of the testing and installation of the meters required, but when the system has increased to a sufficient extent, it will be found advisable to start a separate department to deal with this work.

In describing the arrangements of the work of a meter department it will be convenient to divide it under heads, thus: I. Work in connection with meters. II. Work in connection with instruments and general testing. III. Work in connection with consumers' installations. IV. The commercial and clerical side. These heads may be further divided, as follows: I. Work in connection with meters includes (1) testing and calibrating meters; (2) fixing meters; (3) reading meters; (4) the maintenance of the station meters in a satisfactory condition. II. Work in connection with instruments and general testing includes: (1) testing and calibrating voltmeters, ammeters, etc.; (2) testing resistances; (3) testing lamps for candle-power, efficiency, and life; (4) testing appliances, such as fuses, switches, etc., when submitted for approval. III. Work in connection with consumers' installations includes: (1) the examination of new wiring while in progress on consumers' premises; (2) testing and connecting such wiring when satisfactorily completed; (3) attending to complaints of poor light, extinctions, etc., received during the daytime. IV. The commercial and clerical side includes: (1) entering up the monthly readings of the consumers' meters and making out the accounts ready for the general office; (2) keeping the records of the installations of all the consumers, noting alterations, disconnections, etc.; (3) keeping the meter stock, meters changed, reports, work, and other books of the department; (4) attending to consumers' complaints of accounts; (5) the consideration of any application for the supply of electricity at reduced rates, or for discounts; (6) the allocation of wages, expenses, and costs in connection with the department; (7) buying meters and looking out for the newest and best that are on the market.

A description of a system of interdepartmental working in use at Sheffield and some other towns may possibly be of interest, but as it is not entirely the work of the meter department it has not been placed under any of the foregoing heads. It will now be convenient to consider the internal equipment of the test-room. The test-room should be provided with sufficient shelves for storing meters; nothing is worse than to have meters on the floor or piled upon each other. There should be plenty of spare bench room, and a small vice attached to the bench is very handy.

I.—Work in Connection with Meters.

1. For the purpose of controlling the supply of electricity for testing a switchboard will be required. The one here described controls a maximum supply of 10 kw.—*i.e.*, 50 amperes at 200 volts single-phase alternating current. By means of a suitable transformer it is possible to get almost any voltage from 28 to 300 by altering the connections. This is done by causing the turns on the secondaries of the transformer to help or to oppose each other. Similarly, it is possible to get any current up to 300 or 400 amperes. The link connectors of the transformer therefore give a coarse adjustment, and the fine adjustment is made by means of suitable rheostats. The voltage is measured by Kelvin voltmeters, the current by Kelvin ammeters, and the wattage by a Kelvin balance. There are six main circuits, which branch off from the switchboard as follows: (1) experimental, (2) rheostat (large), (3) rheostat (small), (4) meter bench (one), (5) meter bench (two), (6) main coil of Kelvin balance. These are put in or taken out of circuit by plugs, and the ammeters are connected by plugs with flexible conductors attached. There are 12 pressure circuits provided, six on either end of the board. Only four of these are in use on one end and three on the other. They are as follows: I. (1) meter bench (1) top shunt circuit, (2) meter bench bottom shunt circuit, (3) experimental, (4) photometer; II. (1) meter bench (2) top shunt circuit, (2) meter bench bottom shunt circuit, (3) shunt of Kelvin balance. Two-pin plugs are placed across each of the main circuits for the purpose of measuring the pressure between any pair of circuit leads or absorbed in any piece of apparatus. The use of the main circuits is: (1) Experimental.—A pair of heavy cables run to a pair of big terminals on a bench. The current and the pressure can be adjusted to any figure desired, so that the circuit may be used for any purpose. (2) Rheostat (large).—This is for the control of currents up to 125 amperes. It consists of carbon plates, and the resistance is increased or diminished by slackening or tightening a screw. (3) Rheostat (small).—This is for the adjustment of small currents, from ·1 to 5 amperes. (4) and (5) Meter benches.—These are arranged to hold a total of 48 meters. The meters are placed in position on the bench and the series coils are disconnected from the shunt coils. The series coils are then connected to terminals on the bench by flexible connectors and the shunt coils joined across the proper pressure circuits by small flexibles, to which are attached two-pin plugs. Attention has been given in the design of these benches to the need of fixing up a number of meters for testing in the most expeditious manner possible. All connections are made by plugs or clips. To join up any terminals not in use, copper bridge pieces are employed. (6) Main coil of Kelvin balance.—The balance shunt coil is disconnected from the current coil, and the latter, which constitutes circuit 6, is plugged in in series with the meter benches and rheostats. The shunt coil is connected across pressure circuit II., sub-circuit 3. The use of the pressure circuits is almost obvious. On circuit I. the first two sub-circuits are for the shunts of meters connected to the top or bottom racks of meter bench I. The third sub-circuit consists of a pair of leads which run to two terminals on the working bench, and to which may be connected any apparatus which does not take very much current. The most frequent use to which it is put is that of running incandescent lamps which are undergoing a life test. Sub-circuit 4 belongs to the photometer, to which reference will be made under the heading II. 3. Two sub-circuits are not yet in use. On circuit II., the first two sub-circuits supply the shunts of meters on meter bench II., and the third is the shunt of the Kelvin balance. There are therefore three spare ways on this circuit. The testing of meters is carried out as follows. A number of meters having been joined up in series on the benches with their series coils disconnected from their shunt coils, the current flowing through them is adjusted by means of the rheostats and measured by the balance. A few revolutions of the disc are observed, and the time taken is noted by means of a chronograph. The testing constant of the meter being known, the percentage accuracy can be calculated from these observations. The practice seems to be becoming general among meter makers of constructing all their meters in such a manner that the disc revolves a certain round number of times per minute at full load. Thus Ferranti meters make 40 revolutions per minute at full load, Westinghouse and Schuckert 50, Electrical Company 60. Other makes of meters have a constant marked on the dial, giving the number of watts which cause the disc to make one revolution in an hour. Thomson-Houston meters form a well known example of this kind. A few words on the different kinds of meters will not be out of place here, but it is difficult to say anything new on this subject. The object of this paper is not to say which type of meter is best nor to go into many constructional details. It will suffice to say that any induction meter which is suitable for inductive as well as non-inductive load is usually good. The day of meters with commutators is over; there are now so many good types of induction meters which are greatly superior if only for this reason. The Aron meter is good, but the winding gear has been found to give a lot of trouble on alternating-current circuits; the contacts get dirty because of the sparking which takes place so frequently. Some meters are now constructed with cyclometer dials, and most manufacturers are willing to supply their meters fitted in this way. These are infinitely to be preferred to the old type; the possibility of error on the part of the meter reader is entirely eliminated, and consumers like them because they are easier to read, and they are thus enabled to check their consumption. It will be seen by making a small calculation that testing meters

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as described above is far more economical than the old-fashioned method of using a bank of lamps. A 10-ampere meter under the old method required two kilowatts at full load, the pressure being assumed at 200 volts. By the use of the transformer we have 10 amperes at 28 volts = 280 watts, plus, say, four to six watts in the meter shunt, or a saving in power of nearly 87 per cent. This saving will amount to a considerable number of units during a year.

2. *Fixing Meters.* — The meter, after being tested and adjusted, is sent out to an installation. The meter reader has to note the reading of the old meter, take out the fuses, take down the old meter and fix the new one, replace the fuses, note the reading of the new meter, and try it for starting with an 8-c.p. lamp. If it is a new installation, he has not to put in the fuses nor to try the meter, this being the duty of the testing inspector.

3. *Reading Meters.*—This will be described under IV., 1, referring to consumers' accounts.

4. The maintenance of the station meters is an important matter, and they should receive frequent attention. It is useful for many reasons to know the total number of units generated; the works costs, percentage of waste, etc., are all determined from this total. A small error in large meters such as these makes a lot of difference, and great care should, therefore, be taken that these meters are kept in an accurate and satisfactory condition. Demand indicators are not in use at Sheffield, but for the purpose of testing these a circuit would be run to a suitable rack, and the indicators would be connected in series and set to zero. The required current would be passed through them for 30 or 40 minutes, and readings would be taken. The necessary adjustments would be made from these observations.

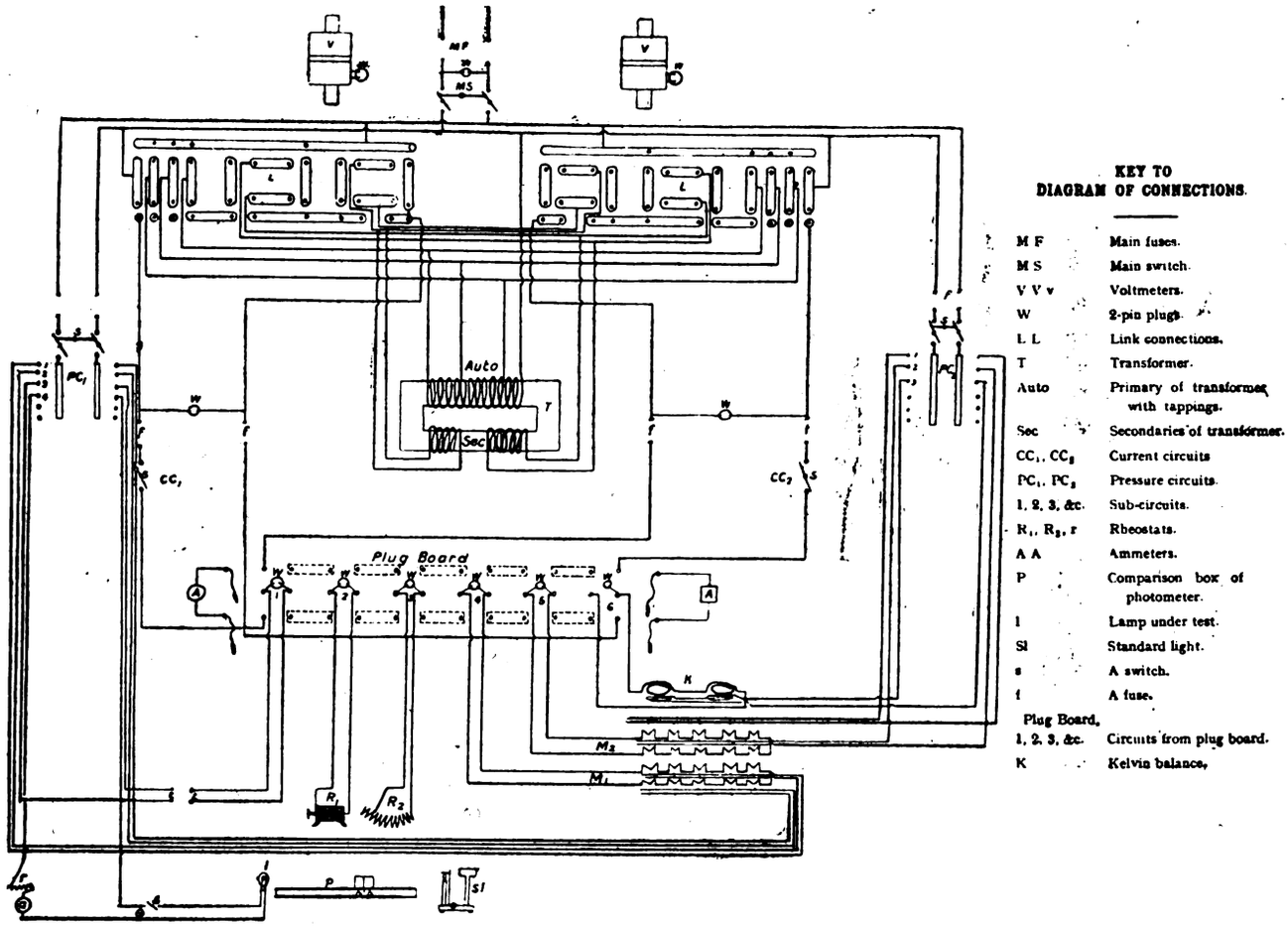
II.—Work in Connection with Instruments.

1. *Testing and Calibrating Voltmeters, Ammeters, etc.*—Any instrument which needs testing is connected across the experimental circuit in series with a rheostat and a standard instrument, and comparisons are made at a number of points in the range. No detailed description of this work is necessary.

2. *Testing Resistances.*—A Wheatstone bridge is the best thing to use for this work. The Vulcan ohmmeter is a cheap and useful instrument, the range being from ·1 ohm to 20 megohms, and the method of using the instrument is the same as the bridge.

3. *Testing Lamps.*—It is very useful to be able to test the candle-power and wattage of lamps, and to know the best lamp to recommend for consumers' use. One of the pressure circuits is in use for this work. A voltmeter, ammeter, and rheostat are connected on this circuit, together with the lamp to be tested. The standard light is a Simmance's 1-c.p. pentane lamp, and the comparisons are made on a direct-reading scale by means of a Bunsen disc. The photometer should be constructed for use in a light room, as space cannot often be spared to build a dark room. The results obtained by careful use of the photometer are very reliable. They agree closely with independent tests made elsewhere, although lamps often come out rather worse than the makers advertise. The lamps are put on for life test in a bank constructed to hold 25 at a time. Tests of the candle-power, etc., are made at intervals of 24, 100, 250, 500, 750, and 1,000 hours. The reason for the test at 24 hours is that some lamps increase in candle-power after they have been running a little while. It is frequently supposed by non-technical people that the energy taken by a lamp increases as time goes on. This, of course, is not the case; the total watts fall slightly, but as the candle-power falls more quickly the watts per candle increase.

4. Not many appliances for use in consumers' installations are submitted, but when they are offered for examination, tests are made under both normal and abnormal conditions. For switches, fuse-boxes, etc., the abnormal conditions are to operate on double their stated capacity at double the proper pressure. The testing of time switches, prepayment devices, etc., may be placed in this division. Two types of time switches which have been submitted for testing may be noticed with advantage. One, known as the tariff contractor, was designed for opening and closing the shunt of the second meter on two-rate systems. It is not intended for use on large circuits. It consists of a clock, driving two cams, which can be set to act at any desired times. When the proper time arrives the first cam causes the contact to spring together, the shunt of the meter is closed, and it registers. At the end of the peak time the second cam comes into operation and the circuit is broken. The second time switch, submitted by a Birmingham house, was operated by two clockwork movements, one of which indicated the time, while the other came into action when released at the time at which the switch was desired to operate. This second clock is driven by a powerful spring, and lifts the switch up or pushes it down by means of a connecting rod and suitable gearing. The few prepayment meters in use in Sheffield are of the vulcan type—1d. in the slot—which have proved quite satisfactory. The penny is inserted, and the handle turned until the coin is heard to drop, when the switch is closed, and the spring wound up to a certain amount. Eight pennies can be inserted at one time. Sixpence per unit is charged for current supplied through prepayment meters, this includes meter rent. The revolution of the meter armature causes the spring to unwind gradually, and when all the energy prepaid has been consumed, the circuit is broken. Practically no



KEY TO DIAGRAM OF CONNECTIONS.

M F	Main fuses.
M S	Main switch.
V V v	Voltmeters.
W	2-pin plugs.
L L	Link connections.
T	Transformer.
Auto	Primary of transformer with tappings.
Sec	Secondaries of transformer.
CC_1, CC_2	Current circuits
PC_1, PC_2	Pressure circuits.
1, 2, 3, &c.	Sub-circuits.
R_1, R_2, r	Rheostats.
A A	Ammeters.
P	Comparison box of photometer.
l	Lamp under test.
Sl	Standard light.
s	A switch.
f	A fuse.
Plug Board.	
1, 2, 3, &c.	Circuits from plug board.
K	Kelvin balance.

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trouble has been experienced with any of these meters since they were installed, with the exception of one or two cases where bent coins have been used.

III.—Work in Connection with Consumers' Installations.

1. *The Inspection of New Wiring while in Progress on Consumers' Premises.*—This is an important part of the duties of the testing inspector. It is difficult to make a thorough inspection of a completed installation; consumers naturally object to having floor boards lifted, capping taken off, etc., when the job has been finished off. It will therefore be found advisable for the inspector to visit new installations while actually being wired, when joints can be examined, samples of cable can be taken, the methods adopted for laying concealed wires can be enquired into, and any other examination can be made. By this means it can usually be assured that the job when finished will be satisfactory, and that all parties will be saved the inconvenience and annoyance entailed by repairs having to be made.

2. *The Testing and Connecting of New Installations when Satisfactorily Completed.*—After the inspection referred to in the preceding paragraph, very little remains to be done except to test the insulation resistance to earth and between leads. There are, it is well known, several ways of doing this. A convenient way is the use of Evershed's ohmmeter and generator, but it is more satisfactory to use the current from the town mains when possible. By this means any possible defect in the generator of the testing set, causing it to give less than the required voltage, is removed. Recently a useful little testing set has been introduced for use on alternating-current mains. Its only fault is that the top reading is only one megohm. It can be made to transform up to double the pressure on the mains and thus comply with the I.E.E. rules. When short-circuited it may be used as a voltmeter. Testing on direct currents may be carried out on the town mains with a Silvertown set, using a 5-c.p. lamp in series, or with a Kelvin set. This is obviously open to the objection that the test is carried out at the declared pressure, instead of twice that amount. In testing on the town mains with direct current, care must be taken to connect the set up properly, or the reading will simply show the resistance of the instrument itself, and not the insulation resistance to earth. The use of batteries is objectionable; they are messy and unreliable, besides which they are awkward things to carry about when they are made for 400 or 500 volts. The insulation test, then, being made, main fuses of the proper size are put in, the main switch is turned on, and all the lamps and other consuming devices are tried to see if they are in working order. The inspector should also try the meter for starting before leaving the job. It will be found convenient to test the amperes on the distribution circuit for a final check. It is not always easy to find the exact number of points on a circuit before the job is completed. For this purpose any small ammeter may be used; one of the watch pattern, reading up to five amperes, is sufficient for installations of incandescent lamps.

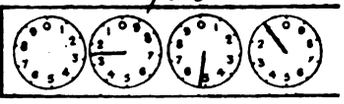
3. *Attending to Complaints of Poor Light, Extinctions, etc., Received During the Daytime.*—In the case of a complaint of poor light, it will be advisable in most cases to send up and see if it is possible to advise the consumer to make any little alterations to the distribution of his lamps, or to put in new lamps. This, of course, is in addition to taking pressure tests. It may be found that a consumer is using three five-light fittings in a shop where 10 lights placed in the proper positions would give him a better result and cost him less money. It is necessary to send a capable and tactful man on work of this kind. Extinctions may be attended to by meter readers, as they are generally due to a fuse having blown for some reason. The instructions given in the Sheffield meter department are as follows: (1) a form must always be taken and the consumer's signature obtained before commencing work; (2) the Corporation's apparatus must first be inspected and afterwards the consumer's installation—defects must be rectified as far as possible, and a full report made on the fuse form; (3) the new fuse inserted must always be of exactly the same size as the fuse blown, and if the new fuse blows it should not again be replaced. On the form referred to the consumer applies to the manager to remedy failure of electric light at premises situated ————, for which service the consumer agrees to payment of a fee, which is 1s. or 2s. 6d. according to circumstances. The inspector makes his report on the same form, and it is handed to the meter superintendent, who decides whether a charge is to be made or not and sends it down to the general office. The third instruction is given in order to ensure that no additional lights are connected without the knowledge of some of the staff. It will be noticed that the meter reader is not allowed to increase the size of the fuse, and thus neither can extensions be connected nor faults burnt out by the insertion of an excessive fuse. During the evening fault work is attended to by the mains department, but the procedure is similar in every way to that of the meter department described above.

IV.—The Commercial and Clerical Side.

1. *Entering up the Monthly Readings of the Consumers' Meters and making out the Accounts ready for the General Office.*—The procedure during meter reading will be readily understood from the following extracts from the meter inspectors' instructions. It should be understood that dial cards are used for taking the readings of the meters.

STREET East Street N° 99.
NAME Smith, J.
METER N° 123456 K 1
10/200

DATE 22-4-04



1. Meters must be read in the exact order in which the cards are placed, and each circuit must be completed before commencing another.
2. The exact position of the hands of the meter must be sketched on the reading card, commencing with the unit dial on the right hand; if a meter has more than four dials the reading of the others may be put down in figures at the left of the card.
3. The readings of meters must be entered on the consumer's meter cards with the date of reading, and initialled by the inspector. Readings should be compared month by month, and any abnormal increase or diminution in the consumption should be reported, in order that the same may be enquired into.
4. Each meter must be tried for starting with one 16-c.p. lamp, and any meter not doing so must be tried with more until it does start.
5. The number and size of any meter running on shunt, not starting with one 16-c.p. lamp, or being otherwise defective, must be taken, and entered in the report book the same day as found.
6. All Corporation seals on cut-outs, meters, etc., must be intact, and the Corporation's "Caution" label must be on every meter. Anything contrary to this rule must be entered in the report book the same day as found.
7. Inspectors must not make any remarks whatever on the state of the Corporation's apparatus or of the consumer's installation. All enquiring consumers must be referred to the office.

The monthly reading takes about 10 days. It is commenced every fourth Monday, so that there are 13 readings in the 12 months. Entering the readings up and settling the queries takes about 14 days. The readings are entered on account cards. The cards are arranged in the most convenient order for reading, and the town is divided into districts. Four men are engaged meter reading, and these follow each other on the different circuits every month: thus in January, A would take circuit 1, B circuit 2, etc.; in February, A would take circuit 2, B circuit 3, and so on. In this way each inspector checks the man who preceded him, and the perpetuation of errors is avoided. If the clerk considers any reading doubtful, he notes the name and address of the consumer with the suspected nature of the fault, and the foreman meter reader examines the meter, checks the reading, and decides whether or not the meter should be changed and tested. When all accounts are entered up and queries settled, the cards are sent down to the general office, where the invoices are made out and the ledgers entered up. Reading and account cards are ruled on both sides.

2. For keeping the records of consumers' installations cards are used giving full particulars.

3. It is almost impossible satisfactorily to keep meter stock records in books. It is better to use cards giving a description of the meter written along the top of the card, and below the movements of the meter are set forth, with dates against them, thus:

No. 123,456	Type N.	Volts 200.	Amps. 10.	K 1.	Testing K 20.
In from makers					20 . 4 . 04
Out to J. Smith, 99, East-street.....					22 . 4 . 04

Received from makers.	Date.
Sent to.....	,,
In from.....	,,

The tests made should be immediately entered in a day book, and with the aid of the date shown on the card it will not be difficult to find any desired test. It is advisable to change consumers' meters at intervals not exceeding two years. A convenient method of keeping up the proper rotation is to use a meter-changing card, ruled on one side, and giving particulars of consumer's name, address, district, pressure of supply, type, constant, size, and date fixed of the meter. This card should then be placed behind a guide card, showing the same month two years ahead.

Name: J. Smith. *Address:* 99, East-street.
District: 3. *Pressure:* 200.

Capacity.	Type.	Constant.	Notice sent.	Fixed by.	Date fixed.
10A	N	1	New consumer	Jones	22 . 4 . 04

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The balancing of the three-wire low-tension network is in the charge of the meter superintendent, and to keep this correctly recorded cards are used, showing the consumer's name, address, demand, polarity, and time of extinguishing. For a two-wire installation with two service lines, a white card is used; for a two-wire installation with three service lines, a salmon-coloured card; and for a three-wire installation, two blue cards. A "totals" card is put at the beginning of each street or section of a street, and this indicates the state of the balance on any particular section at a glance. The card which is left on the consumer's premises is ruled in three columns for date, reading of meter, and inspector's initials. It is made to fold double, and on the outside are placed the consumer's name and address, the number and size of the meter, and its constant for units. There are also a few printed notices and instructions for consumers.

3. The books used in the meter department need not be many. For the use and direction of the workmen three books are needed. They are: (1) the work book, in which particulars of fuse replacing, special meter readings, disconnection, reconnections, etc., are entered; (2) the meter-changing book, in which particulars of all meter changes are recorded; and (3) the inspector's report book, in which workmen report any remarks made to them by consumers, any defects in meters or other apparatus, or any similar matter. The installations connected are entered in a day-book, known as "Watts Wired Book." This book merely shows the name and address of the consumer, the distance in miles from the station, the wiring contractor, the consuming devices connected or disconnected, and the date. For noting particulars of installations, the testing inspector carries a pocket-book with the necessary headings printed in it.

4. It is the duty of the meter department to attend to consumers' complaints of accounts. This is rather a delicate matter at times. Consumers often do not sufficiently appreciate the fact that a few foggy days during a winter quarter make a difference in the amount of their accounts. They then make complaints and the matter is looked into. If the meter is apparently correct the consumer is asked if he will agree to pay the expense of testing if found so, while the Corporation make no charge if the meter is found to be inaccurate. This is, however, a rule which it is often advisable to break through to conciliate consumers. It is also advisable to send up to see if the consumer cannot economise by re-arranging his installation, as in the case of the complaint of poor light mentioned in III. 3.

5. Consumers who use a large amount of power frequently apply for a reduction in the price per unit, and this may often be profitably given. The calculation involved is simple. Taking the total units during a year, divide by 365; the result is the units used per day. Dividing this by the maximum number of kilowatts demanded, the number of hours per day during which the demand is maintained is found. The price to be charged may then be worked out on any two rates, such as 7d. for the first hour and 1d. afterwards. This is, of course, the maximum demand system without the demand indicator.

6. The allocation of wages, etc., is done weekly. It is hardly the object of this paper to advise as to financial management, but it is well to have as few accounts open as possible. Most wages are covered by the four accounts—meters, capital and maintenance, and testing, capital and maintenance. Tools and instruments are charged in separate accounts. The wages of meter readers are charged to revenue, but the wages of men engaged on new work are charged to capital. This, however, as stated above, is not the business of this paper.

7. The purchase of meters is an important matter, but it is more important to see that good meters are bought when a purchase is made. Most makers are willing to go to the trouble of sending a sample meter for examination, and whenever the superintendent of a meter department or the manager of a supply undertaking comes across a meter with which he is not familiar, he should at once endeavour to obtain one for testing. Manufacturers will always send if the user undertakes to buy the instrument if satisfactory.

The staff of the Sheffield meter department consists of meter superintendent, testing inspector and boy, chief clerk, two junior clerks and office boy, foreman meter inspector, meter tester, four meter inspectors, relief man—a total of 14 individuals. Their duties are obvious and have already been referred to in the descriptions which have been given of their work. The system of interdepartmental working before referred to will now be described. It is worked from the general office by mans of the "Ticket Book." The operations in connection with this book are the following: The intending consumer signs the application form and the clerk in the office writes the first ticket, giving particulars of the application. This is sent to the meter department, and the polarity, voltage, and number of service lines to be installed, are decided, and the counterfoil is sent back to the office. At the same time a ticket is issued from the general office to the mains department, directing it to prepare plans, etc. The third ticket to be written is sent from the general office to the mains department, and contains instructions to lay the service as decided above. When the service is laid, the counterfoil is sent to the office, which then sends out instructions to the meter department to fix meters. This is done, and the counterfoil returned. When the contractor's test notice is in and the meters are fixed, instructions to test and connect are sent from the office to the meter department, and when the job is completed the final particulars of the service are sent to the drawing office. Additions are dealt with in a similar way, and thus the necessity of allowing the consumer's application to go out of the office is avoided. This system has been employed at Sheffield for nearly four years, and has been found satisfactory.

This paper has been written with the intention of setting forth clearly and intelligibly a method of running a meter department, which has been tried for a number of years, and has been found to have few defects. The importance of the work of a meter department is not always realised, and if this paper succeeds in causing it to be better understood and appreciated it will have fulfilled its object.

Discussion.

Mr. J. Christie, of Brighton, thanked the author for the valuable paper which he had read. The difference between the units generated and units sold in electricity supply systems was more than could be accounted for by the distribution losses. If this difference could be reduced, as he thought it could, the saving would more than repay the extra cost incurred in meter testing as recommended by the author. He did not believe in a Corporation inspecting consumers' wiring as this should be done by the fire office.

Mr. Dick, of the Reason Manufacturing Company, lamented the fact that there was not a good English treatise on electricity meters. The German and American books did not cover the range of English meters. If they could make 2 per cent more revenue due to more accurate metering it was equivalent to a 15 per cent. saving in the coal bill. In testing meters they should distinguish between the inherent accuracy and the apparent accuracy of the meter. It was no use reading a large number of figures when the accuracy of the last two or three was nil. He thought it was best to buy the most accurate meter and not the cheapest. He quoted an American expert to the effect that the errors averaged against the supply company, and that the possible saving would often more than convert a non-paying company into one earning a good dividend.

Mr. J. Venner made some remarks as to commutator meters, and promised the author a new type of prepayment meter to test shortly.

Mr. W. A. Chamen, of Glasgow, was much in favour of cyclometer dials for meters, but had not found makers very ready to supply them. As regarded staff, Mr. Cridge seemed to recommend two classes of employés, both of which fixed and inspected meters. Was this so? They in Glasgow had put off the introduction of the penny-in-the-slot type of meter. Experiments in the gas department had shown that these meters were often tampered with.

Mr. J. K. Brydges, of Eastbourne, had had quite as much trouble with the permanent magnets of the commutator type of meter as with the commutators. He described a testing battery he had set up of test-tube accumulators with lead wires as electrodes. It was a cheap and effective form, and quite light. He asked the author if it was not illegal to give special reductions to large consumers.

Mr. G. Wilkinson, of Harrogate, criticised the large staff required by the author to look after meters. In his own case one meter man and two lads did the work, with 1,300 meters out on circuit. He made a point of advising all consumers whose consumption was found to be very small as compared with previous quarters that their meters had stopped, and that they would be charged for a consumption based on previous years. This always brought a reply if the reduction was due to the consumer not using the light. They had recently had an inspector appointed by the Board of Trade at Harrogate after much agitation on the meter question. The testing of 120 meters, all of which had been complained of, showed that out of bills totalling £6,000, the total errors were as low as between £30 and £40.

Mr. Cridge, in reply, said he had found that the fire offices did not test insulation often, but preferred to rely on the Corporation tests. He had only got 12 commutator meters, and thought that the commutator troubles were

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more than those due to demagnetisation of the permanent magnets. He had found makers most willing to use cyclometer dials for an extra charge of 1s. 6d. to 2s. per meter. This meter maker had also to do outside work, such as the fixing of meters, etc. There was no more illegality in special rates to large consumers than in the maximum demand system; both gave preferential treatment. The meter readers had always to test the starting up of the meter on one lamp when taking the records.

Polyphase Sub-Stations: Their Equipment and Working.

BY S. L. PEARCE, CHIEF ELECTRICAL ENGINEER, MANCHESTER.

Introduction.

The supply of electrical energy over very largely extended areas, either for traction or lighting purposes, or both, has necessitated the introduction of polyphase systems of generation, transmission at high voltages, and the distribution from corresponding sub-stations of low-voltage direct or polyphase currents. Again, the difficulty of securing convenient and suitable sites in the centre of the supply area has driven some municipalities to put down large generating stations on the outskirts of their towns, and in this case some system of high-pressure transmission and low-pressure distribution becomes a necessity. The sub-station and its equipment is, therefore, one of the most important factors in connection with such a system, and on its suitability success will largely depend. The author does not intend to put forward anything particularly original on this subject, but proposes to deal with the various types of sub-station equipments that have come chiefly within his own experience, and to consider some practical points that have arisen in connection with their working.

Considerations Determining Equipment.

There are several considerations which will determine the particular type of equipment to be employed, and it is desirable briefly to state these: (*a*) traction or lighting requirements; (*b*) frequency of the system; (*c*) two *v.* three phase. The first of these considerations is of great importance, as it will be seen hereafter that some equipments are more suitable for the ever-varying loads and overloads met with in traction work than for the steady lighting loads where a constant pressure is of prime importance. For "mixed" systems—*i.e.*, traction and lighting combined—it will be necessary to consider such equipments as will in a measure combine both the above points. The second consideration will depend almost entirely on the first. As the frequency of a system has such an important bearing on the capital cost, it is desirable wherever possible that this should be kept high, say from 40 to 50 cycles, otherwise the main generators, transformers, and motors will become much heavier, and therefore more expensive, and at this frequency "mixed" systems can be conveniently operated. The lowest frequency at which arc lighting can be done satisfactorily is about 42, and and incandescent lighting between 30 and 40. On the other hand, a low frequency of 25 is desirable for the operation of rotaries, as the difficulties of commutation and parallel running increase with the frequency. The third consideration—viz., the question of two-phase *v.* three-phase—will be decided on for reasons apart from those connected with the sub-station. The relative cost and efficiency of generating plant and transmission lines for two or three phase will have to be taken into account. It may fairly be stated that three-phase generators are cheaper to build and lighter than two-phase, whilst their efficiency is equally good, if not better. The transmission cables are simpler, as also are the switching devices. Theoretically, also, at any rate, a greater power can be transmitted in a three-phase system with a given weight of copper than on a two-phase system. As far as the machinery at the sub-station is concerned there is little to choose between two and three-phase where efficiencies and cost are concerned, as will be seen from Table I., which is taken from Mr. Field's paper on "Systems for Feeding Low-Tension Networks," read before the International Engineering Congress, Glasgow, 1901. Taking these various points into consideration there is little doubt that three-phase is to be preferred, as it is no more complicated than two-phase, has advantages in prime cost, gives a better over-all efficiency, and has been adopted in the majority of installations in this country. The author is aware, however, that there are one or two successful two-phase plants at work. In these cases two-phase has probably been adopted owing to a system of single-phase mains having previously existed. The change from single-phase to two-phase can be readily made, as has been done in the case of the Metropolitan Company, where two-phase motor-generators are used for that part of their system requiring direct current. The equipment to be considered in this paper will be of the three-phase type, with terminal voltages of from 5,000 to 10,000.

Converting Equipments.

(*a*) *Rotary Converters.* — The term "rotary converter" is intended to apply particularly to that type of machine in which the armature is provided with but one set of windings, the same winding serving to receive the incoming primary three-phase currents from the slip rings at one end and delivering the direct current on the secondary side from the commutator at the other end. The voltage on the alternating-current side between slip-rings is, therefore, a definite percentage of the direct-current voltage, being approximately 61 per cent. for three-phase working with three slip-rings, 70 per cent. for two-phase with four slip-rings, 35 per cent. for six-phase working with six slip-rings, and 50 per cent. for four-phase with four slip-rings. [These values are dependent on the pole width.] As rotaries must be operated at low-pressure, static transformers will be required to reduce the feeder pressure before applying to the slip-rings on the alternating-current side. The outstanding advantages to be obtained from the use of this class of converter are low prime cost, high efficiency, ability to stand overload limited only by the temperature rise, small floor space for a given output, and the high power factor which can be maintained over the system. On the other hand, there is a certain want of stability which manifests itself in sensitiveness to variations in the line voltage, causing difficulty in parallel running, and a tendency to hunt and get out of step. This want of stability is more noticeable in rotaries built with laminated steel poles than in those with solid pole pieces. The regulation also is not as flexible as in other systems, and switchgear and switching operations become somewhat complicated; but for purely traction schemes, their high efficiency, and ability to stand very considerable over-loads, are factors of great importance which more than outweigh the disadvantages named. Although the six-phase connection for rotaries is complicated, there is a considerable economy to be gained in the use of it—a fact which is being recognised in the latest installations in this country. Owing to the distributed nature of the tappings on the alternating-current side, the heating of the armature is more uniform, and there is consequently a considerable gain in the output, since this depends on the temperature rise. The step-down transformers may be connected up either "star" or "mesh." The advantage of the latter method lies in the fact that should one transformer be put out of circuit through any cause, the supply will not be interrupted; the remaining transformers will still maintain a three-phase supply to the converter, which can be run at its full load as long as the heating in the two remaining transformers does not become excessive. "Star" connected transformers are cheaper in first cost, since the pressure between the centre point of the star and the ends of either transformer is proportionately less than the line voltage. For lighting schemes with distribution on the three-wire or three-phase system, there is a distinct advantage to be gained by the "star" connection, since the centre point can be connected to the middle or neutral conductor for balancing purposes. It has been pointed out previously that rotaries should be operated at low frequencies of 25 to 30 cycles per second to attain the best results. This guarantees the more stable operation of the machines, and permits a wider range of compounding than is obtainable with higher frequencies. The author believes that the tendency in the future will be towards standardising periodicities of 25 and 50, as the latter, being an exact multiple of the former, enables the prime movers to be built on exactly similar lines, the only difference being in the number of poles. Where rotaries are being operated at 40 to 50 cycles, it would appear desirable to have connected on the same system a proportion of induction motors, which would tend to act as "electric dashpots" in the system, and thus help to make the rotary converters more stable than they would be in a system having nothing but rotories.

(*b*) *Synchronous Motor-Generators.*—This type of equipment

Table I.

Type of sub-station.	Cost.	Efficiency of equipment. Full load	¾-Load	½-Load	Total weight.
	£				Tons.
Three-phase rotary with transformers	A. 2,160	91	89·75	86·75	33
	B. 2,560	92	90·5	88	31
Two-phase ditto	A. 2,240	91	89·75	86·75	34
	B. 2,580	92	90·5	88	32
Three-phase synchronous motor-generator.....	A. 2,400	89·5	88·25	85·25	42
	B. 2,280	86·5	85	81·5	44
Two-phase ditto.....	A. 2,400	89 5	88·25	85·25	42
	B. 2,280	86·5	85	81·5	44
Three-phase induction motor-generator	A. 2,680	89	87·75	84·75	50
	B. 2,260	85·5	84·5	81·5	44
Two-phase ditto.....	A. 2,680	89	87·75	84.75	50
	B. 2,300	85	84	81	45

N.B.—A and B refer to different makers. All the above refer to 500-kw. converter equipment, operating at 25 cycles and 6,500 volts.

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consists of a synchronous motor driving one or more generators, the whole constituting one complete and self-contained set. No intermediate transformers are necessary, as the line pressure is brought straight on to the terminals of the stator of the motor. It is usual to build the motors of the revolving field type, with the exciting current led up through slip rings to the field coils, either from an independent exciter mounted on to the end of the shaft from the generator terminals, from the low-tension lighting 'bus bars, or other means to be described later. The merits of this system in which higher frequencies can be employed are simplicity of operation, flexibility, high power factor in working, and the fact that the regulation of one direct-current side pressure is independent of the alternating-current voltage. As compared with rotaries, they are some 3 to 4 per cent. less efficient, and their ability to stand overloads is determined by the overload capacity of the generator. For lighting and "mixed" systems the synchronous motor-generator has much to commend it on the ground of stability, satisfactory parallel running, and ease of regulation.

(*c*) *Non-Synchronous Motor-Generators.*—This equipment differs from the former only in the employment of non-synchronous motors in place of synchronous motors, and is the simplest type of sub-station plant that could be devised. The high-pressure currents in this case also are led either through choking coils or direct to the motor, and the starting up is accomplished from the high-tension side. Consequently no complicated switchgear is required, and synchronising is obviated. As with synchronous equipments, the regulation on the direct-current side is independent of the alternating current. The great drawback to non-synchrous motors is the comparatively low power factor at which they work. For mechanical reasons the width of the air-gap in induction motors is considerable, more particularly with small units, and it is advisable to watch this closely with a view to keeping it equal at top and bottom of the rotors. In order to avoid heavy lagging currents on the system, the motors should be run well up to their full load. Lagging currents not only waste energy, but pressure regulation becomes exceedingly difficult owing to their demagnetising effects. It is for these reasons that the use of small non-synchronous motor-generators alone is not to be recommended, but a combination of the types (*b*) and (*c*) can be used with good results. In every sub-station means must be provided for starting up from the alternating-current side in the event of low-tension direct current not being available. For this purpose the motor-generator with an induction motor is specially useful owing to the rapidity with which it can be started to enable a supply of direct current to be obtained for starting up the synchronous sets. If the latter be run with their fields "stiffened" or slightly over-excited, the heavy lagging currents of the induction motor may in some measure be compensated for, and the power factor of the system thereby improved. A modification of the ordinary induction motor-generator has recently been brought forward by one firm in this country under the name of "motor-converter." This combination consists of a direct-current generator coupled to an induction motor, the two machines being electrically as well as mechanically interconnected. High-tension currents at 50 periods circulate in the stator windings of the induction motor. Owing to the back E.M.F. of the direct-current machine the speed of the rotor, however, corresponds to half synchronism only. Currents are therefore generated in the rotor windings at a periodicity of 25, and these currents pass into the direct-current armature by suitable cross-connections, and are there commutated. Theoretically half the power of the combination is transmitted through the shaft, and the remaining half through the electrical cross-connections. In the first case, the direct-current machine acts as a generator; in the latter case, the motor acts as a transformer, and the direct-current machine as a generator. To a certain extent, therefore, this machine appears to combine the advantages possessed by both motor-generators and rotary converters, and the practical results obtained therefrom will be of considerable interest. The following table shows the relative cost, efficiency, floor space, and power factor of various sizes of the three classes of equipment, (*a*), (*b*), and (*c*):

VOLTAGE 6,500. FREQUENCY 50.

	Asynchronous motor-generators.	Synchronous motor-generators.	Rotaries.
Output	220 kw.	220 kw.	220 kw.
Costs	£6·1 per kw.	£5·5 per kw.	£3·8 per kw.
Efficiency (full load)	86 per cent.	89 per cent.	92 per cent.
Floor space	12ft. 3in. × 8ft. 5in.	12ft. 3in. × 8ft. 5in.	7ft. × 7ft.
Power factor (full load)	Approx. 92 per cent.	Approx. Unity.	Approx. Unity.

Fig. 1 comprises three curves showing the approximate relative cost of three types of sub-station equipment.

(*d*) *Static Transformers.*—The distribution of polyphase currents at low pressure is undoubtedly coming to the front. There are already in this country instances of new and successful public lighting schemes on this system, and a considerable demand is springing up in various towns for a supply of three-phase current to large works, more particularly in engineering and shipbuilding districts. A sub-station of this type has recently been put down in Manchester for the supply of three-phase current at 200 volts to some extensive locomotive works, where it is expected that the ultimate demand will be approximately 700 kw. It seems reasonable to suppose that the present recognised systems of converting alternating current to direct current will in time be superseded by one embodying direct transformation from high to low pressure. When one considers the increased capital involved in respect of plant and buildings for sub-stations equipped with rotaries or motor generators, the increased labour costs for running and maintenance, and the moderate all-day efficiencies obtained, it would appear that the polyphase system of distribution for mixed "lighting and power schemes" has much to recommend it. The three-phase motor is proving eminently satisfactory where speed regulation is not a prime essential, and the difficulties even in this respect are not insuperable. Three types of transformers have been employed in the equipment of sub-stations for obtaining efficient cooling: (*a*) oil-cooled; (*b*) forced draught ventilation; (*c*) natural draught ventilation. The transformation of polyphase currents can be, and more frequently is, carried out by the use of three single-phase transformers, which may be connected up either "mesh" or "star" fashion. The advantage of using three-phase transformers is a saving in copper and iron, resulting in a lower first cost; further, their common magnetic circuit tends to reduce any variation in the pressure between the phases, and for this reason they are preferable for use on lighting

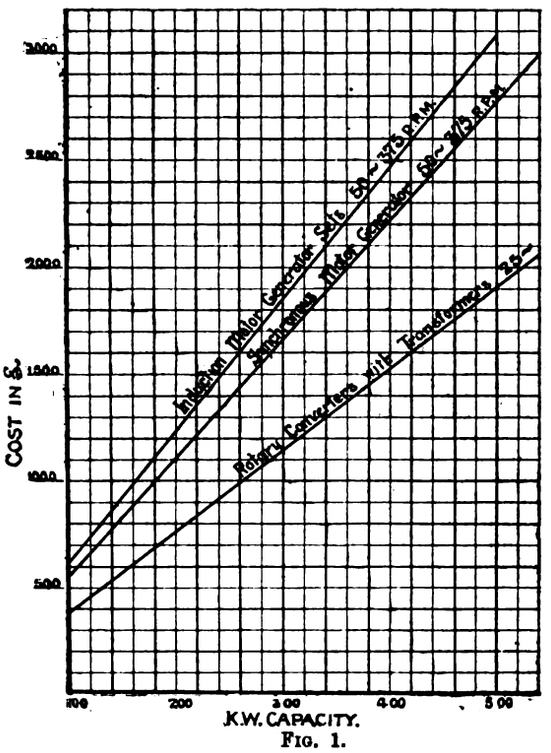

FIG. 1.

circuits. The great advantage in using the single transformer type is that breakdown risks are minimised, and a smaller amount of spare plant is required. These points largely counterbalance the advantages attendant on the use of three-phase transformers. Transformer units should be few in number, and of as large an output as possible, since, although any gain in efficiency by the employment of large units may be inappreciable, simplicity in the arrangement of the sub-station and the reduction of the switchgear required to a minimum are important factors. Either of the two first types (*a*) and (*b*) will give good results, particularly if in the former proper means are taken with the larger units for securing the cooling of the oil by circulating cold water through it, or *vice versâ*. The second method has been more generally used in the author's experience. This type of transformer constructed with sub-divided coils not only keeps the transformer cool by allowing the forced air to circulate, but renders it more easy to insulate for voltages up to 10,000 with perfect safety. Forced-draught cooling involves the use of a blower, which is usually driven by a small induction motor operating at low pressure. Such types of transformers are capable of giving very large outputs for their weights and high efficiencies. There is always the risk of breakdown of the induction motor to be reckoned with, a state of affairs which usually ends in the particular bank of transformers being put speedily out of commission. The third type has much to commend it, as without a doubt air blasts, oil, or any other cooling devices are somewhat open to objection. Given large radiating surfaces inside and out, combined with ample ventilating spaces through which currents of fresh air can continually pass, this

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type should give as good results as either of the former. The following table gives the comparative cost for the various types of a 250-kw. equipment, working at 5,500 volts and 50 periods:

	Three-phase transformers. £ per kw.	Three single-phase transformers. £ per kw.
1. Oil cooled	·8	1·4
2. Cooled by air blast	·78	1·17
3. Natural cooled	·9	1·5

SWITCHGEAR.

The author proposes to deal briefly with this part of the equipment of a sub-station, which has been very truly named the "nerve centre of the system," and upon the high-tension side of which the greatest care and thought should be expended both as to the design and general arrangement, so as to ensure safety and reliability.

Position of Boards.—It will be found convenient to place the high and low tension boards on different galleries, either opposite to or at right angles to one another, but on the same level, with easy means of communication between the two. This arrangement, besides having the advantage of separating the high-tension and low-tension gear, will facilitate the wiring up of the station, and avoid any dangerous crossings of the cables.

Type of High-Tension Board.—Much has been written of this somewhat thorny subject, and the matter is still to a great extent *sub judice*. Three distinct types, however, have come within the author's experience—viz., the flat-board, the multi-frame, and the cellular or compartment board. The former, with its exposed switches, fuses, and wiring, etc., mounted sometimes dangerously low down, and small space provided at the back is quite unsuitable for high pressures, and is rarely seen now in later high-tension sub-stations. Several modifications of this type, however, are in use, such modifications consisting in raising of the height of the high-tension 'bus bars and partially covering them in, live fittings of any description being exposed only at the back and top, the front being absolutely free from any high-tension work, and the instruments mounted at the front being worked off transformers. Examples of high-tension switchboards on these lines have been installed at the Central London sub-stations, and are doing good service. The "multi-frame" type of board may be said to represent very largely the continental practice, and consists of practically two or more distinct frameworks, the first carrying the marble front on which are mounted the switch handles and instruments worked off transformers. The second framework may be behind or above the former, thus forming a second gallery. This latter carries all the high-tension work. Ample passage ways are provided all round, and in addition all high-tension parts are enclosed in caging of iron meshing, with suitable doors which can be locked as required. This type has the disadvantage of taking up considerable floor space, but the possibility of attendants getting round to the high-tension portions at the back is not great, and the boards are readily accessible for cleaning and repairs when required. Next to safety should come efficiency and reliability, and on these points the multi-frame board gives excellent results. The "cellular and backless" type of board in one of its particular forms is well known in this country, and has been most extensively used in single-phase systems. Its adaptation for two and three phase working will be watched with considerable interest, especially as in some schemes it has come into direct comparison with the multi-frame type. The whole arrangement of this type of board is too severely compact for the higher pressures and powers, and repairs are not easily effected when required, but the saving in floor space is considerable, which is a consideration when sub-station sites are restricted in this respect. Other types are generally modifications, combinations, or extensions in some form or other of those named. In some cases the switchgear is sub-divided into sections, occupying different galleries, or forming groups on the same gallery. In other cases all the high-tension gear is remotely controlled, operated by hand direct or auxiliary relay apparatus, either electrical or pneumatic.

Arrangement of 'Bus Bars.—The arrangement of the 'bus bars is the first question to decide when the type of board has been settled. Simplicity, as far as it is compatible with reliability of supply, is essential. With a mixed system the author considers that this is fairly obtained by using one set of 'bus bars for lighting and another set for traction, every feeder and every machine being provided with "change-over" or "selector" switches, so that they can be connected up to either set of 'bus bars. In effect a set of duplicate 'bus bars is thereby provided. Means can also be provided if desired for coupling together the two sets of bars in the sub-station, but where it is the rigid practice to keep the traction and lighting 'bus bars separate, it may be desirable that coupling switches should be provided at the generating station only. In the case of a lighting system only, it is still advisable as a stand-by and as a means of isolating any generator on to any feeder, that a duplicate set of 'bus bars should be provided. The use of a second 'bus bar has always been found invaluable in the testing of any faulty feeder or machine, as it permits of this being done during the hours of ordinary supply. Such an arrangement of duplicate bars is, in the author's opinion, preferable to the so-called ring systems with disconnecting links. For these reasons the extra capital cost involved will be well repaid by the increased reliability and efficiency of working. The question of "fusing" or not fusing is one that is still being much debated. If fuses be decided on, then two conditions may be laid down as essential: (1) they must open circuit cleanly and without enabling a rise in potential to take place; (2) they should be situated on a gallery or in a basement alone, in short they should be severely isolated from the rest of the high-tension gear, where in the event of failure of action the damage is confined to a comparatively small area. They should also be in duplicate. It may safely be stated that excessive rises in pressure on interrupting the circuit are not experienced with oil-break fuses, but whether this or the ordinary type be adopted, the employment of spark gaps in addition on the system is to be recommended, as the additional expense is trifling. Someone has truly said that fuses are very good things to do without, and from the author's recent experience he is inclined to the conclusion that fuses are not to be relied on in extra high-pressure work, and that the substitution of an "overload" oil-break automatic switch with time limit and mechanical or electrical control attachment will give the best results. Such an arrangement should be fitted to each high-tension machine in the sub-station, the high-tension feeder ends being connected straight on to the 'bus bars, and controlled by automatic oil-circuit breakers of the overload type at the power-house end only. In some cases reverse current circuit breakers have been fitted on the feeders at the sub-station ends to ensure continuity of supply in the event of a short-circuit occuring on any one feeder. For the protection of high-tension overload circuit breakers in the event of a feeder breaking down, and to ensure their reliable working, the arrangement shown in Fig. 2 has been adopted in one or

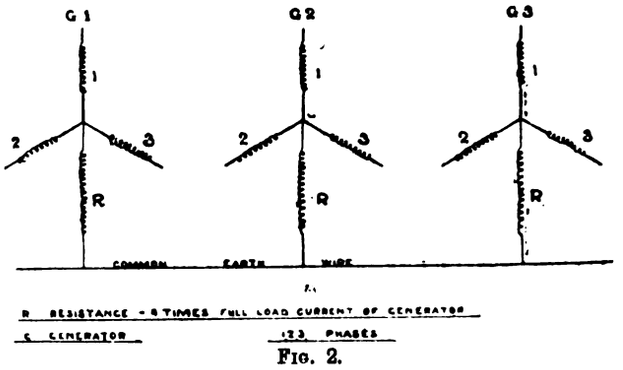

FIG. 2.

two systems in America, and is to be used on the Metropolitan District Railway, London. Between the centre point of the star winding of the main generator or the sub-station converters and the earth bar, a resistance is inserted which will only carry four times the full load current of the machine. As three-core feeder cables rarely break down between cores, but generally to earth, the amount of current passing can only with this arrangement equal four times the full load current of the generator.

Synchronising.—The tendency appears nowadays to be in the direction of synchronising at the line voltage. There appears to be little to recommend this, and it certainly is desirable on the grounds of safety to work off low-tension synchronising 'bus bars.

Cable-Charging Gear.—The question of the advisability of providing cable-charging apparatus is another moot point. The author believes that in the majority of case there is probably no need for this provision, and he would instance the Central London and Glasgow equipments with high-tension feeders some four to five miles in length. The American practice is decidedly opposed to the instalment of this apparatus, and there is hardly a power station in the States to be found so equipped. It would be out of place somewhat to consider the *pros* and *cons.* of the question in this paper, or of the various types used—viz., (1) separate motor-generator forming the cable charger; (2) water resistance; (3) the "Partridge" arrangement, involving the employment of a three-phase transformer, the primaries being connected in series with the three-core cables, and the secondaries connected up to a non-inductive resistance.

High-tension switchgear appears to be passing through a transition stage, designs seem to be changing almost every year, and nothing can be called standardised in this direction. Probably the design of the future will be one that combines the cellular or compartmental arrangement with remote control.

EXAMPLES OF ROTARY EQUIPMENT.

Fig. 3 shows the general arrangement of one of the rotary sub-stations in connection with the electrical equipment of the North-Eastern Railway. The size of rotaries employed is 800 kw. with three-phase connections. All the high-tension gear is placed down one side of the station, and the low-tension

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gear on the opposite side, with the rotaries and their accompanying transformers between. The incoming high-pressure feeders are fitted with spark-gaps, provision being made by means of isolating switches to allow of their inspection while the feeder is alive. The feeder switches are of the oil type, capable of breaking the maximum current of the station, and electrically operated from the low-tension board. In connection with these switches are reverse current relays, which automatically open the switch should the current reverse. The main high-tension 'bus bars are placed on the top gallery and enclosed in fireproof cubicles—the main switches being situated

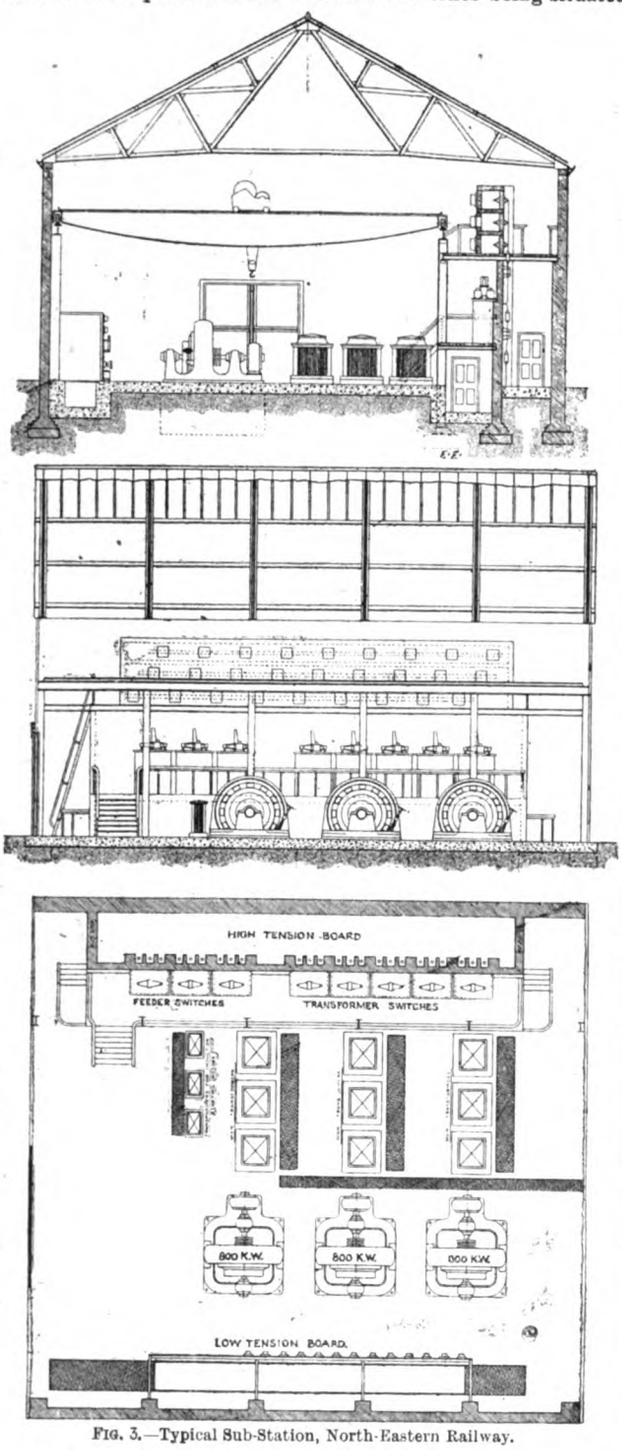

FIG. 3.—Typical Sub-Station, North-Eastern Railway.

on the intermediate gallery—the fireproof wall supporting the high-tension gear being built of cement blocks, with partitions between each phase and each circuit. Electrically-operated switches are placed in the circuit between the high-tension 'bus bars and the primaries of the transformers, fitted with time-limit overload cut-outs, the secondaries being connected straight on to the three slip-rings of rotaries. Provision is made for all high-tension circuit breakers to be inspected and cleaned with safety by means of isolating switches. The main transformers are of 280 kw. each, with a voltage ratio of 5,500/360 working at a frequency of 40. They are oil insulated of the self-cooling type, and are connected up in "delta." The rotaries are started up by means of induction motors mounted on an extension of the armature shaft, separate step-down tranformers being provided for the supply to these motors. The machines have an efficiency of 93·44 at three-quarter load to 93·94 at 1½ times full load. The low-tension switchboard, besides containing the ordinary panels for operating the direct-current side of the rotaries, comprises the panels for the operation of the oil-switches on the high-tension feeders and transformers.

(To be continued.)

PHYSICAL SOCIETY.

At the meeting of this society on June 24, Dr. R. T. Glazebrook, F.R.S., president, in the chair,

A paper on **"Chemical Dissociation and Electrical Conductivity,"** by **A. E. Garrett** and **Dr. R. S. Willows,** was read by Dr. Willows. It has been shown by Beattie (*Phil. Mag.*, 1899) that a mixture of salt and iodine, when placed on a zinc plate and heated, gives rise to electrical conductivity, although separately no such effect is produced. This is shown to be due to the formation of zinc iodide. Following on this the electrical conductivity produced by heating various salts is investigated under different conditions of temperature and electric field. A large excess of positive electricity is found in nearly every case.

Mr. Skinner expressed his interest in the paper, and pointed out that the chief leak did not begin until the iodine was completely vapourised. He asked if the ions were produced in the mixture or in the gas. Had the authors tried the effect of screening the mixture from the electroscope?

Dr. C. Chree remarked on the fact that the authors employed formulæ of the type $I = a t^n$, t representing absolute temperature under circumstances in which n was a large positive number, in one case as big as 100. To fit such a formula I must be practically either infinitely small or infinitely large, except over a very limited range of temperature. He should like some further details as to the method of arriving at formulæ of a type so remarkable physically, and as to the range of temperature wherein they were supposed to hold.

Dr. Willows, replying to Mr. Skinner, said that the effect was still produced when the mixture was covered with a metal plate, but they had not tried screening with mica. In reply to Dr. Chree, he said that their formulæ held over a range of 100deg. C., and that Dr. H. A. Wilson had arrived at a similar formula which applied over a range from 200deg. C. to 1,000deg. C.

A paper on **"The Magnetisation of Iron in Bulk"** was read by **Dr. W. M. Thornton.** The paper is in three sections. The first describes a method of measuring large quantities of magnetism by the use of an exploring coil placed around the core and an exciting coil in series with a recording milli-voltmeter. This was applied to determine the complete loops of magnetisation for two rings of cast steel and cast iron weighing respectively 3cwt. and 6cwt. The results were checked by a quantometer. The second section deals with the curves of rise of magnetising currents, when the core is solid and when laminated, as affected by the reaction of the core currents, and also by the change of permeability during magnetisation. A second simple method is given of measuring large quantities of magnetism in circuits having a large time constant, suitable for testing dynamo-electric machines. From two curves of rise, with the current in one reversed, expressions are given for finding the total induction in the core and its ratio to the residual magnetism. In the last section an example is given of the sudden dip in the curve of rise observed only with large cores. The growth of current in a coil surrounding a solid circular core is calculated by Heaviside's formula, assuming constant permeability. No dip is found in the calculated curve, and it is therefore caused by a brief magnetic impulse which corresponds to the slip of the molecules at saturation seen in Ewing's model of the magnetisation of iron. Photographs are given showing the direction of flow of eddy currents in cores of rectangular section of proportions 1 : 1, 1·5 : 1, and 2 : 1.

Prof. S. P. Thompson expressed his interest in the paper, and referring to the curves showing the rise of the magnetising current, said he thought the explanation given by the author was not the only possible one. He was not inclined to think that the effect was due to internal eddy currents in the core. The fact that the growth of the magnetisation current was irregular was well exhibited in separately excited dynamos with large field magnets, where the effect could be easily seen in the movements of the ampere-meter needle. In the author's curves showing the rise of the quantity of magnetism in a circuit with the current, first with the current direct and then with it reversed, he pointed out that a difference would be expected because the core would not be in the same magnetic condition at the beginning of the two experiments.

Mr. W. H. Pretty said that the question of magnetisation tests of iron and steel in bulk was a very important one. The curves shown by the author suggested the possibility of detecting cavities in steel castings, as such castings would doubtless give curves differing from those representing a truly solid block of the same material cast at the same time and subjected to the same after-treatment. It would be interesting to have a series of tests on the same block of steel, say, in which each process in the manufacture is represented—*i.e.*, as cast after annealing, and after the surface-scale or skin has been removed to various depths; also after the block has been cut up into slabs or laminæ and put together again. Referring to the dip in the curves of rise of magnetisation observed with large cores, Mr. Pretty said it was not unlikely due to internal mechanical stress and the accompanying strain, and that as it became possible to obtain steel more and more homogeneous such internal molecular changes would become more apparent.

Dr. Thornton, in reply to Mr. Pretty, said that he was now experimenting upon the effect of cutting up a large core into laminæ and then building up the core again.

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TRAMWAY ACCOUNTS.

Two sets of accounts relating to tramway matters have been recently issued, each of which is deserving of more than a passing notice, but we shall for the present confine our attention to one. The London County Council give the accounts for the year ended March 31, 1904, which shows a net capital expenditure in respect of the whole of the southern tramways of £2,124,228, of which £140,714 has been repaid out of revenue, leaving an outstanding debt of £1,983,514. The tramways include those worked electrically, with cables, and by horse traction. The detailed receipts and expenditure, unfortunately, give figures which are lump sums, and cannot, therefore, be read with any great amount of certainty. However, we give them as given in the report:

	Electric and cable.	Horse and cable.	Total.
Total receipts	£226,535 15 7	£309,703 11 11	£536,239 7 6
Working expenses	147,658 4 10	294,128 2 1	441,786 6 11
Gross revenue	78,877 10 9	15,575 9 10	94,453 0 7

The report remarks: "We wish to draw particular attention to these figures as showing the comparative receipts and expenses from tramways worked by electrical as against animal power, especially where the fact is taken into account that the total capital expenditure is about the same in each case." It would be much better if such utterly useless and misleading remarks were not made. They render such reports ridiculous, and tend to bring about the oft-repeated criticism that committees of the kind are incompetent and ignorant bodies. No useful comparison can be made from lump sums of the kind given. The whole of the conditions must be known and weighed before comparisons can be made. We must say we emphatically condemn the sentence quoted. It probably is the case that the percentage of working expenses to receipts is greater in the one case than in the other, and in favour of electricity, as has been proved in many instances, but these figures do not necessarily show it. The further figures given in the report do not help us, as they are not detailed. To really institute a comparison we must have not a combination of electric and cable, or horse and cable, but have electric, cable, and horse separately, the mileage receipts of each, and the working expenses per mile on each. No doubt such details are difficult or impossible to obtain; then why talk about comparisons. But we have said more upon this point than we intended. It is interesting to know that 133,139,085 passengers were carried during the year, an excess of 23,523,589 over the previous year, and that the car miles run was 11,536,534, an increase of 1,425,594 over 1902-3. It will be seen that the gross revenue balance is £94,453. The debt charges amount to £100,536, thus leaving a deficit of £8,283. We agree that this state of affairs cannot be regarded as unsatisfactory. The estimated deficit was £15,000. It must be remembered that the system has been in a transition state; hence the receipts will have been considerably diminished, and it is only just to admit that under normal working the deficit would have been changed into a very favourable surplus. Besides the lesser receipts there must necessarily be greater working expenses during temporary arrangements, so that on the whole as a business concern the management must be congratulated. The northern lines, being leased to a company, are not working under similar conditions to the southern lines, and the rent received from this source being brought into the totals gives a surplus revenue carried to appropriation account of £27,657. Roughly speaking, the foregoing gives the result of the year's working. Just a few words upon a subject to which it is well known we have given much thought. Even were the Council to proceed upon

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the lines of the past year, it will be seen that quite early the balance must be on the right side, and that the reduction of debt charges due to reduction of debt really will play a most important part in all undertakings wherein a compulsory reduction of the kind goes on.

RHYMES FROM THE OFFICE.

BY PABLO.

No. 1.—Overtime.*

[* For many years past it has been the custom of a certain electrical engineering firm to furnish "special" teas for draughtsmen and clerks when, owing to stress of work, overtime has been necessary. For some reason, economic or otherwise, a notice was recently posted to the effect that "teas *a la carte*" would be discontinued, but that a "good plain meal" would be provided for men working over. This called forth protests in various forms, one being the set of verses here reproduced. It is pleasing to add that the old order of things has been restored.—P.]

When your neighbour leaves at five—
As he ought—
Consolation please derive
From the thought
That you're staying without fee,
Not for filthy £ s. d.,
That you do it all for glory—
And the tea.

Though lungs cry out for air,
Fresh and free,
And the day be clear and fair,
Heed not the plea.
Could you ramble in the wood,
When you'd left (as if you could !),
Left the glory and the tea,
Plain and good ?

Do you think of eyes of brown—
Or, may be, blue ?
Can you see the gathering frown,
Through lack of you ?
Could you choose a better part
Than the breaking of a heart,
Just for glory and a tea,
NOT *a la carte* ?

EARTHING ARRANGEMENTS AND LEAKAGE INDICATING DEVICES.

BY A. S. C.

The writer does not propose to consider broadly the question of earthing supply systems, but rather to present the everyday practice, more particularly in connection with three-wire distribution systems. It has been urged by some engineers that the middle wire of a three-wire system should be earthed throughout its entire length, or at a number of points on the network. The practice in England, however is to earth the middle wire at one point only, generally at the central station, or distributing sub-station. In almost all cases a switch or fuse is placed in the earth-wire connecting the middle wire to an efficient earth, and a recording ammeter should also be placed in the circuit. A very usual method is to place a light fuse or automatic switch in the earth-wire and to connect a fairly high resistance across the terminals of the fuse or automatic, so that when an excess current, due to a leakage from one of the outers, blows the fuse or opens the automatic, the resistance is put in circuit, and the middle wire is not disconnected entirely from earth. Some indicating device, such as a bell or lamp connected across the terminals of the fuse or automatic, is generally used to draw attention to the earth current passing, and steps should at once be taken to localise and remove the fault.

A very good arrangement which the writer has had in use on more than one three-wire system, and which has been found very useful in localising faults, etc., is described below. A small earthing bar is arranged so that it can be connected to the positive, negative, or middle-wire 'bus bar by means of a plug or three-way switch. The earth-wire is taken from this bar through an ammeter and an adjustable resistance to earth. In the ordinary way this bar is not connected to the 'bus bars, but is only used when a leakage occurs. The middle wire is kept at earth's potential by means of the leakage indicating arrangement, which consists of four lamps connected in series across the outers, with the middle point earthed through a switch, and with a switch in each of the outers. So long as the system is free from "earths" the lamps burn half bright, and on opening either of the outer switches the lamps go out. Opening the middle switch which connects the lamps to earth should make no difference. A leakage occurring on either outer at once lowers the potential of that outer to earth, which fact is indicated by the two lamps on the side on which the leakage is, burning dull or going right out according to the amount of leakage, and the other two lamps becoming brighter to the same extent. It will be seen that a very slight leakage current will be sufficient to cause a noticeable difference in the brilliancy of the indicator lamps. If the leakage current is sufficient to light an 8-c.p. or 16-c.p. lamp, the indicator lamps on the opposite side of the system burn brightly. An "earth" occurring on the middle wire will make no difference in the appearance of the indicator lamps; but when one or other of the outer switches is opened, only the two lamps on that side will go out instead of all the lamps, as is the case when the system is free from "earths." The leakage current, however small, returning by way of earth is sufficient to light the lamps on the side left switched on. By this arrangement an "earth" on either of the outer conductors is at once indicated, and any leakage on the middle wire can be ascertained by opening one of the outer switches. So long as all the switches are in the middle wire of the system is kept at earth's potential. As soon as an "earth" is indicated on one of the outers, the earthing bar referred to before should be connected to earth through the resistance, which can be gradually cut out if the current is not too great.

If the fault is on some consumer's wiring, it is probable that the blowing of his fuses will result from "earthing" the middle wire, and the system will be restored to its normal state. If, however, the fault cannot be removed in this way, it is probable that it is on the mains, and steps should be taken to locate the trouble. A middle-wire "earth" is not of such importance; but in the writer's opinion all faults, however small, should be at once dealt with, and it is by no means such a difficult matter to keep a system absolutely free from "earths" as some engineers maintain. If an "earth" is indicated on the middle wire, the earthing bar should be connected to one or other of the outer 'bus bars, and the same process gone through as before. In the latter case, however, it is not advisable to keep the outer earthed for any length of time.

Unless the trouble is on the mains, it is more than likely that the momentary earthing of the outer will be sufficient to blow the fuses on the faulty wiring and so remove the "earth." This earthing of the outers need not be done at times of heavy load. A little thought and discretion must be used in the matter. If the fault is on some consumer's premises, it is probable that it will occur at about the same time each day, and an attempt can be made to blow the consumer's fuses as soon as the fault is indicated. It is better to put a consumer to occasional inconvenience in this way than to allow faults to go on developing all over the system on the middle wire, as there is sure to come a time when one of the outers becomes earthed, and then *all* the consumers who have faults on the middle wire of their installations will have their fuses blown at the same time. By having the middle wire earthed in many places, it also makes it most difficult to locate faults on the outers of the system.

The arrangement of earth lamps above described can be adapted to suit a five-wire system by connecting two lamps across each circuit, the middle point being put to earth through a switch as before. Of course, if desired, one lamp made for twice the supply voltage may be used in place of the two lamps in series, but necessitates keeping lamps specially for the purpose, whereas if two lamps are put in series on each circuit, lamps for the ordinary supply voltage can be used.

For a two-wire system earth lamps are not required, but

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the same form of earthing resistance with adjustable resistance may be used. The negative of the system should be kept earthed. But the positive should be earthed two or three times in the course of the day, so that any faults developing on the negative may be detected.

WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

(Continued from page 20.)

GERMAN SYSTEMS.

The Arco-Slaby System.—This system, which is in successful use not only in Germany, but in various other countries, is the product of Prof. Slaby—who was present at some of Mr. Marconi's earlier experiments in England—and his assistant, Count Arco. Many of the ships of the German navy and German mercantile marine are equipped with the apparatus of these inventors, and over 50 new stations on this system have been installed during the one year. The various arrangements described by Prof. Slaby cannot be fully discussed here, but the principal features of the receiving and transmitting circuits will be given.

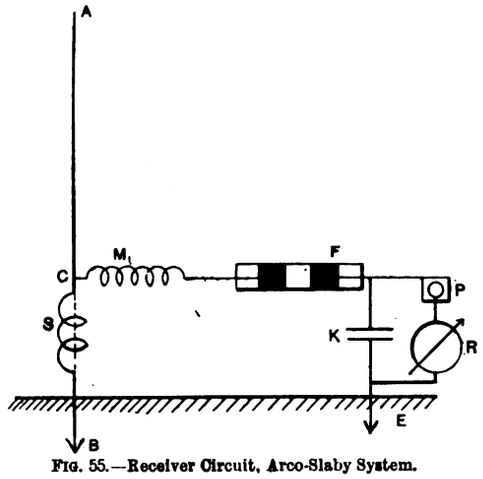

FIG. 55.—Receiver Circuit, Arco-Slaby System.

Fig. 55 shows one form of the receiving circuit, in which A is the aerial, M a coil "of special form and winding, producing at the coherer, F, a tension loop whose amplitude is considerably larger than at A." This coil, M, is called by Prof. Slaby a tension multiplier. Probably the reason for its use is the fact that at the top of an aerial the pressure is greatest (as shown in Fig. 3, p. 291), and hence the coherer ought to be placed there. This is, however,

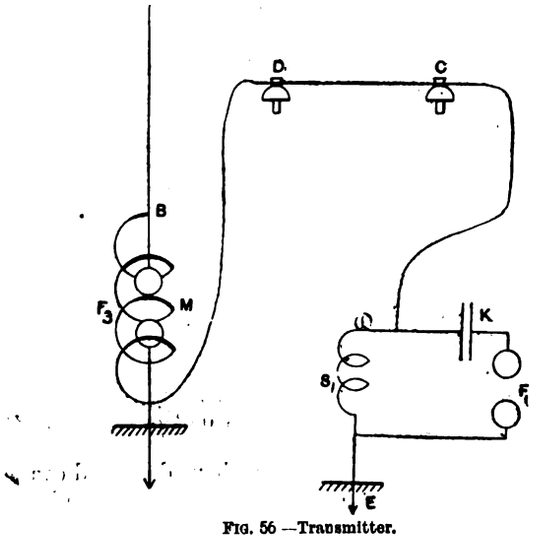

FIG. 56.—Transmitter.

not convenient, and Mr. Marconi got over the difficulty by introducing the transformer or "jigger" (nautical term for "hoister," used here because it hoists or raises the potential) at the foot of the aerial where the pressure is least, but the current greatest. Prof. Slaby by stretching a wire horizontally from the base of the aerial and making this wire of the same length (or inductance) as the aerial, gets a similar arrangement of pressure as in the aerial, and is thus able to place his coherer at a point corresponding to the top of the aerial. It is not necessary that this wire should be all stretched out straight, some of it may be in the form of a coil, and this coil is probably that to which Prof. Slaby refers in the passage quoted above. K is the condenser inserted parallel to the battery, P, of the relay, R. The capacity of K is about 100 times that of the coherer. Other arrangements are possible, for instance, in some cases two coils like M are employed, the coherer being connected to a point on the wire between them.

One form of the transmitting circuit, as used on warships, is shown diagrammatically in Fig. 56. The exciting circuit is earthed at E, and contains the variable self-induction, S_1, the condenser, K, the spark-gaps, F_1, and the insulated connecting wire, C D. In a watertight chamber on the deck is placed the multiplier, M, complete with spark-gap, F_3, and transmitting aerial, B. In the insulated wire, C D, there is, therefore, only the potential of the 15mm. spark-gap, F_1. In the aerial this is increased by the multiplier and spark-gap, F_3, to that of 150mm. or 200mm.

A complete station outfit for low-tension work is shown in Fig. 57, having the inductor (shown high upon the wall),

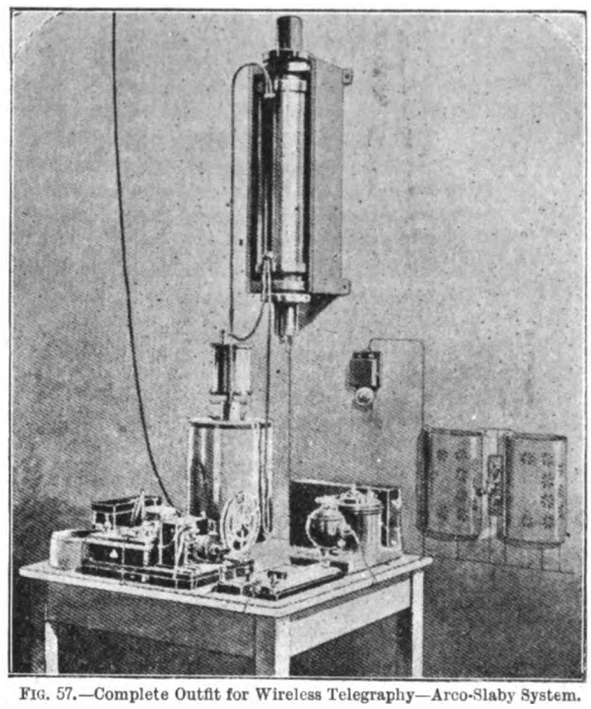

FIG. 57.—Complete Outfit for Wireless Telegraphy—Arco-Slaby System.

the primary condenser, turbine interruptor, Morse instrument, three-step regulating resistance, and lightning arrester. None of these call for special remark, except the mercury turbine interruptor (seen to the right on the table), which consists of a small turbine driven as a centrifugal pump by an electric motor. It squirts mercury through a small opening, two square millimetres in area, in a horizontal plane. A metal segment ring is placed on the turbine shaft, and the mercury strikes against this ring during a part of every revolution. The mercury is connected with one pole of the current supply and the segment ring with the other; the circuit is by this means opened and closed automatically with any desired frequency, which may be varied by varying the speed of the turbine. The turbine casing is filled with alcohol, to quickly extinguish the sparks caused by the break of circuit. For use on board ship the turbine is mounted on trunnions, so as always to remain with its axis vertical. This interruptor works very satisfactorily, but the use of several pounds of mercury is somewhat of a disadvantage, and to get over this difficulty another form has been devised, in which a disc provided with copper segments runs under carbon brushes, being driven by a motor, the variation of the speed of which gives the required variation of interruption.

For large electrical outputs the Grisson rotary converter is employed. This gives a true alternating-current instead

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of the interrupted direct-current, due to the turbine interruptor. It is shown in Fig. 58. P is the inductor, which has besides its two main terminals, P_1 and P_2, a third terminal, P_3, which is connected as shown. Direct-current is sent into coil P_1, P_3, and is kept on till it reaches a maximum. When this is reached the current is passed through the circuit of a second coil, P_2, P_3. The coils have a common iron core, which they magnetise in an opposite

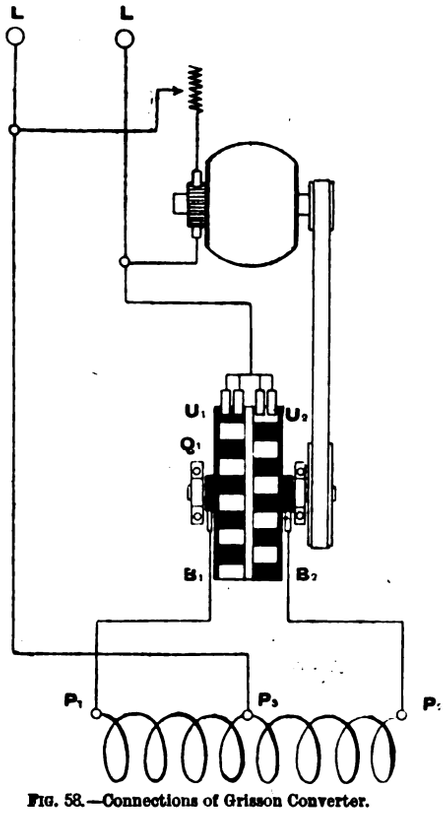

FIG. 58.—Connections of Grisson Converter.

sense, so that when the current is sent through P_2 P_3 a back E.M.F. is induced in the first coil, P_1 P_3, reducing the current flowing in it nearly to zero. At this moment the first circuit is interrupted, and the current in P_2 P_3 immediately rises to its maximum. These operations are performed automatically by a device consisting of two commutators, U_1 and U_2, insulated from each other and mounted on a common shaft, being fitted with collector

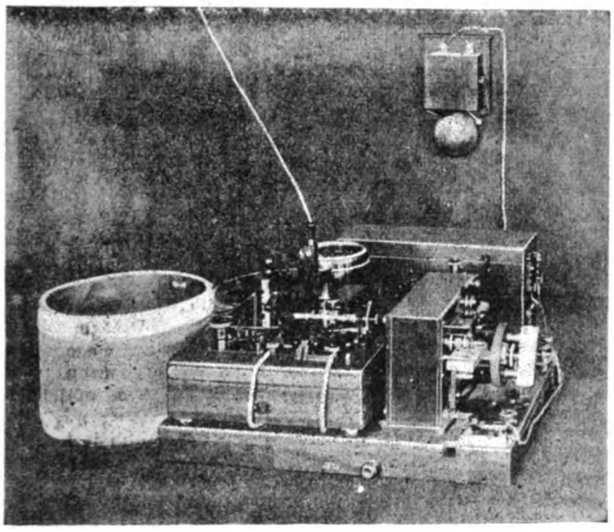

FIG. 59.—Receiving Apparatus.

rings, B_1 B_2, and on the other hand with a common brush, B_3, and makes contact alternately with the segments, U_1 and U_2, or connects them with one another. The contact device is driven by a small electric motor. This apparatus gives a pure alternating current, the frequency of which can be varied from 15 to 100 cycles per second. All the standard inductors of this company can be used with these converters by the addition of the connection P_3.

A view of the receiving apparatus for high-tension work is shown in Fig. 59. The receiver here consists of two separated circuits, which have been designated the weak current circuit and the heavy current circuit respectively. The weak current circuit includes the coherer (Fig. 60), interrupter, coherer cell, relay, condenser, regulating resistance, and make and break switch. The coherer is of special form (patented) which permits its sensitiveness to be varied at will. The ends of the silver plugs are *not* parallel, but taper. If placed with the smallest part of the opening

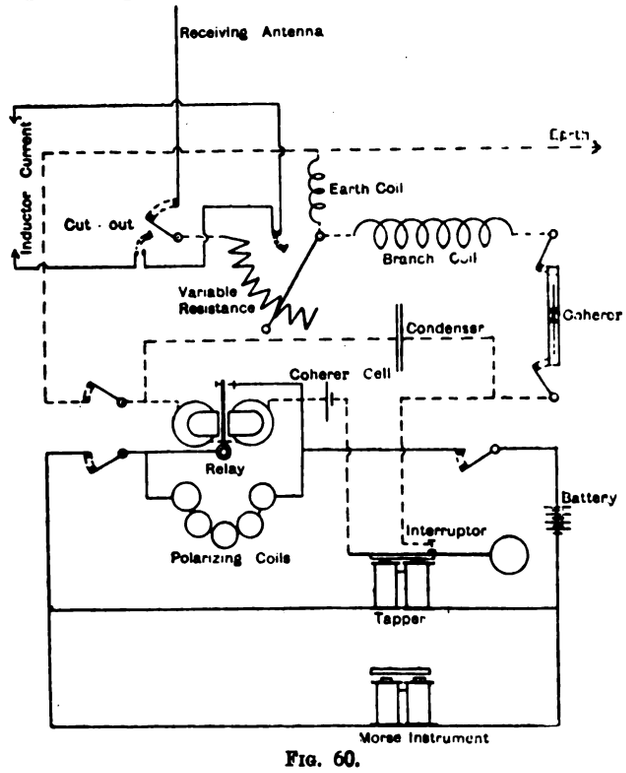

FIG. 60.

downwards the filings fill up the greater part of the space, and the coherer is then most sensitive. If the widest part of the slit is placed downwards, the powder is divided over a large surface, and the sensitiveness of the coherer is least. The "fritter" can be turned on its axis by a thumbscrew, so that any desired degree of sensitiveness can be given even when telegraphing. (The tapering ends are quite common, but the convenient means of turning the slit into any required position may be new.) The weak current circuit is shown by dotted lines, and the heavy current circuit by light continuous lines in Fig. 60. The latter includes the heavy current battery (not shown),

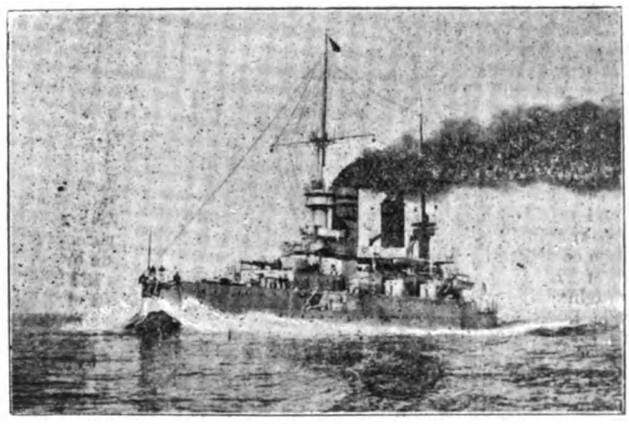

FIG. 61.—S.M.S. "Kaiser Barbarossa."

the tapper, the relay, relay working contact and tongue, polarising elements, Morse magnets, and the alarm (not shown) A microphone receiver of an interesting kind is employed when telephones are used.

The patents of this system are owned by the Allgemeine Elektricitäts-Gesellschaft, by whose permission these illustrations are shown. They publish full information, and show a fac-similie reproduction of a Morse message received

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from the steamship "Deutschland" when at a distance of 150 km. (94 miles).

A warship of the German navy fitted with an installation of this system is shown in Fig. 61. The receiving and transmitting aerials will be seen attached to a sprit on the foremast.

In connection with this matter of long-distance work, Prof. Slaby gives a curve showing the height of masts or antennæ required for a given distance. From this curve the writer has deduced the following approximate *law of distance*, $h^2 = 25{\cdot}6\,d - 112$, where h is the height of aerial in metres, and d the distance of transmission in kilometres. (A kilometre is about five-eighths of a mile.) This law must not be used for values of d less than 10 or greater than 140, and holds good only for distances measured over water. It gives the height of aerial slightly in excess of the correct value (as shown by the curve) for intermediate distances. Mr. Marconi gives the law $d = c\,h^2$, where d is the distance at which the signal may be received, h being the height of the aerial (both in metres), c a number varying from 30 to 1,000, according to the nature of the receiver and transmitter employed. Recent researches made by Mr. Marconi seem to indicate the possibility of tall masts and aerials being dispensed with to a large extent in the near future.

Installations in the Arco-Slaby system have been established for the following countries: Austria, Sweden, Norway, Portugal, Russia, Denmark, and Chili, mainly in connection with their marine requirements. A very interesting station has been fitted up; it is situated on the Zugspite, the highest mountain in Germany, from whence communication is kept up with a station 2,000m. (6,650ft.) lower down.

(To be continued.)

THE SUPPLY OF ELECTRICITY BILL.

The Select Committee of the House of Lords on the Supply of Electricity Bill are now dealing with and taking evidence from the Municipal Corporations Association, the County Councils Association, and the London County Council, as well as certain gas and electric lighting companies, with reference to the proposals of the Bill.

The adjourned meeting of the conference of municipal authorities and companies owning electricity undertakings, convened for the purpose of considering proposed amendments of Electric Lighting Acts and orders, was held on Monday at the St. Pancras Town Hall, the Mayor of St. Pancras (Mr. T. H. W. Idris) in the chair.

It will be remembered that at the previous meeting a committee was appointed, and the committee subsequently passed the following resolution: "That this meeting approves the provisions of Section 1 of the Bill now before Parliament intituled 'An Act to amend the Acts relating to Electric Lighting,' authorising the compulsory acquisition of land for generating station, and that, having regard (*a*) to the report of Lord Cross's Committee in 1898 that where the site for the generating station is acquired under compulsory powers, and is specified in the provisional order or special Act, the undertakers should not be subjected to any further liability than that which, according to Lord Blackburn (Geddis *v.* Bann Reservoir, L.R., 3 A.C., 453), is imposed by the common law in the case of persons exercising statutory powers and duties; and (*b*) that it is reasonable and desirable that the nature and extent of the liability of the undertakers for nuisance should be the same as regards lands now used by them for generating stations and lands to be hereafter compulsorily acquired by them for that purpose, the President of the Board of Trade be requested to include in the Bill now before Parliament a clause to the following effect: 'All lands purchased by any local authority, company, or person, by agreement or otherwise, acquired prior to the passing of this Act and used by them for the purpose of a generating station, substation, or transformer station, shall be deemed to have been purchased by them compulsorily for such purpose, and rules shall be made by the Board of Trade under Section 5 of the Electric Lighting Act, 1882, so as to exclude the application to any such lands of Section 81 of the Electric Lighting Clauses Act, 1899, or any similar provision in any existing electric lighting order of a local authority, company, or person.'" The committee also decided to ask the President of the Board of Trade to receive a deputation from the conference in support of their views.

The **Chairman** said that Mr. Gerald Balfour had stated that he was not prepared to receive a deputation, but that, as the Supply of Electricity Bill had been referred to a Select Committee, the best course for those interested would be to present their views to the committee. The Board of Trade proposed to ask the committee which had been appointed by the House of Lords to consider the Bill, to amend Clause 6, Sub-Clause 1, by the addition of a proviso to the effect that the sub-clause should not apply to any provisional order authorising a company to supply electricity (otherwise than in bulk or for power purposes only) so far as the order related to any district in which a provisional order was in force authorising the local authority to supply electricity. The chairman had presented a petition on behalf of the conference against the Bill, submitting that, having regard to the very large expenditure which had been incurred in the establishment of generating stations and to the great inconvenience and additional expense involved by reason of their being subject to injunctions, provision should be made in the Bill whereby they might be empowered to carry on their undertakings in the same manner and with the same exemption in case of actions for nuisance as would have been the case if they had been expressly authorised by Parliament to use the lands in question for working and using generating stations and plant thereon.

The conference having confirmed the action of the chairman in presenting the petition on behalf of the conference, and thanked him for his promptness and courage, they also agreed to the following addition to Clause 1: "(4) Where any local authority, company, or person having statutory powers of supplying electricity in any area are at the date of the passing of this Act working and using, or have prior to the passing of this Act worked and used, any generating, transforming, or distributing station upon any lands not specifically authorised by Act of Parliament to be taken or used for that purpose, or have prior to the passing of this Act acquired or contracted to acquire any such lands for the purpose of erecting thereon any such station, the Board of Trade may by provisional order authorise such local authority, company, or person to use or continue to use such lands for working and using thereon a generating transforming or distributing station." It was resolved to approve the action of the Shoreditch conference in opposing Clause 6. A committee of five, with the Mayor of St. Pancras as chairman, was appointed to watch the Bill through the committee stage of the House of Lords, and they were empowered to engage counsel and give evidence before the Select Committee.

PERSONAL.

Mr. F. E. Wilkinson, of Redhill, Surrey, at present engineer-in charge of the Reigate Corporation electricity works, has been appointed engineer-in-charge of the York electricity works at a salary of £100 a year.

Mr. J. Milward, chief of the electrical department of the Pacific Cable station at Suva, is inspecting the Australian, Norfolk Island, and New Zealand stations. Mr. Milward says the Pacific Cable is working splendidly, and he has no doubt that within a short time ordinary messages will go through to London in less than an hour.—*New Zealand Mining, etc., Journal.*

Mr. Francis Edward Macmahon, inventor of the telegraph tape machine known as the "ticker," died very suddenly at Newmarket on Tuesday.

Mr. T. W. Peckham, who for the past three years has been second assistant engineer at Hastings Corporation electricity works, has been appointed assistant to Mr. Leonard Andrews, managing director of the Key Engineering Company, Limited. Mr. Peckham was formerly a pupil of Mr. Andrews at Hastings.

The Bath Town Council have agreed that the salaries and wages of the following be increased from April 1 last—namely: Mr. F. Hale, station superintendent, £150 to £175 per annum; Mr. C. S. Walker, shift engineer, from 40s. to 45s. per week; that Mr. D. T. Miles, mains superintendent, be granted an honorarium of £25 in respect of extra duties extending over a period of two years past, and an increase of salary from 65s. to 70s. per week; Mr. Northcot, £150 to £160; Mr. Shapley, £150 to £175.

TRADE NOTICES AND NOVELTIES.

New Pattern Aron Portable Meter.

The General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., inform us that they are now placing on the market a new pattern Aron portable meter. This meter has been designed to meet the demand which has sprung up in connection with the management of the meter departments of electrical undertakings for a satisfactory means of checking the accuracy of consumer's meters "in situ." In a great many cases it is found that the removal of a contested meter only results in proving its accuracy, and thus entails considerable needless expense. By the use of the Aron portable standard the necessity of removing meters for testing is obviated, and the accuracy of contested meters may be proved or disproved in position. In general principle the meter is the same as the Aron meter in any of its other numerous forms, though arranged slightly differently to suit the particular class of work which it has to perform. Fig. 1 shows the general external appearance of the instrument, and Fig. 2 shows the same open and connected up by means of its flexible leads in series with another meter to be tested. The main points of difference between the standard portable and the ordinary type of Aron meter may be noted in the second illustration, and are briefly as follows: The pendulums are balanced and controlled by springs, which have the effect of making the meter more sensitive and independent of being set perpendicular, any ordinary table or floor being sufficiently level for testing purposes. The connections are all on the top of the meter case, and are plug type. The meter shown in the illustrations is arranged for 10 amperes at either 200 or 400 volts. The Aron portable standard meter can be arranged with any amperage up to 500 amperes, and any voltage or combination of voltages—

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indeed, the same meter may be made to serve for 200 and 400 volts, both alternating and direct. This, of course, makes

FIG. 1.

the meter a universal standard, and, combined with its extreme portability and accuracy without special precautions as to

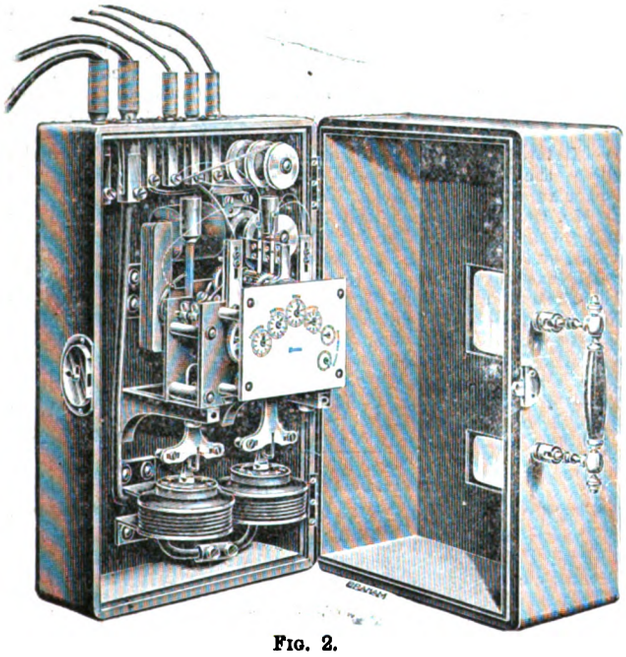
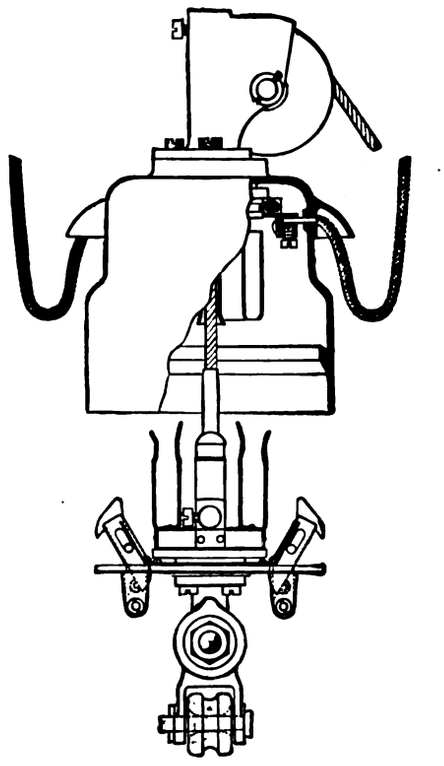


FIG. 2.

levelling, makes it a most useful instrument in any test-room equipment.

Arc Lamp Couplings.

The Bergmann Electrical Works, 6, Victoria-avenue, Bishopsgate-street Without, E.C., are placing on the market a new design in arc lamp couplings. The coupling proper consists of a cast-iron shell forming the top part. In the centre of this shell is a tube with a bell mouth, through which the hoisting rope passes, and when the lower part of the coupling carrying the lamp is raised, another tube enters this tube, thus ensuring the lower part of the coupling being quite central with the top. These two tubes are practically guides, the hoisting rope passing through the centre of both, as will be seen from our illustration. Under the weather-proof hood at the top are the two terminals; these lead to two circular contacts which are concentric with each other, the lower part having projecting lugs which make contact with the circular contacts in the top part. The contact area is ample for 20 amperes, though this is never likely to be reached in practice. Porcelain is used throughout for insulating purposes. There are also two other types, one with a device to relieve the hoisting rope of the weight of the lamp, which is set when the lamp is on the ground, and comes into operation when the lamp is raised, and another which also relieves the rope of the weight of the lamp, but acts automatically every time the lamp is raised there being no necessity to reset on each occasion, an operation likely to be overlooked if the trimmer is in a hurry. This arrangement for relieving the supporting rope consists of two catches which slip into a groove on the inside of the top part of the coupling, acting automatically every time the lamp is raised. These couplings are made with a pulley on the top of the upper half of the coupling, as shown in the illustration, so that it may be bolted to a plate or similar flat surface, where it may be fixed. The supporting rope is clipped by means of side pressure between two plates, and as the turns of the rope are of large diameter and the fastening is



independent of the sharp bend in the centre, the life of the rope at this point is longer than any other part.

Catalogues.

CRANES.—John M. Henderson and Co., King-street Engineering Works, Aberdeen, illustrates and describes the Mitchell-Williams patent compensating-derricking cranes. Fast and safe luffing has become an indispensable adjunct to all jib cranes used for modern dock, quay, warehouse, etc., work, and the great advantages to be gained by the use of the cranes, particularly on waterside work, will be apparent.

FORTHCOMING EVENTS.

THURSDAY-SATURDAY, JULY 14-16.

Association of Municipal Engineers.—At Shrewsbury, annual meeting.

GLOUCESTER ELECTRICITY ACCOUNTS.

The accounts of the Gloucester Corporation electricity department for the year ended March 31, 1904, show a total expenditure on capital account of £67,275. Appended are abstracts of revenue account, balance-sheet, and statement of electricity generated, sold, etc.

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,559	12	5
Repairs and maintenance of plant, etc.	152	14	2
Repairs and maintenance of mains, etc.	230	7	8
Repairs and maintenance of lamps	296	12	3
Rates and taxes	259	15	4
Management expenses—salaries, etc.	640	17	4
Insurance	48	18	4
Free wiring rental	10	8	9
Total expenditure	3,199	6	3
Balance of revenue account	3,170	18	11
	£26,370	5	2

Cr.	£	s.	d.
Sale of current, less discounts and allowances	5,964	9	10
Rental of meters and free wiring rental	173	4	7
Miscellaneous receipts	232	10	9
	£26,370	5	2

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BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—loans received, less paid off	49,397	8	3
General district fund—cost of provisional order	285	12	7
Sundry creditors and interest on loans	4,803	18	3
Due to treasurer	14,485	13	5
Amount of loan repaid out of revenue	3,477	11	9
	£72,450	4	3

Capital Outlay and Assets.	£	s.	d.
Capital account—amount expended for works	67,275	9	6
Stores in hand	1,300	17	3
Sundry debtors for current supplied	1,573	5	0
Public street lamps	329	19	7
Other debtors	101	19	1
In hands of engineer	10	0	0
Balance at debit of revenue account	1,858	13	10
	£72,450	4	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		431,993
Quantity sold: Public lamps	91,889	414,339
Quantity sold: Private consumers by meter	322,440	
Quantity used on works		17,654
Total quantity accounted for		431,993
Number of public lamps		74
Total maximum supply demanded (kilowatts)		358

BLACKBURN ELECTRICITY ACCOUNTS.

From the accounts of the Blackburn Corporation electricity department for the year ended March 25, 1904, it appears that the total expenditure on capital account to that date amounts to £220,466. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	7,386	8	3
Repairs and maintenance of plant, etc.	511	16	7
Repairs and maintenance of mains, etc.	1,011	6	0
Lamps, carbons, and fittings, etc.	1,190	7	7
Rates and taxes	2,019	3	6
Management expenses—salaries, etc.	1,685	5	3
Insurance	76	14	0
Bad debts	11	15	5
Total expenditure	13,892	16	7
Balance carried to profit and loss account	14,656	19	11
	£28,549	16	6

Cr. Income.	£	s.	d.
Sale of current to ordinary consumers	12,000	11	10
Public street lamps	2,304	8	8
Tramway	11,160	14	0
Other Corporation departments	1,018	1	3
Rental of meters	383	5	11
Rental of motors and lamps	453	17	7
Transfer fees	2	0	0
Sale of lamps, fittings, etc.	1,226	17	3
	£28,549	16	6

GENERAL BALANCE-SHEET.

Expenditure and Assets.	£	s.	d.
Capital account—amount expended for works	220,466	12	1
Stores on hand	1,900	3	10
Sundry debtors for current supplied	7,573	6	0
Sundry persons for lamps and fittings	2,814	9	7
Petty cash	10	0	0
Amount in banker's hand	4,980	1	8
Sinking fund account	837	2	11
	£238,581	16	1

Liabilities.	£	s.	d.
Capital account—amount received	206,701	3	10
Sundry creditors for coal and stores	5,176	19	6
Amount owing for interest on loans	1,320	0	0
Sinking fund account—amount uninvested	837	2	11
Amount to credit of depreciation fund	976	9	10
Surplus—loans repaid, etc.	23,570	0	0
	£238,581	16	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			3,327,116
Quantity sold: Public lamps	254,364		2,895,181
Quantity sold: Private consumers by meter.	855 105		
Quantity sold: Tramways	1,785,712		
Quantity used on works			77,752
Total quantity accounted for			2,972,933
Quantity not accounted for			264,183
Total maximum supply demanded (kilowatts)			1,778

Number of public lamps: 202 arc lamps, 432 incandescent lamps.

LEGAL INTELLIGENCE.

IS A CLERK A "WORKMAN"?

At Sunderland Police Court last week, Newton Cockburn, a clerk, was summoned at the instance of the Corporation on a charge of having refused to pay his tram fare. The town clerk (Mr. F. M. Bowey) prosecuted for the Corporation, and Mr. J. R. Storey defended.

The **Town Clerk** explained that on June 10 the conductor of a workmen's car, on going round to collect the fares, asked the defendant for his fare. Defendant asked for a "transfer." This was a workman's ticket, which enabled workmen to travel any distance on the system for 1d. The conductor pointed out that he was a clerk, and could not have a workman's ticket, but would have to pay the ordinary fare. Defendant refused to do this, and gave the conductor his name and address. The object of the Corporation was not to exact a severe penalty under the by-law, but simply to dispel any notion that people were entitled to take the benefit of these workmen's cars when they were not workmen coming within the section. The section relating to workmen's cars conferred benefits upon artisans, mechanics, and daily labourers, by running certain cars at such hours as might be most convenient for such workmen. Mr. Bowey quoted a dictionary definition of the word "mechanic," showing that the word applied to those who were skilled in the shaping of material, wood, or metal, etc.

Mr. Storey said that since the cars had been running to the East-end the clerks at the North-Eastern Marine Engineering Company had been getting these transfer tickets.

Colonel Reed (chairman): Because they have been doing wrong in another case, that does not affect this one.

Mr. Storey: It is a question of justification. According to the by-law, Mr. Bowey says only a man dressed in fustians and so forth is a workman.

The **Town Clerk**: I never said so.

Mr. Storey: It really amounts to this: a plater or riveter, a skilled workman earning £6 or £7 a week is entitled to get tickets for these cars, whereas a poor struggling clerk, with 20s. or 30s. a week, is debarred, simply because he has a clean collar and a black coat.

Colonel Reed: We sympathise with you, but it is the Act of Parliament we have to deal with. I don't think you will do much good by going on any longer.

The **Defendant**, in the course of his evidence, said that when he saw two other clerks, who were in a better position than himself, get workmen's tickets, he considered he was entitled to one.

By **Mr. Bowey**: He had always had workmen's tickets. He knew transfer tickets were issued from the Orphan Asylum. He had travelled on the same route, and been given a workmen's ticket since the summons was issued.

The **Chairman**, in giving the decision of the bench, said they were quite satisfied that the fare demanded should be paid, and that the defendant was not a workman, nor a mechanic, but a clerk. As the defendant had gone to some expense, he would simply be fined 1s., to include costs; but any repetition of the same offence would be severely dealt with. The public must understand that they were not entitled to travel as workmen unless they were *bonâ fide* workmen.

OBSTRUCTING A CAR.

The Colne magistrates last week heard a case brought by the Colne and Trawden Light Railways Company against a carter named Lee, who was in charge of a two-horse van, and was stated to have wilfully obstructed a car on two occasions by refusing to let it pass.

The main street of Colne, where the tramlines are laid, is very narrow for a considerable distance, and a wagon cannot pass a car except at one or two points.

The **Defendant** denied the obstruction, and on his behalf it was claimed that he had an equal right to the highway, no matter at what speed he was driving, and was not called upon to cross the road in order to let the car pass, and render himself liable to prosecution for being on the wrong side of the road.

The **Magistates** decided that there had been wilful obstruction, and inflicted a fine of 20s. and costs, but agreed to state a case.

COMPANIES' MEETINGS AND REPORTS.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.

At the annual general meeting of this Company the report, of which particulars were given in our issue of the 17th ult., was adopted. In December last concessions from the municipality were obtained for the electrification of the Company's undertaking, and also the Nueva system. The work of preparation for the laying of the track in Buenos Ayres is now actively proceeding, and the Chairman believed that before the shareholders met next year the Company would have reached that great landmark in their history when 30 miles of line would have been electrified, and when they would come under new conditions as to the pooling arrangement with the Nueva Company. Mr. H. F. Gunning was elected a director in the place of Mr. R. W. Cairns who resigned.

ELECTRIC CONSTRUCTION.

The following report is to be submitted to the shareholders at the eleventh annual general meeting. The net profits for the year amount to £14,773. 1s. 2d., and, adding £4,394. 13s. 10d. brought forward from last year, the amount available for distribution is £19,167. 15s. The directors recommend that this profit be appropriated as follows:

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dividend at the rate of 7 per cent. per annum on the preference shares (to be paid on July 30 next), £4,394. 12s.; dividend at the rate of 4 per cent. on the ordinary shares (to be paid on July 30 next), £8,968; to general reserve fund (which will then amount to £32,000), £2,000; balance carried forward to next account, £3,805. 3s. The year has been marked by excessive competition among the manufacturers of electrical machinery, and the Company's manufacturing profit has inevitably suffered. The competition still continues, and the margin of profit at present prices is small. The orders in the books include important contracts with the London County Council and the Great Western Railway Company. Revenue has been charged as formerly with £5,000 for depreciation, also with maintenance and all renewals of plant. The depreciation account now amounts to £53,000. The relations with the employés continue satisfactory, and the usual bonus, but reduced proportionately with the dividend, has been awarded to all who have for 12 months given good and zealous service. The balance-sheet shows an important improvement in the financial position. The Company's interest in the Crystal Palace District Electric Supply Company, Limited, which was taken over from the old Corporation has been sold; and the Madras electric tramways undertaking has been transferred to the Madras Electric Tramways (1904), Limited, in consideration of £50,000 in cash and £70,000 in fully-paid shares of that company, which, on the basis of last year's profits, should yield a dividend of 5 per cent. The cash thus realised has provided for repayment of the advance from the company's bankers. As the general reserve fund was partly made up of profit on other assets of the old Corporation previously realised, that account has been debited with £4,000 to meet the loss in realising these properties. The company's future income will benefit by these realisations. The directors who retire at the annual general meeting are Sir Henry C. Mance and Mr. J. Irving Courtenay. They are eligible for re-election. Messrs. James Meston and Co. offer a renewal of their services as auditors.

NEW GENERAL TRACTION.

The report of the New General Traction Company, Limited, for the 12 months ended March 31 last shows that, after paying £3,272 for general expenses, £9,294 for debenture interest, and £3,511 for interest on loans, a loss of £6,659. Deducting this from the balance brought forward, there remains £5,523, which is transferred to a special reserve account. In last year's report it was mentioned that measures were taken to overcome the difficulty which stood in the way of completing the Philadelphia system. Owing, however, to rigorous weather in the United States, it was not until the spring of this year that work could be resumed, and it is only within a very recent date that the directors have received cable advices that the through rail connection has been completed, so that the whole of the line should soon be open for traffic. The Parliamentary Bill for the extension of the Coventry tramway system was duly passed. A contract has been entered into by which the construction work at Coventry is now being carried out by this company. It is expected tha the new extensions will be finished before the end of the year, and the relaying of a portion of the existing old track should be completed shortly afterwards. To enable the Company to carry out these important works, to complete the Philadelphia system, and to provide for the general purposes of the Company, an issue has been recently made of £80,000 4 per cent. prior lien debentures, of which £60,000 has been subscribed at 97½ per cent. and allotted.

NEW COMPANIES REGISTERED.

Amalgamated Dry Batteries, Limited.—Capital, £20,000. Object: to adopt an agreement with B. Sherman, and to carry on the business of manufacturers and vendors of electric dry batteries, etc.

Sykes and Sugden, Limited.—Capital, £6,000. Object: to acquire the premises known as Spring-place Works, belonging to A. Sykes, in Springwood-street, Huddersfield, and the business of an electrical engineer and steeplejack carried on by him at the said premises as W. D. Berry and Sons, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for light, heat, motive power, etc. Registered office: Spring-place Works, Springwood-street, Huddersfield.

Harvey and Co., Limited.—Capital, £240,000. Objects: to acquire as a going concern the business of Harvey and Co., Limited, to adopt an agreement with the said old company and its liquidator, and to carry on the business of steam, hydraulic, electric, mechanical, and general engineers, etc. Registered office: Hayle, Cornwall.

Incandescent Heat Company, Limited.—Capital, £120,000. Object: to carry on the business of designers, constructers, workers, reorganisers, and improvers of, dealers in, and advisers in respect of furnaces, heating or combustion chambers, tubes, receptacles, or surfaces, fuel or boilers, or any apparatus, plant, or arrangements connected with the problems, manner, or means of generating, applying, or using heat or fields of heat, or of obtaining combustion; quantity surveyors, draughtsmen, designers, consultants, contractors, mechanical and electrical engineers, builders, smiths, founders, glass-blowers, producers and suppliers of gas, electricity, or other power, tubemakers, etc. Registered office: 52, Gracechurch-street, E.C.

H. S. Martin, Limited.—Capital, £10,000. Object: to acquire the business formerly carried on by H. S. Martin, and recently by W. Carter, at 30 and 32, High-street, East Grinstead, Sussex, and to carry on the business of chemists, druggists, drysalters, herbalists, mineral water manufacturers, oil and colour men, importers and makers of and dealers in chemicals and apparatus for electrical, photographic, and scientific purposes, etc. Registered office: 30, High-street, East Grinstead.

Reliance Works Company, Limited.—Capital, £10,000. Object: to adopt an agreement with Sir H. A. White, and to carry on the business of mechanical, electrical, and general engineers, electro-platers, etc.

Cann, Limited.—Capital, £3,000. Object: to carry on the business of manufacturers of and dealers in automobiles, motorcars, motor bicycles, mechanical and electrical engineers. Registered office: 13 and 14, Miller-street, Camden Town.

Hunter Electric Candle-Lamp Company, Limited.—Capital, £800. Object: to acquire certain inventions relating to electric incandescent lamps and fittings and letters patent and benefit of application relating thereto, to adopt agreements with N. Burt and Co. and C. C. Regnart, and to carry on the business of manufacturers of and dealers in electric candle-lamps and fittings, etc. Registered office: 17, Newman-street, Oxford-street, W.

T. H. P. Dennis and Son, Limited.—Capital, £30,000. Object: to acquire the business of wholesale and retail ironmongers, locksmiths, bellhangers, gas and hot-water engineers, electrical and mechanical engineers, and general merchants now carried on by T. H. P. Dennis at 20 and 21, High-street, Chelmsford, as T. H. P. Dennis and Son. Registered office: 20 and 21, High-street, Chelmsford.

Lewis Motor Company, Limited.—Capital, £2,000. Object: to acquire and become licensees of patents for electric motors, dynamos, and other electrical appliances, with a view thereto to adopt an agreement with F. M. Lewis, B. P. Scattergood, C. H. Johnson, A. R. Chorley, and the Electric Construction Company, Limited, and to carry on the business of manufacturers of electric motors and dynamos and other electrical goods and appliances, electricians, electrical, metallurgical, mechanical, and chemical engineers, suppliers of electricity, contractors for the construction and equipment of tramways and railways with electric or other mechanical power, etc. Registered office: 4, South-parade, Leeds.

Paddington Electric Supply Company, Limited.—Capital, £1,000. Object: to carry on the business of electrical, mechanical, and chemical engineers, electricians, contractors, suppliers of light, heat, sound, and power by electricity, galvanism, magnetism, or otherwise, manufacturers of electric apparatus, etc. Registered office: 19, Carnaby-street, Golden-square, W.

Farnham and District Electric Supply Company, Limited.—Capital, £1,000. Object: to carry on the business of an electric light and power company in all its branches, to fix, construct, lay down, and maintain all necessary cables, wires, lines, accumulators, to construct or acquire any tramways in or near Farnham, etc. Registered office: York Mansion, Westminster, S.W.

Bishop's Stortford and Stanstead Electric Lighting Company, Limited.—Capital, £1,000. Object: to carry on at Bishop's Stortford, Hertfordshire, and Stanstead, Essex, and elsewhere, the business of suppliers of electricity for light, heat, motive power, or otherwise, electricians, engineers, contractors, etc.

Expansion Sprinkler Syndicate, Limited.—Capital, £25,000. Object: to adopt an agreement with J. Fiddes and J. F. Watt to manufacture and deal in fire extinguishers, sprinklers, alarms, and appliances, and to carry on the business of iron and steel converters, electrical and general engineers, etc. Registered office: 66, Hatton-garden, E.C.

Brentford Electric Supply Company, Limited.—Capital, £1,000. Object: to carry on the business of electrical and mechanical engineers, contractors, electricians, suppliers of electricity, manufacturers of electrical apparatus, carriers of passengers and goods, owners of railways and tramways, generators, accumulators, transmitters, etc. Registered office: Moorgate-court, Moorgate-place, E.C.

Camberley Electric Supply Company, Limited.—Capital, £1,000. All particulars are the same as in the Brentford Electric Supply Company, Limited, noted above.

Hayward's Heath Electric Supply Company, Limited.—Capital, £1,000. Object: to carry on the business of suppliers of electricity for light, heat, motive power, or otherwise, electricians, mechanical engineers, manufacturers of and dealers in apparatus and articles used in connection with the generation, distribution, supply, accumulation, and employment of electricity, etc. Registered office: Moorgate-court, Moorgate-street, E.C.

Liens Registered.

Ingleton Electric Lighting and Power Company, Limited.—Debenture registered June 27, for £600. Holder: J. C. Walker, of Ingleton. Charged on the undertaking and all the property, including the uncalled capital, but subject to prior issues of debentures for £1,200, £800, £200, and £400.

Eastern Telegraph Company, Limited, London, E.C.—Lien registered June 27, for £10,000 debenture stock, ranking *pari passu* with previous issues amounting to the total of £1,849,120. Holder: F. R. de Levanté, 141, Hill-street, Peckham, S.E. Secured by a first charge on the undertaking and revenue of the company.

APPOINTMENTS VACANT.

Rolling-Stock Superintendent, London County Council Tramways Department. Salary, £400 per annum. Applications by 10 a.m. on July 16.

Clerk of Works, Erith, Kent; construction of additions and alterations to the electric light station. Salary, £3. 3s. per week, payable monthly. Applications by 10 a.m. on July 8.

Resident Engineer, Mains Superintendent, and an Installation Inspector, a Meter Superintendent, and an Accountant, St. Marylebone Electricity Department. See advertisement.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Belfast.—The Harbour Board require two electric cranes. Tenders by July 11.

Worksop.—Tenders are to be obtained for cables, etc., for mains, and additional feeder, estimated at £1,000.

Rhyl.—The Urban District Council invite tenders for 1,400 yards of ·2 concentric feeder cable. Tenders by 18th inst.

Aurelia (Perugia, Italy).—The Municipality require tenders for an electric lighting installation by Aug. 18.

Thorne (Yorks).—The Parish Council invite tenders for lighting the town from Sept. 1 to April 30, 1905. Tenders by 14th inst.

Kingston-upon-Thames.—The Corporation invite tenders for addition to electric works building. Specification, etc., may be obtained from the Borough Surveyor. Tenders by July 14.

Batley.—The Corporation invite tenders for one 350-kw. steam dynamo and switchboard extension for same. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by July 16.

Halling (near Rochester).—Tenders are invited for electrical installation at the cement works of Messrs. Wm. Lee, Son, and Co., Limited, Halling. Particulars may be obtained from the Works Manager.

Plymouth.—The Education Authority invite tenders for electric light installation at the Municipal Technical School. Specifications, etc., can be seen at 11, The Crescent, Plymouth. Tenders by 12 noon on 21st inst.

Paris.—The Post and Telegraph Department, rue de Grenelle No. 103, require tenders for telegraph and telephone apparatus, telephone cables, material and chemicals for galvanic elements, etc. Tenders by July 22.

Devonport (Tasmania).—The Town Board invite tenders for the supply and delivery of alternatively 50 or 100 smallest-size meters to read direct in B.O.T. units on 220-volt direct-current circuits. See advertisement in last issue.

Felixstowe.—The Urban District Council invite tenders (Section C) extensions to feeders. Specifications, etc., may be obtained at the offices of Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on July 9.

Glasgow.—The Trustees of the Clyde Navigation invite tenders for two electric 32-ton coaling hoists for Clydebank Dock. Specification, etc., may be obtained from Mr. Geo. H. Baxter, 16, Robertson-street, Glasgow. Tenders by noon on July 25.

Whitby.—The Urban District Council invite tenders for (a) distributor and street-lighting cables; (b) network and service-boxes. Specifications, etc., may be obtained from Mr. H. S. King, electrical engineer. Tenders by 10 a.m. on July 18.

Acton.—The District Council invite tenders for erecting electric lighting sub-station and engineer's house, supplying wrought-iron unclimbable fencing and hurdles. Specifications may be obtained at 57, High-street, Acton. Tenders by 3 p.m. on 12th inst.

Erith.—The Urban District Council invite tenders for (1) rails, fishplates, and bolts; (2) permanent-way construction. Specifications, etc., may be obtained from Mr. C. H. Fry, Council Offices. Tenders by 12 noon on July 11. See advertisement in former issue.

Suakim.—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

Dartford (Kent).—The Metropolitan Asylums Board invite tenders for installation of fire-alarms at Darenth Asylum, Dartford. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C., on and after 9th inst. Tenders by 10 a.m. on 20th inst.

Wimbledon.—The Urban District Council invite tenders for extensions to the present refuse destructors at their electricity works. Particulars may be obtained from the Engineer and Surveyor to the Council, Council Offices, Wimbledon. Tenders by 10 a.m. on 25th inst.

Manchester.—The Highways Committee invite tenders for laying underground telephone pipes (Contract No. 10), with other appurtenant works. Specifications, etc., may be obtained at the City Surveyor's Office, Town Hall, Manchester. Tenders by 10 a.m. on July 11.

Aston Manor.—The Corporation invite tenders for the supply, delivery, and erection complete of pipework, etc. Specifications, etc., may be obtained from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on July 28. See advertisement in former issue.

Middleton (Lancs.).—The Corporation invite tenders for the supply of 3,000 tons of engine coal to be delivered at the Electricity Station, Townley-street, Middleton, during ensuing 12 months. Particulars may be obtained from Mr. S. Pauls, borough electrical engineer. Tenders by July 11.

Devonport.—The Corporation invite tenders for the supply of 4,500 tons of Welsh steam coal, delivered in cargoes of from 250 to 600 tons, for 12 months, for the electricity department. Particulars can be obtained at the office of the Borough Electrical Engineer, Newport-street, East Stonehouse, Devon.

Homerton.—The Metropolitan Asylums Board invite tenders for installation of telephones at the Eastern Hospital, Homerton, N.E., and Western Hospital, Fulham, S.W. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C., on and after 9th inst. Tenders by 10 a.m. on 20th inst.

Radcliffe.—The Urban District Council invite tenders for the construction of permanent-way, including copper bonding, of about 5 miles 1 furlong of route length line, being 6½ miles single line with passing places. Specifications, etc., may be obtained from Mr. W. L. Rothwell, engineer to the Council. Tenders by 16th inst.

St. Pancras.—The Borough Council invite tenders for the supply and erection of main switchboard at the King's-road power-house, Camden Town, N.W. Specifications, etc., may be obtained at the offices of the Electricity Department, 57, Pratt-street, N.W. Tenders by 12 noon on July 19. See advertisement in former issue.

Cleckheaton (Yorks).—The Urban District Council invite tenders for the supply of various stores, including 300 tons Bowling slack to electricity works; 300 tons Featherstone washed nuts to electricity works. Particulars may be obtained on application at the Town Hall. Tenders to Mr. J. Armitage, clerk, Town Hall, Cleckheaton, before 4 p.m. on 11th inst.

Bridgend.—The Committee of Visitors invite tenders for supply and erection of a complete telephone and fire-alarm installation for the Angelton and Parc Gwyllt Asylums, Bridgend. Specifications, etc., may be obtained from Mr. W. E. R. Allen, Glamorgan County Council Offices, Cardiff. Tenders by noon on July 6. Note.—Tenders already received have not been opened.

Dartford.—The Urban District Council invite tenders for carrying out an extension of underground and pilot cables drawn into existing spareways, and for the laying of private and public lighting cables, together with all necessary roadwork, junction boxes, etc. Specifications, etc., may be obtained from Mr. W. Kay, clerk to the Council. Tenders by 12 noon on the 19th inst. See advertisement in last issue.

Warrington.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, trolley wires, etc., forming complete overhead equipment for about 550 yards of double track, including special arrangements at the swingbridge over the Manchester Ship Canal. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by 12 noon on July 12.

Bristol.—The Electrical Committee invite tenders for h.t. switchgear, water-tube boilers, two 1,000-kw. three-phase extra high-tension turbo-alternators, two 500-kw. induction-type motor-generators, e.h.t. to d.c., e.h.t. cables, e.h.t. transformers, e.h.t. switchgear. Specifications, etc., can be obtained from Mr. H. Faraday Proctor, city electrical engineer. Tenders by 10 a.m. on July 15. See advertisement in last issue.

Handsworth.—The Urban District Council invite tenders for the supply and delivery of the following in connection with the electric lighting: (4) water-tube boilers; (5) engines and dynamos; (6) overhead hand travelling crane; (7) storage battery; (8) arc lamps and posts; (9) switchboard and boosters. Specifications, etc., can be obtained from Mr. H. Ward, The Council House, Handsworth, near Birmingham. Tenders by July 11.

Derby.—The Corporation invite tenders for the making, erecting, setting to work, and maintaining in good order for twelve months on the site of the intended pumping station, of various machinery, including an electric light installation, consisting of compound high-speed engine and dynamo and sundry fittings, etc. Specifications, etc, may be obtained at the office of Messrs. James Mansergh and Sons, 5, Victoria-street, Westminster. Tenders by noon on July 13.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the Electricity Works, Rochdale, Lancashire, of two steam turbines direct connected to two 3-phase alternators, or alternatively for alternators connected to high-speed triple-expansion engines (Contract No. 7); and also for one motor-driven 3-phase alternator (Contract No. 8). Specifications, etc., may be obtained at the offices of Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster. Tenders by July 18. See advertisement in last issue.

Bélmez, &c. (Spain).—The *Gaceta de Madrid* of June 23 contains a notice inviting tenders for the electric lighting of Bélmez, Pueblo Nuevo del Terrible, and Peñarroya for a period of seven years. Tenders will be received by the Ayuntamiento of Bélmez on 30th inst. A provisional deposit of 582½ pesetas (or about £16) will be required from persons tendering. The adjudication will turn upon the amount to be charged by the contractor for each candle-power per month. It appears that the personal attendance of tenderers, or persons authorised by them, is required at the adjudication.

Greenwich.—The London County Council invite tenders for the supply, delivery, and erection of three 3-ton electric travelling jib cranes and two electric locomotives upon the wharf of the electricity generating station now being erected by the Council at Greenwich. The jib cranes will be operated by three-phase alternating currents, and the locomotives by direct current. Certain parts of the locomotives—viz., the motors, controllers, wheels, and axles—will be delivered to the contractor by the Council. Specifications, etc., may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on July 12.

Lerida, etc. (Spain).—The *Gaceta de Madrid* of June 22 contains notices calling for tenders for the construction and working of telephone systems in Lérida and in El Llano del Beal, in the province of Murcia. In each case tenders are to be presented either to the Dirección-General of Telegraphs, 10, Calle de Carretas, Madrid, or at certain local offices within 30 days of publication of the notice in the *Gaceta*. In each case the concessionaire will have to pay to the State 10 per cent. of all receipts; the maximum period of the concession will be for 20 years, and the adjudication will turn on the reduction of this period. A provisional deposit of 2,000 pesetas (or about £57) is required in the case of the Lérida telephone service, and of 500 pesetas (or about £15) in the case of the El Llano del Beal telephone service.

Berga, etc. (Spain).—The *Gaceta de Madrid* for June 26 publishe a Royal decree calling for tenders for the installation and working of a

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telephone system and central stations at Berga and sub-stations at Gironalla, Puigreig, Balsareny, Sallent, Castelladral y Cardona. Tenders will be received within 30 days' date of publication at the office of the Dirección-General of Posts and Telegraphs, 10, Calle de Carretas, and at the office of the Civil Governor, Barcelona, a provisional deposit of 2,000 pesetas (or about £57) being required from persons tendering. The maximum period for the concession is for 20 years, and the adjudication of tenders will turn on the reduction of this period. The *Gacetas* may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between 10 a.m. and 5 p.m. (Saturdays 10 a.m. to 1 p.m).

Reichenberg (Austria Hungary).—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

RESULTS OF TENDERS.

Preston.—The tender of Mr. T. B. Garnett, at about £1,500, for offices for the electrical engineer at the electricity works, was accepted.

York.—The Education Committee have accepted the tender of J. Naylor and Son, York, at £201. 15s. 6d., for installing electric light at Fishergate school.

Perth.—The Electricity Committee have accepted the tender of Davidson and Co., Belfast, at £425, for the installation of a fan for induced draught at the electric works.

Maidenhead.—The tender of Oliver and Co., at £278, for 12 lamp-posts with arc lamps, incandescent side lamps, lowering gear, erected and painted complete, has been accepted.

Northfleet (Kent).—The tender of J. Ellingham and Sons, Dartford, at £1,497, has been accepted for levelling site, etc., for new works, for Messrs. Henley's Telegraph Works Company, Limited, at Northfleet.

Worthing.—The Corporation have accepted the tender of Rowland Bros., East-street, Horsham, at £1.689, for erection of refuse destructor buildings and chimney on land adjoining the sewage pumping station, Worthing.

Finchley.—Richard Hornsby and Sons, of Grantham, have obtained a contract for a water-tube boiler plant for the Urban District Council's Squires-lane generating station, to work alongside the existing plant, which is also of the Hornsby "upright" type.

Handsworth (Staffs).—The Urban District Council have accepted the tender of J. Elwell, Sherborne-street, Birmingham, at £142, for the supply of unclimbable wrought-iron fencing to be erected at the electric light and power station site, Piers-road, Handsworth.

Maidstone.—The Electricity Committee have accepted the tender of R. Benzie's Successors for the supply of coal from June 21 to June 21, 1905, as follows: Welsh, 20s. 5d. and 18s. 2d.; through and through, 15s. 11d. and 16s. 11d.; North Country, 15s. 3d., 14s. 9d., and 15s.

Ilford.—The Urban District Council have accepted the following tenders for extension plant: 1,000-kw. Westinghouse-Belliss, British Westinghouse Company, Limited; extension to main switchboard and extension to distributing-switchboard, Messrs. Kelvin and James White, Limited; water-purifying plant, Messrs. Lassen and Hjort; feeder pillar, etc., Henley's Telegraph Works Company, Limited.

Wiring.—The May-Oatway Fire Appliances, Limited have accepted the following tenders for wiring buildings: Hay Bros. and King's Theatre, Glasgow—Carrick and Topping; Provident Co-operative Society, Leith—W. Douglas, Limited; Adam Smail, Dundee—J. Maxwell and Son; E. Chalmers and Co., Leith—D. T. Niell and Co.; St. Mungo Manufacturing Company, Govan—Carrick and Topping.

London County Council.—The Education Committee have received the following tenders in connection with the Poplar Technical Institute: (1) a 50-kw. electric generating plant, W. Sissons and Co., Gloucester, £475* (drawings included); W. H. Allen, Son, and Co., Bedford, £520 and £5 for drawings; Mr. Peter Brotherhood, London, £541; Belliss and Morcom, Birmingham, £546 and £25 for drawings. *Recommended for acceptance.

Loughborough.—The Town Council have accepted the following tenders: Drew-Beer and Co., Westminster, at £163. 15s., for five steel roof principals required for the boiler-house at the electricity station; Ferranti, Limited, Hollingwood, £596, switchboard; J. Spencer, Limited, Wednesbury, £627. 10s., piping, feed pumps, tanks, etc.; W. T. Henley's Telegraph Works Company, London, £6,515. 2s. 5d., electric cables, maintenance at 1½ per cent.

Spennymoor.—The Urban District Council have received the following tenders: Tudhoe Gas Company, for one year £3. 4s. 6d. per lamp, three years £9 per lamp; Northern Counties Electricity Supply Company, for one year £2. 7s. 6d. per lamp, for three years £2. 5s. per lamp (accepted). The lamps to be the same size as used during the past season, except that the company propose to place the larger lamps, which have been in use during the last six months, on all the posts from the railway station to the County Hotel.

Ayr (Scotland).—The District Lunacy Board have accepted the following tenders for electrical plant: (1) Sir Hiram Maxim Electrical and Engineering Company, Limited, Collington-street, Westminster, at £829, for boiler, pump, feed-water heater, piping, &c.; (2) J. and D. Meikle, Ayr, £640, building, chimney, flues, foundations, and iron roofing; (3) Bruce Peebles and Co., Limited, Edinburgh, £1,616, engines, dynamos, and main switchboard; (4) Lowdon Bros. and Co., Dundee, £3,107, electric wiring and mains, etc.

Neath (Wales).—The Corporation have received the following tenders for the supply, delivery, and laying of electric light mains, feed pillars, and switchboards in their area:

Callender's Cable Company, London (accepted)	£1,411
Western Electric Company, London	1,351
Johnson and Phillips, Old Charlton	1,400
British Insulating Company, Prescott	1,435
Siemens Bros. and Co., Westminster	1,437
St. Helens Cable Company, Warrington	1,592
R. Alger and Sons, Newport, Mon.	1,651
W. T. Henley's Company, London	1,820

Royton (near Oldham).—The Urban District Council have received the following tenders for tramways construction:—Section A—permanent way: Hughes and Stirling, Bootle, Liverpool; J. Brunton, Hull; R. W. Blackwell and Co., Limited, London; W. Griffiths and Co., Limited, London; Edmondson and Wyatt, Oldham; G. Freeman and Sons, Hollinwood; J. G. White and Co., Limited, London; Bennie and Thompson, Warrington; Dick, Kerr, and Co., Limited, London; W. H. Worthington, Manchester; A. Graham and Sons, Huddersfield; J. E. Mayall, Oldham; W. Underwood and Bro., Dukinfield (accepted); J. and W. S. Briscoe, Stockport; G. Law, Kidderminster; Pegg and Bailey, Derby. Section B—overhead construction and equipment: F. M. Smith and Co., Limited, Salford; G. Hill and Co., Old Trafford; British Insulated and Helsby Cables Company, Limited, Prescot; W. Underwood and Bro.; Dick, Kerr, and Co., Limited; British Thomson-Houston Company, Rugby; R. W. Blackwell and Co.; Brush Electrical Engineering Company, London (accepted); J. G. White and Co., Limited. Section C—cables: Callender's Cable and Construction Company, Limited, London; W. T. Henley's Telegraph Works, Limited, London; Siemens Bros. and Co., Limited, London; British Insulated and Helsby Cables Company, Limited; W. T. Glover and Co., Limited, Manchester (accepted); St. Helens Cable Company, Limited, St. Helens; W. F. Dennis and Co., London; Johnson and Phillips, Kent; Western Electric Company, London; Simplified Underground Conductor Company, Liverpool.

London County Council.—The following tenders have been received for wiring and fittings in connection with the electric light installations for the Tooley-street fire station and the new fire stations in course of erection at Bayswater and Kilburn:

Tooley-street Station.

Rashleigh, Phipps, and Co., 102, Oxford-street, W.*	£133	10	0
L. Sunderland and Co., 39, Victoria-street, S.W.	135	0	0
Durell and Co., 58, Fenchurch-street, E.C.	141	13	0
National Electric Construction Company, Limited, 34, Victoria-street, S.W.	148	0	0
G. Weston and Sons, 153, Fenchurch-street, E.C.	150	0	0
O. Clark and Co., St. Mark's-road, North Kensington	152	0	0
Duncan, Watson, and Co., 100, Charing Cross-road, W.C.	153	0	0
W. H. Johnson, 200, Upper Kennington-lane, S.E.	154	7	0
F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W.	157	0	0
A. H. Marshall and Co., 270, High-road, Leytonstone	158	10	0
Alliance Electrical Company, Limited, 137, Regent-street, W.	166	5	6

Bayswater Sub-station.

Rashleigh, Phipps, and Co.*	121	2	6
L. Sunderland and Co.	140	0	0
O. Clark and Co.	145	0	0
Durell and Co.	154	13	0
W. H. Johnson	158	7	0
G. Weston and Sons	160	0	0
F. J. Coleby and Co.	162	10	0
Duncan, Watson, and Co.	164	0	0
A. H. Marshall and Co.	164	5	0
Alliance Electrical Company, Limited	179	15	0
National Electric Construction Company, Limited	195	0	0

Kilburn Sub-station.

Rashleigh, Phipps, and Co.*	143	0	0
L. Sunderland and Co.	149	0	0
O. Clark and Co.	165	0	0
G. Weston and Sons	170	0	0
Durrell and Co.	171	13	0
W. H. Johnson	172	2	0
A. H. Marshall and Co.	174	10	0
F. J. Coleby and Co.	175	0	0
Duncan, Watson, and Co.	175	0	0
National Electric Construction Company, Limited	188	0	0
Alliance Electrical Company, Limited	192	9	0

* Recommended for acceptance.

The tender of the New Conveyor Company, Limited, Smethwick, at £4,763, for the supply, delivery, and erection of the two combined coal and ash conveyors required for use in connection with the first portion of the Greenwich electricity generating station, has been recommended for acceptance.

Proposed Light Railway.—The Nantyglo and Blaina Council have decided to support a proposed light railway between Brynmawr and Abertillery, provided the roads are suitably widened. The scheme is being promoted by a company.

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BUSINESS NOTES.

TRACTION.

Maidstone.—The new Corporation tramways were inspected by the Board of Trade yesterday.

Ripon.—The Board of Trade has confirmed the Ripon and District Light Railways Order, 1904.

Dundee.—Contracts amounting to some £760 have been awarded by the Corporation for the extension of the tramway depôt.

Tarperley.—The Light Railway Commissioners will hold an enquiry on the 27th inst. into the application for a provisional order.

Witney-Andoversford.—The Board of Trade have confirmed the provisional order for the construction of a light railway between these towns.

Liverpool.—The question of introducing a universal 1d. fare to and from all parts of the city figured in the agenda for Wednesday's meeting of the Corporation.

Paisley.—An experimental run has been made on the Johnstone section of the company's system, and proved quite satisfactory. The line only awaits the Board of Trade inspection.

North-Eastern Railway.—It is stated that there is a possibility of the company electrifying the 12 miles of suburban railway on the south side of the river between Newcastle and South Shields.

Bradford.—The Tramways Committee have considered the question of ½d. fares, and decided to make enquiries of other corporations using ½d. fares with a view to seeing how far they could be applied in Bradford.

London United Tramways Company.—Mr. Clifton Robinson has intimated that a service of cars will run from Hounslow to Hampton Court every Sunday during the summer if they are well patronised.

Horsforth.—The Urban District Council have published the statutory notice of their application to the Board of Trade for an extension until August, 1905, of the date fixed for the commencement of the tramways.

District Railway.—The Bill authorising the company to charge zone fares, and limiting luggage to 28lb., has passed through committee in both Houses, the Select Committee of the Commons giving their approval last week.

Leeds.—The Corporation have published the statutory notices of their application to the Board of Trade for an extension until August, 1905, of the date fixed for the commencement of the tramways authorised by orders of 1902 and 1903.

Bettws-y-Coed.—A petition, subscribed to by some 2,000 signatories, has been presented to the Board of Trade against the scheme for an electric service to Beddgelert, which has been submitted to the Board for confirmation by the Light Railway Commissioners.

Luton.—At the meeting of the Town Council last week the Tramways Committee presented a recommendation that Wellington-street should not be included in the tramway scheme. A motion to the opposite effect was, however, carried after a lengthy discussion.

Stockport.—The Town Council, by 23 votes to 17, rejected a proposal of the Tramways Committee to offer the Stockport and Hazel Grove Tramways Company £23,000 for their system of horse cars, in favour of an amendment that negotiations be closed without further offer.

Great Northern and City Railway.—The receipts for the week ending 25th ult. dropped to only £873. The company have opened a station at Highbury, and fixed the fares to the city at 1½d. single and 2d. return, as against 2d. and 3d. respectively of the North London Railway.

Lancaster.—A question was asked at last week's meeting of the Corporation as to whether the Tramways Committee had considered the advisability of continuing the tram line from Dalton-square to Stonewell, for which the Corporation possess powers. It appears that the committee have not yet thoroughly investigated the matter.

Nottingham.—The scheme for extending the tramways to Sneinton, *via* Manvers-street, has been adopted by the Corporation, the estimated cost being £110,000, including considerable street widening. The proposal that a branch be constructed along Forest-road has been rejected by the Corporation both on commercial and æsthetic grounds.

Barrow-in-Furness.—The Ramsden Dock section of the tramways, which are worked by the British Electric Traction Company under lease from the Corporation, were inspected and passed by the Board of Trade last week, and the cars were put into use forthwith. The Ferry branch is expected to be ready in a week or so, and will complete the system, which extends to some 7½ miles.

Chesterfield.—A special meeting of the Town Council was held last week to consider tenders for the laying of an electric tramway system 3½ miles in length from New Brampton to Whittington Moor. Particulars of the awards appeared in our last issue. The contractors undertake to commence the work within three weeks of the receipt of the order, and complete it within three months of commencement.

Poole.—Further evidence on behalf of the Bournemouth Corporation was tendered last week in connection with the arbitration proceedings between the Corporation and the Poole Electric Traction Company to decide the price to be paid for the latter's undertaking. As Mr. Lawrence, K.C., the umpire, will be engaged for some weeks as Commissioner of Assize, the proceedings have been adjourned *sine die*.

Gloucester.—At the last meeting of the Corporation a recommendation of the general manager that eight recorder clocks, similar to the one now in use at Wotton, be obtained, in order to automatically check the service of cars, was adopted. From the opening of the service up to the 22nd ult. the total number of miles run was 52,580, there were 562,151 passengers carried, and the gross receipts, £2,132. 19s. 2d., averaged 9·73d. per car mile.

Warrington.—Application is to be made to the Board of Trade for a further prolongation of time for the construction of tramways in Padgate-lane and Manchester-road. The respective tenders of Mr. J. A. Ewart for the construction of the permanent light railway No. 1 from Stafford-road to Victoria-square, Stockton Heath, at £2,935. 15s. 8d., and Messrs. Babcock and Wilcox, Limited, for the supply of four mechanical stokers at £957, have been accepted.

Lancashire and Yorkshire Railway.—An increased service of electric trains was instituted between Southport and Liverpool last Friday. Up to half-past nine in the morning there will be three electric trains only, the remainder of the service being supplied by steam trains; but between 9.30 and 4.15 the service will be exclusively electrical. In addition to the regular service, there will be several express trains, which are timed to cover the journey in 25 minutes.

Brighton.—The balance-sheet for the year ended March 31 shows a deficiency of £4,778. It is proposed to increase the fares over the longer distances from 1d. to 1½d. The present fares are considered insufficient to cover working expenses and to provide properly for depreciation. Heavy gradients necessitate the consumption of 50 per cent. more current per car mile than in most other towns. The route from the Aquarium to the railway station, *viâ* North-road, is rapidly approaching completion.

South Lancashire Electric Traction Co.—In the Palatine Court at Manchester on Monday Vice-Chancellor Hall granted an application for the appointment of a receiver in a debenture holders' action against the South Lancashire Electric Traction and Power Company. It was stated that the half-year's interest due on Jan. 1 last had not been paid, and the security had now become enforceable. Mr. John Salter, manager of the company, and Mr. Henderson, chartered accountant, London, were appointed.

Aston.—The tramway in Victoria-road is practically finished, excepting the junction where the tramway crosses Park-road, which will remain in abeyance until the line in Park-road is completed. The contractor is busily engaged in the construction of the line in Park-road, also a continuation of the line in Witton-lane. He is also making arrangements for the commencement of the reconstruction of Lichfield-road tramway, and the construction of a temporary track in connection therewith is now in progress.

South Shields.—Amended tenders have been sent to the Corporation by the South Shields Tramways Company, and Messrs. Rowcliffe and Co., who are acting on behalf of a Manchester syndicate. The former now offer an alternative tender for the construction as well as working of an electric tram system in the borough, and they also reply to the criticisms of the Corporation. The borough officials have been instructed to report upon the new tenders, which will be considered at an early meeting of the Tramways Committee.

Heywood.—The Corporation have sealed a memorial to the Board of Trade for a further prolongation of the period for the commencement of the tramways, authorised by the Corporation's 1902 order, until Aug. 8, 1905, and the period for the completion until Aug. 8, 1906, on the ground that the tramways cannot be constructed without interfering with the Manchester, Bury, and Rochdale Tramways; and by Section 38 of the order of 1902, the Corporation are prohibited from interfering with such tramways until they have acquired them, for which purpose an arbitration has been held.

Anti-Electrocution Patent.—A provisional patent has been obtained by Mr. W. E. Walmsley, of Liverpool, for a mechanical device designed to prevent electrocution on railways, which, being fitted between the sleepers at certain intervals, limits the electric current to the length of the particular section of the line on which the train may be travelling at the time. On contact with the train the device would automatically cut off the current from the section just passed and turn it on for the next section. It is credited with being easily and cheaply made, and effecting a considerable economy in current.

Bury.—The work of reconstructing the route between Bury and Tottington for electric traction will be commenced on Monday. Two sets of men will be engaged, one for beginning the work at Tottington and working towards Bury, and the other working from Bury Bridge to the centre of the town. A conference of representatives of the Salford, Bury, and Whitefield Councils has been held at Manchester with a view to arranging through running on the network of trams which will shortly connect Bury, Radcliffe, Whitefield, and Salford. Certain proposals were made which the Bury Tramway Committee will consider, and another conference will then be convened.

Westinghouse Automatic Signalling.—It is just a year since the inauguration of the Westinghouse automatic signal system on the Ealing and Harrow branch of the Metropolitan District Railway took place, and now the whole of this railway is being so equipped. A week or so ago four track circuits worked on the same principle were brought into use at the Highbury Station of the Great Northern and City Railway. This installation is the first application of the Westinghouse automatic signals on a London tube railway. The Westinghouse Brake Company, Limited, of King's Cross, carried out the installation, which, we understand, is giving complete satisfaction.

Preston.—The Corporation have referred to committee the question of restricting the service of tramways on Sunday mornings. The Penwortham, Ashton, and Deepdale section has been completed. In regard to the Ribbleton-lane route, the Corporation confirmed the Tramway Committee's acceptance of Messrs. Dick, Kerr, and Co.'s tender for the construction of the permanent way and overhead equipment. The contract amounts to £15,725, an increase of £500 on the

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schedule price of the other contracts being agreed upon, as the track was at a greater distance from the town. The question of the erection of telegraph wires over the tramway wires has been referred back to committee, dissatisfaction being expressed at the result of negotiations with the Post Office.

Birmingham.—At a recent meeting of the Corporation it was stated that it would be necessary to widen several streets in connection with the tramway scheme, and this is being done where possible by reducing the footpaths, which has elicited the disapproval of a section of the inhabitants, who allege that some of the footpaths were too narrow before. A question was asked at Wednesday's meeting as to whether the conduit system could not be employed for the centre of the city, especially Corporation-street, which it was considered would be disfigured by overhead wires. The Chairman of the Tramways Committee replied that they did not wish to restrict themselves to any system, and the only objection to the conduit system was the additional expense. He added that a single line only would be laid along Corporation-street in the first instance.

Argentine Tramways.—The shareholders of the City of Buenos Ayres Tramways Company are to be asked at a special meeting to consent to the absorption of their undertaking by the Anglo-Argentine Tramways Company. The city company have for some time past been contemplating the conversion of their system from horse to electric traction, but owing to the onerous terms sought to be imposed upon them by the authorities the directors had to abandon the project. A proposal was, however, put forward by the Anglo-Argentine Company, who have obtained a concession for electrifying the line, and it is this proposal which the directors now recommend for the shareholders' acceptance. Its effect is to guarantee interest on the company's debentures and a dividend on the share capital at the same rates as paid at present. This guarantee will be a preferential charge with profits on the Anglo-Argentine Company.

Dewsbury.—Major Druitt, who conducted an enquiry into the collision of a tramcar with various vehicles at Dewsbury on May 26, states in his report that, so far as can be judged, the car was in good order at the time, and had nothing wrong with the brakes. He thinks the worst accident was caused by the anxiety of the driver to prevent the first collision, and that afterwards the driver lost his head. Major Druitt remarks that a much higher standard of training is required for men who are put in charge of electrically-worked brakes than for those who have to use purely mechanical brakes. In this connection the Westinghouse Company state that the application of their magnetic brake, or, in fact, any brake operated by electric power, is perfectly simple, and that the driver need not possess a theoretical knowledge of its working, while an electric brake takes rather less time than a mechanical one to bring a car to a stop.

Derby.—The receipts of the Corporation tramways for the five weeks ended the 25th ult. amount to £1,789. 2s. 6d. This represents a decrease of £223. 11s. 10d. as compared with the corresponding period last year, though little significance attaches to the figures in view of the reconstruction operations. The committee have decided, subject to the approval of the Council, to extend the tramways from East-street to Victoria-street, opposite the new tramway offices. The estimated cost is £2,000. The laying of the track for the new electric tramways is finished on the Osmaston route, and from Alvaston to the Midland Railway Station. Large gangs of men are now engaged on the tracks along Normanton-road and Burton-road. The lines from the Midland Station along Bateman-street and Douglas-street to the Pear Tree district are finished. On the Osmaston-road and Alvaston routes the horse trams are being utilised at present. It is expected that the scheme will be sufficiently advanced to allow the electric trams to run on the Alvaston and Osmaston-road routes next month.

The Underground.—The report of the Legal and Parliamentary Committee, presented at yesterday's meeting of the St. Marylebone Borough Council, stated that the Metropolitan Railway Company had submitted a proposal (with plans) to erect an electrical sub-station in Upper Baker-street. A sub-committee interviewed the company's engineer, and enquired if it were possible for the company to erect the proposed sub station on another part of the site, when the engineer stated that it would be impracticable, and also pointed out that unless the sub-station was constructed on, or near, the site proposed, it would be impossible to work trains by electric traction into Baker-street Station, and that the proposed improvements to this section of the railway could not be carried out unless the Council decided to favourably consider the application of the company. The Portman Estate was opposed to the site, and did not agree that the company could not find another suitable site for their sub-station. The committee recommended the Council to refuse their approval of the plans.

Belfast.—The minutes of the Law Committee, presented at the meeting of the Corporation last week, stated that representatives of the Belfast and County Down Railway Company attended the committee and expressed the willingness of that company to agree to an amendment of the Aberdeen clause of the Corporation Tramway Bill, to allow the Corporation to take out of the revenue of the lines an amount equal to that received by them at present from the Belfast Street Tramway Company for rent, interest, and rates, and to apply the balance of revenue after £20,000 had been accumulated to public purposes, and also to agree to the reinstatement of Clause 42 of the Bill as submitted to the Lords Committee by limiting it to the working of existing tramways—*i.e.*, the Belfast and Cavehill Tramway. The Corporation confirmed the resolutions of the committee that these terms be approved of, and that application be made for the reinstatement of Clause 42 in the Bill as submitted to the Lords Committee, limiting it to the working of the Cavehill Tramway. At a special meeting of the company the terms of sale to the Corporation were confirmed by the shareholders. At a meeting of the Tramways Committee on Wednesday it was unanimously agreed that the city surveyor (Mr. H. A. Outler) and the electrical engineer (Mr. V. A. H. M'Cowen) should prepare a joint report as to the relative merits of the various systems of electric traction now in use, and should submit it at the next meeting of the committee. In response to a communication from the Belfast branch of the United Carriage Company, Limited, the Chairman stated that he was sure the committee would be even more anxious than the Belfast Street Tramways Company had been to employ local labour in the construction of the cars.

Newcastle.—The progress of the Tyneside Company's Bill for inter-running powers received a check when it came up for third reading in the House of Commons last week. Sir Jas. Woodhouse moved that the Bill be referred back to committee, as there was not a sufficient public demand for a through service to justify the granting of compulsory powers. Sir W. Plummer, one of the Newcastle representatives, seconded the motion. Sir E. Strachey, chairman of the committee which dealt with the Bill, opposed, contending that through running would be a great boon to the Tyneside workmen, and that the committee had inserted a clause safeguarding the interests of the Corporation. Mr. J. W. Benn supported the resolution, observing that if the House ratified the committee's decision it would create a dangerous precedent, and one result would be that the London County Council would be inundated with applications for such powers. Mr. Bonar Law, Parliamentary Secretary to the Board of Trade, deprecated the suggestion that a great principle was involved, and opposed the resolution on similar grounds to Sir E. Strachey. Eventually the resolution was carried by a majority of 36, the number of votes for being 178 against 142. The Bill was, therefore, ordered to be sent back to the committee for reconsideration. The receipts last week amounted to £3,420, as against £3,247 in the corresponding week of last year. There were 762,075 passengers carried, as against 715,916. The Tyneside Company's Bill came before the House of Commons Select Committee on Wednesday, when it was decided to adjourn until July 19 to give the parties an opportunity of coming to an agreement respecting running powers. In the event of no agreement being arrived at, the Corporation are then to call further evidence against running powers.

Harrow and Uxbridge Railway.—The new line was formally opened on the 30th ult., when the directors travelled by special train from Baker-street to Uxbridge, inspecting the South Harrow viaduct and Ruislip station on the way. At the terminus of the branch Mr. John James Mellor, chairman of the Harrow and Uxbridge Railway Company, presided at a lunch at which there were present Sir Charles McLaren, M.P. (deputy chairman), Mr. Frederick Cox, Mr. Jabez Light, Lieut.-Colonel Olifford Probyn and Lieut.-Colonel William Terry (directors), Sir Christopher Furness, M.P., Sir Frederick Dixon-Hartland, M.P. for Uxbridge, Mr. A. C. Ellis (general manager), Mr. R. H. Selbie (secretary), Mr. A. B. Garside (assistant general manager), Mr. H. B. Palmer (superintendent of the line), Mr. W. H. Brown (goods manager), and the chairman and many of the members of the Urban District Councils of Uxbridge and Harrow. In the course of the speeches made by the Chairman, Sir Frederick Dixon-Hartland, M.P., Sir Christopher Furness, M.P., and others, reference was made to the value of the undertaking to Uxbridge for developing that town and the neighbouring district of Ruislip as residential localities. The line is seven miles long, and joins the Metropolitan Railway at Harrow and the Metropolitan District Railway at South Harrow. The power will be obtained from the Metropolitan Company's generating station at Neasden and a sub-station at Ruislip; but pending the completion of these the line is being operated by steam. The high-voltage current from the Neasden power station will be transformed at the sub station to continuous-current at 600 volts. New rolling stock of the open corridor type will be used when the line is worked electrically. There are two new stations, Uxbridge and Ruislip, and at the former there is a large goods yard, where a profitable business is expected to be done on account of the easy connections with other railways.

Leicester.—The Tramways Committee's report, recommending the purchase of 40 additional cars, the extension of car-sheds, and increased office accommodation, was presented at last week's meeting of the Council. It was stated that the new electric tramways, so far as they had been opened, had more than realised the highest expectations. They were carrying from 25,000 to 30,000 passengers per day extra. Taking the week from June 12 to June 18 they carried on the Stoney-gate line 91,266 passengers, as compared with 44,020 on the same line in the corresponding period of last year; on the Belgrave section the number was 90,738, against 32,550 last year. The 40 extra cars would bring the total number up to 100. The Tramways Committee had secured the option of ordering another 50 cars at the same price—£510 each—such option to continue until Christmas. The proposed car-shed extensions were estimated to cost £10,000, and the Board of Trade would be asked to sanction a loan to that amount. With regard to the increased office accommodation, the committee proposed to have all the staff under one roof. The estimated cost was £2,500. Since the opening of the new tramways no serious accident had occurred. The report was adopted. The Board of Trade held an inspection on Tuesday of the High-street, St. Nicholas-street, Applegate-street, Narborough-road, Hinckley-road, and Fosse-road, and the Clarendon Park-road extensions. These routes will no doubt be certified as ready for traffic. An inspection was also held of the newly-constructed permanent way in Humberstone-gate, Humberstone-road, East Park-road, Evington-road, and the completion of Aylestone-road, with the view of certifying these for public traffic. They are not yet electrically equipped, but every effort will be used to push on with the work. Aylestone-road, it is understood, will be equipped at the earliest possible moment. The inspector again highly complimented the Tramways Committee on the excellent construction of the permanent way and equipment. A main sewer has to be laid along Melton-road before that section can be commenced, and the work of laying the sewer is being hastened on.

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Sheffield.—The summary of the past year's working shows that the gross profit for the year, after paying working expenses, amounts to £79,578. 17s. 5d., as compared with £71,957. 5s. 9d. in the previous year, an increase of £7,621. 11. 8d. Of this £32,874 has to go in payment of interest on loans, and £19,394 in repayment of principal, leaving a net balance of £27,309 to be carried to the accumulated surplus account. Passengers paid in 1d. and ½d. fares £232,351, as compared with £214,035 in the previous year. The income from all sources, including £912 from advertisements on the cars, amounted to £235,981, as against £216,308 in the year ended March, 1903. The total working expenses, exclusive of interest and sinking fund, amount to £156,402, or an average of 6·507d. per car mile run, as compared with £144,351 and 7·033d. per car mile in the previous year. The electric traction cost per car mile during the past year was ·139d. below the previous record, which is equal to £3,340. Passengers carried reach the enormous total of 61,450,993. Of these 49¾ millions paid 1d. fares and 11¼ millions ½d. fares. The year's increase of passengers was 4½ millions. The distance travelled by the cars was 5,768,231 miles. They have run 842,148 miles more this year than last. There are 23 inspectors, 360 motor-men, and 378 conductors. In accordance with the resolution of the Council confirming the agreement of the Tramways Committee to contribute towards the capital expenditure on street widenings and street works necessitated through tramways construction, the sums of £2,452. 13s. 3d., being proportion of interest on improvements, and of £685. 17s. for proportion of sinking fund on sundry street improvements, have been paid to the Improvement Committee this year. The Tramways Committee have paid out of their accumulated surplus £7,949. 5s. 9d. to discharge the deficiency on the district rate. The total amount contributed to relief of rates since electric traction commenced in 1897 is £50,620. 10s. 8d. The amount expended on renewals during the past 12 months has been £3,771. The committee recommend that £33,771, making a present total of £50,000, be set aside out of the unappropriated surplus towards the renewals fund. The accumulated surplus amounts to £143,369. Other details are as follows: average street miles of tramway, 31¾; traffic revenue per mile run, 9·667d.; traffic revenue per street mile of tramway, £7,318. 3s. 2d.; average number of cars running daily, 167·49; average number of passengers per car per week, 7,017; average traffic revenue per car per week, £26. 10s. 8d.; average fare per passenger, ·907d.; average total expenditure (working expenses and service of debt) per mile run, 8·682d.; average total revenue per mile run, 9·818d.; percentage of working expenses compared with income earned, 66·277; percentage of service of debt compared with income earned, 22·15; percentage of total expenditure compared with income earned, 88·427.

London County Council.—The accounts for the year ended March 31, presented at Tuesday's meeting of the Council, show that the total receipts, apart from the northern system leased to the North Metropolitan Tramways Company, amounted to £536,239. The actual working expenses were £441,786, leaving a surplus of £94,453. Against this, however, have to be placed debt charges, amounting to £100 536. 14s. 9d., for interest and sinking fund and a charge of £2.200 for income tax, leaving a deficiency of £8,283. 14s. 2d. This deficiency is attributed mainly to loss of receipts from the dislocation of traffic during the reconstruction for electrical traction. The loss of receipts under this head is estimated at about £30,000; while, in addition, the receipts were greatly affected by the exceptionally bad weather. When the estimates for the current year were passed it was anticipated that the deficiency on the working of the southern lines would be upwards of £15,000. It has also to be remembered that, so soon as capital expenditure is incurred, charges have to be met for interest and repayment of debt; and it has in some cases been found necessary to incur heavy capital expenditure on the reconstruction of tramways some considerable time before the lines can be worked electrically. The total number of passengers carried during the year was 133,139,085. As compared with the previous year's figures, when the number of passengers was 109,615,496, this year's total shows an increase of 23,523,589, which in a large measure is due to the fact that electrical cars were run on many of the lines, whereas in the preceding year a service of horse cars could only be maintained with some difficulty while those lines were under reconstruction. Of the total number of passengers 37·13 per cent. were carried at ½d. fares, 48·30 per cent. at 1d., 8·51 per cent. at 1½d., 4·67 per cent. at 2d., 0·15 per cent. at 2½d., and 1·24 per cent. at 3d. The average fare per passenger was 93d., the same as in 1902-3, and the number of car-miles run was 11,536,534, being 1,425,594 more than in 1902-3. The permanent-way has been well maintained, and the machinery, plant, and rolling-stock have been kept in thorough repair. The expenditure for permanent-way repairs, amounting in all to over £10,000, was chiefly in connection with the lines acquired from the late South London Tramways Company in November, 1902, which were in a very unsatisfactory condition. In regard to the northern system, the receipts for the year 1903-4 from the North Metropolitan Tramways Company by way of rent of the tramways, depôts, buildings, etc., amounted to £56,529. 6s. 4d., the percentage on excess of the gross receipts of the company over those of the year 1895 to £5,712. 2s. 8d., and percentage on cost of extensions, etc., to £2,516. 6s., so that the sum received from the company was £64,757. 15s.; while rents amounting to £296. 9s. were received from tenants of property in Parkhurst-road, Holloway, purchased as part of the undertaking, and miscellaneous items amounted to £7. 0s. 10d. The percentage on excess of gross receipts was less by £10 464. 9s. 10d. than the amount received from this source in the year 1902-3, but this is owing to the fact that the company had sold its lines outside the county, and the receipts from these are not taken into account in calculating the amount due to the Council under this head. The total receipts from all sources have amounted to £65,061. 4s. 10d., and the expenditure, mostly for rent drawbacks, to £794. 4s. 7d., leaving the net receipts £64,267. 0s. 3d. Out of this sum interest and sinking fund charges, amounting to £36,609. 16s. 7d., have been paid, so that the surplus revenue is £27,657. 3s. 8d. Capital expenditure, not properly chargeable to either the northern or southern system, amounting to £104,893, was incurred during the year, and the general account shows a deficiency of £10,677. The surplus revenue available on April 1, 1903, was £29,869. 6s. 5d., of which £20,000 has been applied in relief of rates, leaving a balance of £9,869. 6s. 5d. The deficiency on the southern system and the general account represent £18,965, and after deducting this from the £27,657 surplus on the northern system there remains a balance of £8,692, which, being added to the surplus from last year (£9,869), shows a surplus up to date of some £18,550. The committee's report stated that arrangements had been made for taking over the London, Deptford, and Greenwich tramways from yesterday, and asked for a special maintenance vote of £26,000. The Bridges Committee asked for £14,000 for the reconstruction or alteration of Kingaland-road bridge in connection with the electrification scheme. The design of the engines and dynamos for the Greenwich generating station, under construction by Messrs. Lovatt and Co., having been settled, the Tramways Committee recommend that the work of laying the foundations be also carried out by that firm, they having agreed to execute it at the schedule prices of the existing contract. It should be noted in connection with the annual accounts that the percentage of working expenses to receipts is far greater in the case of horse than in mechanical traction on the southern system.

LIGHTING AND GENERAL.

Cardiff.—Electric light is to be installed at St. Mary's Church, Bute Docks.

Dover.—The engineer is to prepare specification and invite tenders for free wiring.

Woolwich.—The electric mains are to be extended to the Bostal Estate, at an estimated cost of £4,613.

Wrexham.—Sanction has been received to the borrowing of £5,600 for electric mains extensions and machinery.

Erith.—The Works Committee are considering a proposal to light the secretary's and the Education Committee room with electric light.

Hove.—The Hove Electric Light Company propose obtaining a provisional order to supply current in Shoreham and south-west district.

Leeds.—At Wednesday's meeting of the City Council it was decided to apply for sanction to borrow £100,000 for electric lighting purposes.

Stockton.—The question of extending the electric lighting mains to Hartburn, Norton, and Eaglescliffe is before the electrical engineer for report.

Wells.—The Mutual Electricity Supply Company intend to apply for a provisional order to enable them to supply electricity within the Town Council's area.

Black Sea Cable.—The Black Sea cable between Odessa and Constantinople passed in the hands of the Indo-European Telegraph Company on July 1.

Redditch.—The report of the Lighting Committee recommending that application be made for permission to raise a further loan of £8,500 has been adopted.

Kingswood.—All opposition to the Kingswood electric lighting provisional order having been withdrawn, it has been referred to the Select Committee on Unopposed Bills.

Crewe.—The Town Council have decided to apply for sanction to borrow £4,500 for enlarging the plant at the electricity works. About 70 new consumers are waiting to be connected.

Llanelly.—The Llanelly Borough Council are corresponding with the British Insulated Wire Company with regard to the electric lighting order, which they fear might be cancelled by the Board of Trade.

Bridgend.—A rebate of 2½ per cent. is to be allowed to consumers of electric light who paid their accounts within one month after they become due. The number of consumers has increased from 69 to 71.

Derby.—The analysis of revenue receipts and expenditure of the electric lighting departments for the year ended March 31, 1904, shows a net profit of £1,719. 10s. after payment of interest and sinking fund.

Chorley.—We understand that the Town Council have accepted the offer of Mr. Oswin Hansom to take over the Chorley Electric Lighting Order, 1898, on payment of £384, the costs incurred in obtaining the order.

Burnley.—A letter from the wholesale and retail trades section of the Chamber of Commerce, asking for a reduction of the charges for current, has been referred to a sub-committee of the Electricity Committee.

South Shields.—The sum of £1,303. 16s. 8d., representing the net profits on the electric light undertaking, after deducting £300 already transferred to the general district rate account, is to be transferred to the reserve fund.

Inverness.—Edmundson's Corporation have paid £2,386 to the town, the sum due under the contract. They intend to apply for a provisional order in terms of agreement, and a site which they have purchased for a generating station has been approved.

Bridlington.—The Town Council have decided that the price to be charged for electric current supplied from the generating station (when completed) should be 5d. per Board of Trade unit for lighting purposes, and 3d. per unit for heating and power purposes.

Electric Construction Co.—The net profit for the year ended May 31 amounted to £19,167, including £4,394 brought forward,

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The directors recommend a dividend at the rate of 4 per cent. on the ordinary shares, place £2,000 to reserve, and carry forward £3,605.

Birkdale.—The Birkdale District Electric Supply Company have agreed to supply current for lighting the hospital at 2d. per unit. The draft agreement *re* flat rate for supply of electrical energy for lighting purposes for the district has been approved by the Urban District Council.

Cromer.—The chairman and directors of Edmundson's Electricity Corporation on Monday invited their customers and many of the principal inhabitants to an official inspection of their electricity supply works, which was largely attended. The works were opened by the chairman of the Urban District Council last year.

Gravesend.—The Council have decided to apply for a provisional order to extend the area of supply defined by their order of 1898, so as to include part of the area of the urban district and parish of Northfleet. This will not in any way interfere with the negotiations between Gravesend and Northfleet already referred to by us.

Newquay.—The committee recently appointed to consider the question of electric lighting have recommended that the Southern District Corporation be informed that it was not the intention of the Council to erect arc lamps for public lighting, but to utilise the present lamps with the unrust burner, should the system be adopted.

Cannock.—At Tuesday's District Council meeting the Chairman gave an explanatory statement with regard to the proposal to establish electric lighting for the district, and, subject to approval, an agreement with Messrs. Whittaker Bros., of Dudley, for carrying out certain works is to be signed. The site of the proposed works is at the rear of the Council offices.

Liverpool.—At Wednesday's meeting of the Town Council it was decided to apply for sanction to the borrowing of a further sum of £400 000 for purposes connected with the supply of electrical energy, £325,000 being for work that the committee have already been ordered to do by the Council; the remaining £75,000 is to be put at the disposal of the committee to go on with.

Meter Testing.—The meter department of the Electrical Company, Limited, 121 to 125, Charing Cross-road, W.C., have just issued a handbook on meter testing, with the definite purpose of making the method of testing the accuracy of the company's meters perfectly clear, and to give details of such information as is mostly asked for by those unacquainted with these particular meters.

Worthing.—The last report of the resident engineer contains the following figures: number of applications to date, 314; consumers connected, 281; equivalent number of 8-c.p. lamps (private) applied for, 17,597; number connected, 15,617; total number connected (including public and private), 18,000; number of motors on circuit, 18, and aggregate capacity of same, 108 h.p.

Metropolitan Electric Supply Co.—The directors recommend a bonus of £6 per share, payable on July 19, to holders of ordinary shares, out of profits on capital account made by the sale of the St. Marylebone undertaking. At an extraordinary meeting, to be held on the same date, the chairman will explain the views of the Board as to dealing with the balance of the purchase money.

Electric Power Storage Co.—The directors have declared a dividend of 6 per cent on the ordinary shares for the year ended May 31 last. The profit for the year, including the balance of £594 brought forward, is £10 360. Out of this sum the directors have carried £3 500 to the reserve fund and £1,000 to the contingent fund, which will absorb a further £5 339 and leave £470 to be carried forward.

Devonport.—The Devonport Corporation will now supply electricity for lighting, power, and heating purposes at the following scale of charges—viz.: lighting—not exceeding 1,000 units per annum between April 1 and March 31. 4½d. per Board of Trade unit net; all units in excess of the first 1,000 units per annum, 4d. per Board of Trade unit net; power and lighting, 2½d. per Board of Trade unit net.

Hull Telephones.—There are indications that the suggestion of the Hull Incorporated Chamber of Commerce that public telephone call boxes should be placed at the local and suburban railway stations will shortly be carried into effect. The National Telephone Company have already made application to place a call box at Paragon Station, and applications are also being made for placing call boxes at four other stations.

Glasgow Telephones.—The Corporation telephone accounts for the past year show a surplus of £3,650, which is carried to depreciation account, this now standing at £5,743. The net revenue was £49.639, showing a balance over expenditure of £20,519. Of this £8 525 was absorbed for interest and £8,343 for the sinking fund. The capital outlay now amounts to £30,782, and there are unexhausted borrowing powers of £50,000.

Bangor.—At last week's meeting of the City Council the electrical engineer's salary was increased by £40 per annum. In the meantime Mr. Percy White has been appointed consulting electrical engineer in connection with the Carnarvon Corporation electric lighting scheme. On Wednesday it was agreed that the engineer be allowed to undertake the commission for the Carnarvon Corporation conditionally that the increase in his salary be postponed until April, 1905.

Perth.—The accounts of the electricity department show a revenue of £5,764, and an expenditure of £3,380, leaving a balance at the credit of the sinking fund account of £1,425. There is a debit balance of £49 602 on the borrowed money account, and £700 at the credit of the contingent account. In the general balance account assets and liabilities are put down at £52,926. In the estimates for the current year the unit is reduced from 4½d. to 4d. to private consumers.

Gloucester.—The electrical engineer has reported on the capacity of the existing lighting plant, pointing out that, after making allowance for stand-by, next winter's load would probably be equal to the full capacity of the existing plant, and that the committee should without delay arrange for the installation of the additional plant which would be required at the end of the year 1905. The Works Sub-Committee have been requested to consider and report upon the matter.

Bognor.—The Urban District Council have asked the Board of Trade, as the extension of the Electric Lighting Order, 1899, would expire on June 30, to defer further consideration of the question of revoking the order for six months to enable the Council to make the necessary arrangements for providing electric lighting in the town. Mr. V. Collinson, of Leadenhall-street, London, has given notice to apply to the Board of Trade to supply electricity within the urban district.

York.—The Electric Light Committee recommend the Council to authorise the extension of mains throughout Coney-street and Spurrier-gate. With a view to evading, as far as possible, any inconvenience to traffic, the city electrical engineer is to confer with the city engineer. A demand for current having arisen on Holgate-road it is proposed to lay a main from St. Paul's Church to the Fox Inn. The extension works at the station on Foss Islands will be formally opened on Monday afternoon, July 18.

St. Marylebone.—The technical legal difficulties which had arisen respecting the form of receipt, and in consequence of which the St. Marylebone Borough Council were unable to complete the purchase of their electric lighting undertaking on June 30, have now been settled. According to a promise by Mr. J. Wilson, town clerk, the deed was to be brought before the Council for sealing last night. The Council have made arrangements for a temporary loan of £1,300,000 at 3½ per cent. per annum to enable them to complete the purchase.

Stowmarket.—The town has now been placed in telephonic communication with Ipswich, Woodbridge, Felixstowe, and the trunk lines throughout the country by the National Telephone Company, Limited. Ordinary messages can be sent from the call office to Ipswich, Woodbridge, or Felixstowe at a charge of 2d. for three minutes; to London the charge will be 1s., and Bury St. Edmunds 6d., for the same length of time. There will also be an exchange and call office at Needham Market within the next few days.

Lancaster.—The report of the electricity department shows a total net profit of £1,506, as compared with £1,353 for the previous year. Of this sum £750 has been paid over to the borough fund and £756 carried to reserve fund; the latter now stands at £4,241. The total for sale of current and rent of meters has increased by £1,681; the income from public lamps is also more by £76. The total expenditure has increased from £5,796 to £7,559, the increase in interest and redemption being £762. The total capital expenditure is £60,595.

New Firm.—We are informed that, owing to a steady increase, the business hitherto carried on by Mr. F. Winter, 8, Redcross-street, in supplies for electrical and general manufacturing purposes, will now be carried on under the title of Dr. Heinr. Traun and Sons' London Agency, with Mr. F. Winter as manager and Mr. G Almenräder as assistant manager. Mr. Almenräder has been with the firm for the last 18 years, and although there is a formal change of name the business will be carried on here and elsewhere by the same persons and in the same manner as heretofore.

Coventry.—An enquiry has been held into an application of the City Council for power to borrow £31.675 for the purpose of the extension of the electric light works. Mr. Jeckell said that the amount for which sanction to borrow was applied for would be distributed as follows: mains, £12 000; new sub-stations completely fitted, £200; transformers, £3 000; new generating plant at works, £6,725; boiler, £1,159; crane, £450; buildings, £1,500; foundation, £250; feed pumps, £250; pipes, £500; extension of coal conveyor, £300; extension of economiser, £300; motors for works, £150—total, £31,757.

Luton.—The electrical engineer reported at the last Town Council meeting that since May 16 last 10,561 units had been generated, an equivalent to 68 8-c.p. lamps and two motors of 2½ h.p. connected, making a total of 169 consumers with 10,795 lamps and 52 motors of 177 h.p.; and at the present time over 356 additional lamps and three motors of 5½ h.p. were being wired. The number of units generated showed an increase of 76 per cent. over the number generated during the corresponding period of last year. Extensions of mains, estimated to cost about £326 and £248 respectively, were dealt with in committee.

Rathmines.—The accounts of the Electric Lighting Committee show an apparent loss of £955 for the last year. The Council are supplying electric light to private consumers at 4½d.; the cost is 3·87d. Public lighting is charged 2·7d. It is suggested that the public lighting should be charged at the same rate as to the private consumers. The total credit for public lighting last year was £2,979, but if charged at 4½d. it would amount to £4,965, and instead of showing a loss of £955 on the year's manufacture, it would show a credit balance of £1,034. The matter has been referred to the Electric Lighting Committee.

Maidstone.—An extension of 170 yards of mains is to be made in King Edward-road at an estimated cost of £68, and 15s. will be charged per lamp per annum for the hire of lamps for outside lighting of shops, the consumer paying for the electrical energy. The last electricity financial statement shows that the value of electricity supplied for quarter ending March 31, 1904, was £2,241; collected, £2,007; balance, £236; overdraft on revenue account, £692; temporary loan on capital account, £1,341; temporary loan on motor account, £804; temporary loan on free wiring, £381—£2,528—total, £3,220.

Retford.—At the meeting of the Town Council on Friday the Gas Committee presented a report as to the advisability of supplying electricity in the borough. They estimated five miles of cables to cost £3,000, the erection of a plant at the gasworks to run 2,000 lights at £6,000, and a building for three engines at £500. With regard to the cost of production the estimates were: fuel and gas, £250 a year;

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wages, £250; and £100 for extras. The Gas Committee, with the addition of five members of the Council, were appointed to engage an expert to go over the town and submit to an early meeting a scheme and detailed information.

Manchester.—At Wednesday's meeting the Chairman of the Electricity Committee (Mr. Howarth) said the electricity undertaking had, so far, not been a great financial success, but the prospect was brightening. In two years the amount of electrical current generated had gone up from 10 million units to 29 millions, mainly due to the completion of the tramways, but there was also an increasing demand for electricity for power purposes from industrial companies and firms. In the early days of the Manchester electricity department, he said, the committee had gone a little too far with their expenditure on capital. This it was which made the profit at present look somewhat small.

Kilmalcolm.—A provisional order was obtained by the local electric light company in 1903, and the supply was started last Christmas, which practically forms a record in having the supply started in same year as provisional order was obtained. The town is practically built on rock, and therefore a great amount of blasting was required for opening tracks for laying of cables. Already over 100 consumers are now connected to the supply mains, and, we are informed, applications are still coming in. Considerable extensions are to be made to the supply mains and station plant to meet increased demand for next winter. The resident engineer is Mr. James Brown, late of Govan.

Dudley.—The Electrical Committee propose that a 400-kw. engine and dynamo be purchased from the Ferranti Company and installed at the generating station. Also that the charge to consumers of power be reduced to 1d. per unit for 22 hours, and 6d. for the hours of heavy load. The electrical undertaking's output for the year ending March 31 last shows an increase of 470,000 units, compared with that for the previous 12 months. The gross income for the year was £10,661, and the working expenses £5,649. The gross profit was £5,012, of which £4,356 was absorbed in principal and interest on loans, leaving a net profit of £655. The net profit for the previous 12 months was £396.

Torquay.—The Town Council on Tuesday instructed the electrical engineer to prepare drawings and general scheme for the proposed new electric light and power station in Upton Valley, having regard to the fact that the Dolter Tramway Company's Bill has passed the committee of the House of Lords. The total amount of the Council's capital outlay in connection with the new electricity station, to supply the Dolter Company with current, will be £10,000, of which £8,000 is for machinery. The minimum sum payable by the company, £1,200 per annum, is more than required to pay the costs of generation, interest, and sinking fund charges upon this £10,000, while the Council will benefit in other ways.

Neath.—An enquiry has been held into an application of the Corporation to borrow £5,000 for electric light purposes. The Town Clerk said the Council obtained a provisional order in 1901, and had entered into an agreement with the South Wales Electrical Power Distribution Company, who would be in a position to supply current in September. A tender of Messrs. Callender Cable Company at £1,412 had been accepted. Mr. D. M. Jenkins, borough engineer, concurred with the estimate of Mr. Henry Thomas Sully, Bristol, the consulting engineer, of 40,000 units. A number of people had given their names as customers. It has been suggested to light the new public library and the market, now under construction, with electricity.

St. Annes.—Mr. J. H. Clothier, the electrical engineer, in his report for the month ending June 25, says: Since the last report we have received 11 applications for 396 lights. There is an increase of 50 per cent. in units sold for private lighting compared with the corresponding month of last year, whilst the lamp connections and consumers still continue to increase at an even rate. Units sold during May, 1903, 8,868; 1904, 42,694; units sold to May 31, 1903, 21,503; 1904, 87,477; equivalent to 8-c.p. lamps connected, 1903, 11 348; 1904, 14,568; units sold per 8-c.p. lamps connected, 1903, 0·78; 1904, 0·61; maximum load lighting, 1903, 107 kw.; 1904, 147 kw.; ditto traction, 1903, nil; 1904, 400 kw.; total number of consumers, 1903, 186; 1904, 264.

Stock Exchange.—The Stock Exchange Committee have appointed July 20 as a special settling day for Rhodes Electrical Manufacturing Company's 6,133 ordinary shares of £1 each, fully paid, Nos. 35,001 to 41,000 and 43,101 to 43,235, and 33,000 vendors' ordinary shares of £1 each, fully paid, Nos. 5,001 to 35,000, 41,001 to 43,100, and 43,236 to 44,135. Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to London United Tramways (1901), Limited, further issue of 25,000 5 per cent. cumulative preference shares of £10 each, fully paid. The committee have also been asked to appoint a special settling day in Marconi's Wireless Telegraph Company's further issue of 25,000 shares of £1 each, fully paid, Nos. 196,128 to 221,127.

Newton Abbot.—The Urban Electric Supply Company's electricity works were opened on Monday by Mr. H. T. Parker, chairman of the Lighting Committee of the Urban District Council. Messrs. Parker Bros. were the contractors for the work. The plant consists of dynamos giving 180 amperes at 500 volts, and batteries of a capacity of 360 amperes. At present there are 6,800 8-c.p. lamps in use. Owing to the number of applications received this number will shortly be increased to 7,300 lamps. The street-lighting includes 20 10-ampere arc lamps and three 3-ampere enclosed arc lamps; 117 40-c.p. half-night lamps, 101 40-c.p. all-night lamps; 26 80-c.p. all-night lamps, and a single 160-c.p. lamp. There are 18 electric motors connected with the cables. Mr. F. C. Pay is the managing engineer, with Mr. Dayian as assistant engineer.

Southwark.—The Guardians have accepted the following offers: (*a*) City of London Electric Lighting Company, Limited, for lighting Board-room and offices. In each of the two winter quarters: for the first six units per 8-c.p. lamp, 5d. per B.O.T. unit, and 2d. per unit for any excess in each quarter beyond six units per 8-c.p. lamp; in each of the two summer quarters: for the first three units per 8-c.p. lamp, 5d. per B.O.T. unit, and 2d. per unit for any excess in each quarter beyond three units per 8-c.p. lamp. (*b*) London Electric Supply Corporation, Limited, to supply current to the new northern relief station and dispensary, 81, Borough-road, for 12 months certain, and thereafter, subject to three months' notice on either side, at the price of 4½d. per B.T.U., and to allow a discount of 5 per cent, for prompt quarterly settlements.

Pamphlets for Distribution.—Mr. H. F. Friederichs, electrical engineer to the West Hartlepool Corporation, has recently issued two handy and efficient pamphlets, entitled "Electricity for Lighting Purposes," and "Electricity as a Motive Power." They were originally got out with the idea of counteracting the effects of the pamphlets distributed by the local gas company. As these identical pamphlets are being widely distributed by the various gas companies in this country, Mr. Friederichs considers that he has attained the end he had in view, and at the same time the Corporation's electricity undertaking obtained a good advertisement. We are asked to say that if any station engineer would like a copy it is to be had for the asking, and he is at liberty to alter the contents to suit local conditions, and to use it if helpful to the cause it was originally got out for.

Ealing.—At the last meeting of the Town Council the Electricity Supply Committee reported that a scheme formulated by Captain Purvis for the formation of a fire brigade at the works was considered, and it was resolved to provide a steam siren, extra hydrants, chemical extincteur, and fire pails at a cost not to exceed £50. Fifteen men to form the brigade, and to be paid 6d. per hour for attending drills (not during regular working hours), the maximum cost of drills for the first year being £5. 12s. 6d. and subsequent years £4. 10s. It being suggested that Captain Gravener should be informed of the arrangements made, so that he might co-operate with the brigade at the works in the event of a fire, it was said the committee would willingly avail themselves of Captain Gravener's help if he could be of any assistance to them; but if a fire should occur at the electric lighting station it must be put out in a few seconds, and the staff there should be drilled as to what switches they would have to break, etc.

Mirfield.—The Urban District Council have signed an agreement with the Yorkshire Electric Power Company for the supply of electricity in bulk from the company's new station at Thornhill. The agreement is of a somewhat novel character, as the Council are undertaking the lighting supply, and allowing the company to supply direct to large power users who require motors. Thus the Council are saved a heavy expenditure on a generating station and electrical mains, and it is confidently anticipated that the undertaking will prove profitable from the commencement. The Council's consulting engineer, Mr. A. B. Mountain, of Huddersfield, after considering the question of putting down a small generating station to supply the district, recommended the taking of a supply from the company. The negotiations have been carried out by Mr. E. B. Wilson, clerk to the Council, and Mr. W. B. Woodhouse, the company's chief engineer. A supply of electricity will be available at the end of the year

New Issue—Electric Supply Corporation, Limited.—This company acquires provisional orders for the supply of electric light and power in 18 towns in England and Scotland, and the prospectus now issued is remarkable for the absence of any claim for promotion profit. It is stated that the entire capital of £250,000, in ordinary shares, will be applied to meeting the actual cost of plant and machinery and preliminary expenses; and a very advantageous agreement has been entered into with Messrs. Crompton and Co., Limited, who have contracted to carry out all the works at a profit of 15 per cent. on the prime cost. It is estimated on the basis of results in similar districts, that the company will be able to earn 10 per cent. on its ordinary shares, which have no preference shares in front of them. The business at Chelmsford, which is taken over as a going concern, has been very successful, and encourages anticipations of equally good returns in the other towns in the earlier days of development. Out of these five have recently commenced supply, and the erection of plant and laying of mains will be immediately proceeded with in the remaining districts. The agreements with the local authorities, under which the undertakings may be purchased on the expiration of varying periods, ensure favourable terms to the company. The list of applications will open on Tuesday, 12th inst., and will close on Friday, 15th inst.

Maidenhead.—As it will be some time yet before the Royal Assent will be given to the extension order, the Council have decided to apply at once for power to borrow £3,000 for the extensions carried out and projected in the original area. Messrs. Burstall and Monkhouse estimate this as follows: Plant at station—cooling tower, pumps and pipes, grease separator, etc., £607; mains—new town feeder, £450; extensions of distributing mains in Bath-road, Rutland-road, Cranford Villas-road, Norfolk-road, over Maidenhead Bridge, Boyn-hill-avenue, St. Mark's-road, £530; provision for new extensions, £400; public lighting—arc lamps in Bath-road, £330; additional incandescent lighting, £216; services and meters, £400; cost of loan, stamps, contracts, etc., £67—£3,000. Their recommendation that as soon as the Royal Assent has been given the districts adjacent to the present area should be proceeded with has been agreed to. These would be Maidenhead Court, Bray, and Taplow from the river to the Dumb-Bell, and they would require a capital expenditure of about £3,000, and could be served from the plant at present in the station by extensions of the existing mains. The outlying districts of Taplow, Hitcham, Burnham, Cookham, Cookham Dene, Holyport, etc., will require special mains and machinery. The last report of the resident engineer shows that the public lighting extensions are now rapidly progressing. The outside department has been very busy with consumers, 10 new services having been laid, nine of which have been connected up. Application for 674 8-c.p. lamps have been received during the month, being more than was anticipated in the last report. The total number of lamps applied for now stands at 12,700.

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Yarmouth.—There were some remarkable figures disclosed in a set of tenders examined by the Education Committee on Tuesday for installing the electric light into certain schools. For Northgate School one firm asked £86, the next highest tender was £121, then came one of £170, after that £179, and finally £182. For Nelson School the prices quoted varied from £40 to £83. For St. George's School the differences were startling, for while the lowest figure was £48, the next highest was £62; then came £93, after that £96, followed by £104, with £150 as the top price. Tenders for the Priory School ranged from £73 to £176, an equally startling discrepancy, and for St. James's School from £43 to £107. The accepted tenders appear in another column. The committee have stated, in explanation of the different quotations, that local firms had not enough hands to do the work in the time, but the accepted firm was a large concern, and was, therefore, able to quote so much more cheaply. Its figures were within £5 of the estimate of the borough electrical engineer.

Kensington.—Applications received from the Post Office for permission to lay pipes for telephone wires, etc., in Colville-terrace (south side), Walton-street (north-west side), West Cromwell-road (north side), Hogarth-road (north-west side), Earl's Court-road (north-east side), and North-row (south-east side), and notices from the undermentioned electric lighting companies relative to proposed extensions—viz.: Notting Hill Electric Lighting Company, Limited, Colville-square, Colville-gardens, Powis-square, Talbot-road, and Colville-terrace; Brompton and Kensington Electricity Supply Company, Limited, Barkstone-gardens and Richmond-road; have been agreed to. The Council have received a letter from the Willesden Urban District Council stating that they have been memorialised by a number of ratepayers and residents in the Harrow-road to light such road by means of electric arc lamps, and enquiring whether, in the event of the District Council agreeing to such request so far as their side of the roadway is concerned, the Borough Council would be prepared to so light the section of the road under their control.

West Bromwich.—In their last report the Electricity Committee stated that in August, 1901, the Council fixed the price of electrical energy for power purposes at 1d. per unit. The committee had since found that in the case of motor installations of 3 h.p. and under, the income at the present charge was not sufficient to cover sinking fund and interest on the average cost of a service, and therefore recommended that for all motor installations of 3 h.p. and under the consumers should be given the option of an increase of ½d. per unit in the charges or pay for a minimum consumption of 200 units per horse-power per quarter. Also, in cases where light and power are used on the premises, the current for power purposes shall be registered by the lighting meter, the indicator being placed in the lighting circuit only so that all current used for power will be charged for at the 1½d. rate. They further recommended that application be made for sanction to borrow £1,300 for further mains extensions. Sanction had been received to loans of £1,751, £548, and £1,000 for extensions, street-lighting, and effecting other necessary improvements.

London County Council.—On Tuesday it was agreed to lend the Bermondsey Borough Council £31,000 for electric lighting and dust destructor purposes, and the Shoreditch Borough Council £7,000 for electric light installation. A report was submitted concerning the proposed erection of a generating sub-station at Streatham and the acquisition of a site, involving an expenditure of over £21,000. The site chosen by the Highways Committee is adjacent to the Wandsworth Borough Council's depôt. It contains an area of about 22,000 square feet, and has an entrance from the private road at the side of the Council's depôt, and also a frontage to Daysbrook-road in the rear. The owner being willing to dispose of the land for £1,500, the Council agreed to pay that amount for it. The cost of erecting the sub-station is estimated at about £7,500, and the provision of plant, etc., at £12,000. Notices under Electric Lighting Acts and orders were agreed to as follows: Crystal Palace District Electric Supply Company, to lay high-tension mains along portions of Sydenham-road, West-hill, and Charleville-circus, and to build a transformer box at the junction of West-hill and Crystal Palace Park-road; Brompton and Kensington Electricity Supply Company, to lay low-tension mains along a portion of Richmond-road; Charing Cross and Strand Electricity Supply Corporation, to build a street box at the junction of the Haymarket and Pall-mall East; County of London Electric Supply Company, to lay low-tension mains along Baakerville-road; London Electric Supply Corporation, to lay high and low tension mains along portions of New Cross-road, Billington-road, and Briant-street, and to fix a converter box in Billington-road; Metropolitan Electric Supply Company, to lay extra high-tension mains along portions of Great Chapel-street and Carlisle-street from Titchfield-street to Dean-street; Notting-hill Electric Lighting Company, to lay mains along portions of Colville square, Colville-gardens, Colville-terrace, Talbot-road, and Powis-square; St. Pancras Borough Council, to lay mains across Stanhope-street and along portions of Drummond-street, Hampstead-road, and Tottenham Court-road, and to lay mains along a portion of Tottenham Court-road.

London Gazette.—A receiving order has been made out on debtors petition in the estate of Frederick William Parkes and Edward Sadleir (trading as Parkes and Sadleir), electrical fitters and engineers, trading at Dingle, Colwyn Bay, Denbigh. An order has been made to wind-up the Electro-Voelker Syndicate, Limited, 65, George-street, Croydon, Surrey. The following committee has been appointed to act with the official receiver and liquidator of the Automatic Telephone Company (1903), Limited: Andrew James Crane, The Bungalow, Seabrook, Hythe, Kent; George Augustus Paul, 110, Capel-road, London; James White, 43, Gordon-square, London; Charles Gregory Penney, 70, Bishopsgate-street, London; John Dixon Gibbes, 38, Weymouth-street, London. The partnership between George Ernest Mansfield and William Goddard Dexter, electrical engineers, 84, Vulcan-road, Leicester, trading as Mansfield and Dexter, has been dissolved by mutual consent; George Ernest Mansfield will continue the business. The partnership between Thomas Usher and William Schmahl, 6, Farringdon-avenue, London, E.C., and Newcastle-upon-Tyne, trading as Armorduct Improved Electric Conduit Company, has been dissolved by mutual consent. The partnership between James Herbert Edwards, Frank Armstrong, Alfred Langrish Stephens, and William Dillworth Armstrong, electrical and mechanical engineers, Bristol, Cardiff, and elsewhere, trading as Edwards and Armstrong, has been dissolved by mutual consent; James Herbert Edwards and Alfred Langrish Stephens will continue the business. The Lincoln Tramways Company, Limited, will be wound up voluntarily; Edwin Pratt, Clarence House, Lindum-terrace, Lincoln, has been appointed liquidator. The Louis Leakey Aluminium Company, Limited, will be wound up on account of liabilities; Mr. James Fitzpatrick, 147, Leadenhall-street, London, E.C., has been appointed liquidator. The partnership between John Altman and Stanley James Rising, trading as the Metropolitan Lighting Company, 157, High-road, Kilburn, has been dissolved by mutual consent. The final meeting of the Dover Electricity Supply Company, Limited, will be held at the Burlington Hotel, Dover, at 12.30 p.m. on Aug. 3.

Robertson Electric Lamps Outing.—In order to mark the completion of another successful year the staff and employés of Robertson Electric Lamps, Limited, Hammersmith, chartered a special last Saturday and betook themselves to Dover and Folkestone. Those who went to the former place had an opportunity of witnessing some of the festivities in connection with Lord Curzon's installation as Warden of the Cinque Ports. There were about 400 in the train, all as jolly as sand boys, though most of them were girls; we have at various times seen them at work, cheerfully and diligently pursuing their allotted tasks, and it may be taken for granted that they did not lack application when on pleasure bent. It speaks volumes for the management and all concerned that there was not the slightest hitch or annoying incident barring a slight accident, which deserves to be noted as it arose from a singular cause rather significant of the times we live in. On the return journey an accumulator battery of bottles remained for some time an unsolved problem, as amongst the whole party, Pressmen included, not a single corkscrew could be found. The programme, which was carried out with lavish hospitality, included, as far as the staff was concerned, a dinner, for the success of which compliments are due to Foster's Dover Castle Hotel, followed by a most delightful drive. A well-appointed four-in-hand, supplemented by a drag, first took the party through shady Kentish lanes to Newing Green. Here an old-fashioned garden was found, full of luscious strawberries, also a bowling green, some swings, etc., all of which found their use in turn to while away a pleasant hour in the glorious sunshine. The next halt was made at Limpne Castle, and, while admiring the extensive view, the party, which had spread out picnic fashion, fell the victim to Mr. Robertson's camera. A thoroughly enjoyable drive through Hythe, Sandgate, and the Undercliff finished up again at Fosters, where tea was laid. As in the morning Mr. C. J. Robertson, director, and Mr. C. Wilson, manager, took the chairs. There were practically no speeches. Mr. Heeden, one of the superintendents proposed "Success to the Firm"; Miss Fuller, holding a similar position, proposed a well-deserved vote of thanks to the secretary of the organising committee, Mr. G. W. Saville White, which was carried by hearty acclammation. Mr. Wilson welcomed the visitors, who were unanimous in having had a splendid time aided by the jovial goodfellowship which permeated the gathering. This was the eighth outing of the firm, and, with the exception of additions, there were no new faces to be seen. A similar remark was made with regard to the employés, showing that the firm's policy of encouraging dinner and recreation clubs, social evenings, &c., is bearing fruit.

Dover Hydraulic Bridge.—On Saturday the inspector of the Board of Trade, Major-General Hutchinson, C.B., attended to witness the running of the first train over the new branch railway from a junction in the Harbour Station, over Strond-street, along Union-street, across the entrance to the Wellington Dock by the new steel bridge, continuing across Cambridge-road and the Esplanade, to the Prince of Wales Pier, and along the pier to the new Port of Call Station, 500ft. long, which has been erected near its extremity. The run, says the *Dover Express*, to which we are indebted for the following particulars, was a success gratifying to all concerned. The new railway from the Dover Harbour Station to the Prince of Wales Pier, which is a single line 24 chains in length (80 chains make a mile), has been constucted for the Dover Harbour Board by Messrs. Pearson and Son, Limited. Mr. Walmisley has acted for the Harbour Board as consulting engineer. The main feature of the new line is the electric hydraulic bridge over the Wellington Dock entrance. This bridge, which is formed of two cantilevers, is of mild steel, having a total length of 134ft. 11½in., the portion that swings across the dock entrance having a radius of 91ft. 1½in. from the centre pivot, and the rear portion being 43ft. 1in. long. The total weight of the bridge, which was built by Messrs. Armstrong, Whitworth, and Co., of Elswick, near Newcastle-on-Tyne, is 300 tons. It carries a single line of railway, and the bridge, which has a clearance of 17ft. between the cantilevers, will permit two horse vehicles to pass each other with plenty of clearance. It is decked with karri wood, covered with bluegum treads, and iron ways for the wheels of vehicles. On the west side there is a cantilever path for foot passengers, with a width of 4ft. 11in. from the centre of the main girder. Such a big bridge requires considerable power to manœuvre it, and the method by which this is applied is very interesting. In a small engine-house beside the brick tower is an engine actuated by electric power derived from th Corporation mains. This works a 12in. ram in the adjoining tower which pushes an accumulator to the top of the tower, which is 45ft. high. This accumulator is loaded with 29 tons of ballast. The weight of this falling produces an hydraulic pressure of 750lb. per square inch, necessitating pipes with specially devised connections to convey the power to the bridge. The machinery is capable of opening and shutting the bridge at least 10 times an hour. The bridge is carried on an

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hydraulic centre pivot, which raises the bridge when required to be swung 3in. or 4in., so as to clear its bearings. The bridge, on being raised, cants up at its further extremity, the back part being loaded with Kentledge cast out of the old bridge. On the bridge being lowered it becomes horizontal. The turning of the bridge is effected by a ring 16ft. diameter under the bridge, to which is attached a big chain. To turn the bridge the quarter of a revolution that is necessary to open it, this chain has to be hauled a distance of 12ft. The chain being passed over a sheaf, is attached to an hydraulic ram, which has a movement of about 6ft., and this is sufficient, owing to the chain being doubled, to move the chain 12ft. and cause the bridge to make the necessary quarter turn to open it. The hydraulic pivot of the bridge rests on a granite block, and this in turn rests on a 6ft. square block of concrete which is taken down on to the solid rock 22ft. below. General Hutchinson, one of the Board of Trade inspectors, who made the test both of the bridge and the viaduct, has reported that both the viaduct and the bridge are quite safe, and the railway is fit for traffic. The viaduct, under the influence of a load greater than two engines, deflected only $\frac{1}{16}$ft., whilst the deflection on the bridge was only $\frac{1}{8}$ft., the span there being considerably more. The results of these tests are considered exceedingly satisfactory, and the whole work does great credit to both the designer and the constructors.

COLONIAL NOTES.

Kingston (Jamaica).—An accident occurred on Monday in the power-house of the electric works. A large pipe conducting water into the works burst at a time when 60 men were working in the building, and all were swept into the adjacent river by the inrush of water. It is reported that 34 men were drowned, while 17 others are missing.

Rand Central Electric Works.—Result of working for June: "Kilowatt-hours generated 949,835, yielding a gross revenue of £8,800." For the corresponding period of last year the result was: kilowatt-hours generated 675,241, yielding a gross revenue of £6,136. *Financial Times.*

Mian Mir.—Four of the tenders for the installation of electric light and electric punkah-pulling, Mian Mir Cantonment, are under the consideration of the Director-General, Military Works.—*Indian Engineering.*

New Zealand.—The Waipori Falls Electric Power Company, Limited, intend to present a petition to the General Assembly of New Zealand at the ensuing session praying for leave to introduce a Bill to authorise the company to supply and use electrical energy within the counties of Taieri, Bruce, Tuapeka, and Waikouaiti, the city of Dunedin, the boroughs of Milton, Mosgiel, Green Island, Caversham, South Dunedin, St. Kilda, Mornington, Roslyn, Maori Hill, North-East Valley, West Harbour, and Port Chalmers, and the road districts of Peninsula, Tomahawk, and Portobello, and to undertake all works necessary for that purpose. The *New Zealand Mining, Engineering, and Building Journal* says: "The Wellington Press were furnished with some amusement over the various engineering disputes and mistakes in Otago's capital. But the Empire City has its own little troubles, and one has just arisen which the law courts may be asked to solve. The point is whether the electric syndicate under its agreement with the City Council has the monopoly of supply of electric light and power for the city. The City Council claims that the syndicate has no monopoly, and that they can compete with the syndicate. Certainly if the syndicate did not secure themselves against competition from their own concessionaires then they were much less prudent than business people generally are."

PROVISIONAL PATENTS, 1904.

JUNE 27.

14433. Improvements in electric ignition, lighting, and battery charging systems, parts of which are applicable for other purposes. Ivon Molesworth de Havilland, 18, Hertford-street, Coventry.

14442. Improved means for electrically connecting railway rails or other conductors. John Stirling Alexander, Fife House, Kingston-on-Thames.

14460. Improvements in or relating to the reduction of the difference of phase in electric current circuits. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Badische Anilin and Soda Fabrik, Germany.)

14463. Improvements in or relating to electromagnetic apparatus for opening, closing, or short-circuiting electric circuits. Valère Alfred Fynn, 70, Chancery-lane, London.

JUNE 28.

14500. A method of chemically treating arc-lamp carbons whereby all wastage is stopped on same while lamp is burning and life of carbon is considerably increased and better distribution of light obtained at arc. Albert Ernest Carter and Cecil Charles Fowler, Corporation Electricity Works, North-road, Brighton.

14504. Improvements in and connected with electrolytic cells. James Hargreaves, May Villa, Peel House-lane, Farnworth, Widnes, Lancs.

14510. Improvements applicable to the "trolley poles" of electric tramcars. Frank Nicholson, 4, St. Ann's-square, Manchester.

14519. Automatic electric rail protector. Henry Sanderson, 99, Laygate-lane, South Shields.

14520. Improvements in branch connections for electric cables. Franklin Everhart and John Joseph Dossert, 46, Lincoln's-inn-fields, London. (Complete specification.)

14523. Telephone systems. Wallace Fairweather, 65, Chancery-lane, London. (American Electric Telephone Company, United States.) (Complete specification.)

14543. Improvements in thermo-electric couples. William Henry Bristol, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14544. Improvements in thermo-electric couples. William Henry Bristol, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14545. Improvements in thermo-electric couples or apparatus. William Henry Bristol, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14553. Improvements in electric burglar alarms. Amos Getto, 53, Chancery-lane, London. (Complete specification.)

14567. Improvements in electricity meters. Isaac Octave Revilliod, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14568. Arrangement of electric cable working with high voltage. Siemens-Schuckert Werke G. M. B. H., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 29, 1903, being date of application in Germany.) (Complete specification.)

14577. Improvements in liquid lift controllers or resistances for use with either alternating or direct-current circuits. Ernest Daniel Knights, 18, Buckingham-street, Strand, London.

JUNE 29.

4663A. Improved means for rupturing electric currents. Percy Holbrook Thomas, The Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 27, 1903, being date of application in United States.) (An invention comprised in application No. 4663, dated Feb. 25, 1904.) (Complete specification.)

14597. Improvements in and relating to time switches for electric current, gaslight, or similar purposes. Frank Simon Smith and John Henry Smith, Imperial-chambers, Albert-street, Derby.

14617. Improvements in the contacts of electric wire connections. Edward Lycett, 77, Colmore-row, Birmingham. (Complete specification.)

14663. Improvements in and relating to electromotor driving. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

JUNE 30.

14684. Improvements in and connected with dynamo-electric machines. Henry Oliver Farrell, 106, Princess-street, Manchester.

14717. Improvements in insulating electric conductors especially suitable for the firing plugs of internal combustion engines. John Leighton and Ernest Hacking, 24, Southampton-buildings, Chancery-lane, London.

14727. Improvements in and relating to electric railways. Joseph Cook Angus, 70, Chancery-lane, London.

14728. A gravity controlled electric current indicator with a long range of movement. William Joseph Still, 63, Lincoln's-inn-fields, London.

14733. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

14734. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

14735. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

14736. Improvements in and relating to electric cut-outs and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14737. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14738. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14739. Improvements in brush-holders for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14740. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14741. Improvements in protection against reversal of energy. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14743. Improvements in or connected with electric or other railways. John Edward Neale, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

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14761. Improvements in or relating to driving gear for electrically operated cranes, trolleys, travelling winches, and the like. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Martin Becker, Germany.)

14762. Improvements in electromagnetic operating devices for levers, valves, and other mechanism. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Martin Becker, Germany.)

JULY 1.

14767. An improved nipple for use in connection with electrical conduit tubes and fittings. Hugo Hirst and Charles Edward Gunner, 71, Queen-Victoria-street, London. (Complete specification.)

14770. Improvements in electric light reflectors. Hugo Hirst and John Hillery Collings, 71, Queen Victoria-street, London.

14786. Improvements in and connected with the supply of electric current to the "live" rail or wire of electric traction systems. George Wordsworth Peard and Ambrose Mitchell Martin, 15, Water-street, Liverpool.

14792. Electric railway automatic feeding appliances. Ernest Rothwell, 71, Great Cheetham-street West, Manchester.

14814. Improved clip for clamping or binding the trolley wires to fittings in overhead wire systems of electric traction. John Henry Luby and William Harris, Lloyds' Bank-buildings, Bristol. (Complete specification.)

14815. Improved section insulator for overhead wire systems of electric traction. John Henry Luby and William Harris, Lloyds' Bank-buildings, Bristol. (Complete specification.)

14821. Improvements in and relating to electro-capillary apparatus. James Tarbotton Armstrong and Axel Orling, 61, Chancery-lane, London.

14841. Improvements in and relating to the regulation of dynamo-electric machines. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 2, 1903, being date of application in Germany.) (Complete specification.)

14847. Improvements in electrical fire alarms and thermo-indicators. Casimir Cyon, 40, Chancery-lane, London. (Complete specification.)

JULY 2.

14879. Improvements in and relating to apparatus for controlling the lighting and extinguishing of gas, the flow of fluids, or the actuation of electric switches, and for analogous uses at predetermined times. Harry Wightman Harris, 55, Chancery-lane, London.

14911. Improvements in electric arc lamps. Adolphe Bellardent, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 5, 1903, being date of application in France.) (Complete specification.)

14918. Improvements in and relating to automatic telegraphic apparatus. Antoine Damaskinos, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 21, 1904.

1903.

14062. Electrical cash-checking machines. Guess.

14175. Gas or vapour electric apparatus, such as mercury vapour lamps and converters for lighting or other purposes. Le Tall. (Cooper-Hewitt Electric Company.)

14190. Wireless telegraphy. Brown.

14247. Electric resistances. Von Kramer.

14363. Telephone call recording systems. Lake. (Automatic Telephone Meter Company.)

15243. Means for automatically regulating electric currents generated by dynamos. Watkins. (Consolidated Railway Electric Lighting and Equipment Company.)

20633. Attaching electrical insulators to insulator brackets. Chambers.

20634. Attaching insulators to the tubular arms of telegraph and like poles. Chambers.

23863. Electric distribution systems. Hallberg.

26721. Cohering receivers used in space telegraphy. Peters.

28401. Electric arc lamps. Perdrisat.

1904.

707. Electric block-signalling systems. Werner.

1314. Electric igniters for explosion motors. Ropiquet and Daveluy. (Date applied for under International Convention, May 30, 1903.)

3426. Electric switches. MacDiarmid and Bates.

4394. Brush-holders for dynamo-electric generators. Deutsch.

6389. Electrical distribution. Woodbridge.

7129. Telegraphic signal systems. Burke.

8235. Systems of electrical distribution. Peck. (Date applied for under International Convention, May 1, 1903.

8986. Electrically propelled road vehicles. Soc. Anon. L'Electrique. (Date applied for under International Convention, Jan. 14, 1904.)

8612. Transmission of electrical impulses. Richmond.

10058. Electric switches. General Contracts Company, Limited, Cook, and Chipperfield.

10142. Electrical conductors. McGeorge.

11471. Dynamo-electric machines. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

11862. Electric arc lamps. Haddan. (Allgemeine Beleuchtungs und Heizindustrie Actiengesellschaft.)

12087. Prepayment electrical measuring instruments. Conrad. (Date applied for under International Convention, June 24, 1903.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅞-1
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5⅞-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	101-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	3¼-3⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	85-88 xd
Brush Electrical Engineering, Ordinary, Nos. 1-105,751 ..	2	..	¾-1
—— Non. Cum., 6 per cent. Pref.	2	..	¾-1⅛
—— 4½ per cent. 1st Debenture Stock	100	..	96-99
—— 4½ per cent. 2nd Debenture Stock	100	..	71-76 xd
Callender's Cable, Debentures	100	..	102-106
—— Ordinary	5	–	9¼-10⅛
—— 5 per cent. Pref.	5	–	5¼-5⅜
Crompton and Co.	5	–	12-12½
—— 5 per cent. Debentures	100	–	93-96 xd
Edison and Swan United, "A" Shares, 1-99,251	5	..	2⅛-2⅜
—— "A" Shares, 01-017,139	5	..	1-2
—— 5 per cent. Debentures	100	..	75-79
—— 4 per cent. Deb. Stock, Red.	100	..	74-79 xd
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼-1½
—— 7 per cent. Cumulative Pref.	2	–	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	..	9¼-9⅜
—— 4 per cent. 1st Mort. Deb. Stock	100	..	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	11¼-12¼
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-19¼ xd
—— 4 per cent. Debentures	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	36-39
—— 5 per cent. Bonds	100	–	99-102 xd
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200 ..	1	–	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv. ..	100	–	122-127
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	–	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary	5	–	10⅜-11¼
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 ..	5	–	7-7¼
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	105-108
Charing Cross and Strand, Nos. 1-70,000	5	–	7¼-8
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4¼-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-6⅜
—— 4½ per cent. Debentures	100	–	106-109 xd
City of London, Ordinary	10	–	11-11¼
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	101-104 xd
County of London Electric Supply, Ordinary	10	–	7¼-8¼
—— 6 per cent. Cum. Pref.	10	–	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	5¼-6¼
—— 6 per cent. Cum. Pref.	5	–	5⅜-5¾
—— 4½ per cent. First Mort. Deb.	100	–	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	..	88-93 xd
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
—— per cent. Debenture Stock Red	100	–	102-105
Kensington and Knightsbridge and Notting Hill	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1¼-1⅜
—— 6 per cent. Pref.	5	–	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	93-96
Metropolitan Ordinary	10	–	20¼-21¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	103-112 xd
—— 3½ per cent. Mortgage Debenture, Red.	100	–	96-99 xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	13-14 xd
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) ..	100	–	98-101
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510	5	–	5¼-6
—— 4 per cent. Debenture Stock	100	–	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., [illegible]rd., 1-12,000..	5	–	2¾-3¼
—— 4 per cent. Debenture Stock	100	–	86-90
South London, Ordinary		–	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-30,060	5	–	14¼-15¼
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	96-99 xd
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¼-5
Westminster, Ordinary	5	–	12¾-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6¼-6⅝

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 –	90-93
—— 4 per cent. Pref.	100 –	102-105
—— ,, ,, deferred	100 –	79-82
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 –	113-116
City and South London, Consolidated Ordinary	100 –	47-49
—— 4 per cent. Debenture Stock	100 –	106-109
—— 5 per cent. Pref. Stock '91	100 –	123-126
—— ,, ,, ,, '96	100 –	120-123
—— ,, ,, ,, '01	100 –	115-122
Liverpool Overhead, 5 per cent. Pref.	10 –	10-10¼
—— Ordinary, 1-50,000	10 –	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— –	99-101
Waterloo and City, Ordinary	100 –	89-92
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 –	5-5¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 –	135-140
Blackpool and Fleetwood Tramroad	10 –	13⅜-13⅝
Brisbane Tramway Invest., Ltd., Ord., 1-75,000	5 –	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 –	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 –	96-101 xd
British Columbia Electric Railway Co., Ord. Def.	100 –	100-103
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 –	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 –	105-106 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	98-101
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10 –	9¼-9⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10 –	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100 –	115-118
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	2¼-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 –	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-87,500	5 –	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 –	105-108 xd
—— Prov. Certs., all paid	100 –	101-104 xd
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅛-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 –	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10 –	2¼-2⅜
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18-19
—— 6 per cent. Cum. Pref.	all –	14-14½
—— 4½ per cent. Deb Stock	100 –	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 –	3¼-4
—— 4 per cent. Debenture Stock	100 –	88-91 xd
Kidderminster and District Lighting and Traction, Pref.	5 –	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10⅜-11¼ xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	102-104 xd
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 –	¼-⅜
—— 5 per cent. Cum. Pref., 500,001-814,016	1 –	⅜-½
New General Traction, Ordinary	5 –	¼
—— 6 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 –	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12½
—— 5 per cent. Cum. Pref.	10 –	9⅜-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 –	93-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	9-10
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,152 5 per cent. Preference	1 –	1
—— £528,0 4½ per cent. Debenture Stock	100 p.c. –	100 p.c.
Telephones.—		
National Telephone, Preferred	100 –	104-106
—— Deferred Stock	100 –	86-89
—— 6 per cent. Cum. First Pref.	10 –	11-13
—— 6 per cent. Cum. Second Pref.	10 –	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 –	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100 –	97-97¾ xd
—— 4 per cent. Deb. Stock, Red.	100 –	102-104
Oriental Telephone and Electric Company	1 –	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 2	1,447	1,387	+ 60	+ 1,216h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 2	367	348	+ 19	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	,, 2	39	—	—	—	1½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 3	1,174	1,111	+ 63	- 45	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 2	5,855	5,383	+ 472	—	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 1	990	900	+ 90	+ 989	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	June 23	857	1,017	- 160	+ 531	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	July 2	793	899	- 105	- 631	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 3	1,928	1,926	+ 2	- 185	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	June 29	1,044	1,000	+ 44	+ 800	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	July 2	4,694	4,201	+ 493	+10,216	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 3	1,189	981	+ 208	+ 260h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 1	5,385	5,376	+ 9	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 2	1,113	795	+ 318	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 3	375	—	—	—	8½	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 2	2,179	2,126	+ 53	+ 1,038	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 2	317	269	+ 48	+ 316	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 2	6,476	6,788	- 312	- 2,506h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	36·6a
City & South London Railway	,, 3	2,511	2,455	+ 56	— h	6⅝	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	June 30	550	626	- 76	- 910	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 24	225	234	- 9	- 131	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 25	251	267	- 16	- 253	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 30	219	166	+ 53	+ 293h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 30	3,836	3,964	- 128	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 30	1,060	1,075	- 15											
Dundee City Tramways	,, 22	851	867	- 16	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	July 2	756	772	- 16	+ 972	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 2	15,351	14,136	+1,215	- 250h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	June 1	224	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 29	3,214	3,140	+ 74	+ 1,147	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 18	1,312	1,130	+ 182	—	34	34	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	July 2	2,240	1,924	+ 316	+ 3,276	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 2	511	572	- 61	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	June 30	153	219	- 66	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 29	221	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	July 2	6,273	6,036	+ 237	+ 4,597	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	June 25	1,097	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 25	10,674	10,774	- 100	+ 5,585	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	July 3	1,689	1,672	+ 17	+ 60h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	June 18	12,488	8,596	+3,892	+22,131	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	July 2	214	—	—	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 2	12,918	12,676	+ 242	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 2	125	75	+ 50	+ 700	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 2	3,420	3,247	+ 173	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 2	524	471	+ 53	+ 1,628	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 2	2,220	2,183	+ 37	+ 2,207	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	June 20	131	150	- 19	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 30	474	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	July 4	4,197	4,000	+ 197	+ 4,695	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 2	238	—	—	—	7½	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 3	4,788	4,796	- 8	+ 1,907	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	June 16	966	1,187	- 221	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 22	391	332	+ 59	+ 297	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	July 1	601	365	+ 245	+ 3,299	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	June 26	1,361	1,405	- 44	+ 343	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	July 2	842	811	+ 31	+ 416	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	June 30	1,107	—	—	—	1⅞	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 29	748	497	+ 251	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

X-Rays.—Prof. Bozzoli, director of clinical medicine at the University of Turin, has communicated to the Royal Academy of Medicine his observations on the result of the use of X-rays in the treatment of certain serious diseases of the blood. He states that their action was very efficacious, enabling him to effect a cure in a case of leuchæmia which was considered incurable.

Rontgen Society.—The annual general meeting of this institution was held on the 7th inst., when the report and balance-sheet were adopted, and officers elected for the ensuing year. It may be mentioned that the council have arranged that the library of the society, at 19, Hanover-square, shall be open to members for reference every Thursday afternoon, from 5 p.m. to 7 p.m. Members are invited to send to the librarian any contributions of interest—books, journals, skiagrams, tubes, etc.

Wireless Telegraphy.—It is reported that the reason for the rejection by the Argentine Government of the Marconi Company's proposals to erect a radiographic station in the republic was that the Government considered the terms proposed by the company too high, and that the technical department of the Argentine telegraph service advised this course on the ground that the benefit derived from the station would not compensate for the cost of its installation. The Government, it is said, viewed the matter entirely from the commercial standpoint, and were not influenced by any other considerations.

New Publications.—"The Universal Directory of Railway Officials, 1904" (London: The Directory Publishing Company, Limited. 10s.). The latest edition of this volume has been carefully revised, and additions have been made relating to many parts of the globe. Practically all the mechanical tramways of the United Kingdom are included.—"Ready Reference Tables," by Carl Hering (London: Chapman and Hall). This, the first of a series of volumes in preparation by the author, deals with conversion factors, and, within the limits of a moderate-sized and elegantly-bound production, contains a quantity of information.

Electricity in Mining.—A lecture was delivered last Saturday at Bridgend by Mr. W. A. Scott, of Cardiff, to the Mid-Glamorgan Association of Colliery Managers on the subject of the application of electric power in mining operations. The great economy, said Mr. Scott, accruing from the adoption of electric power in place of steam and compressed air, when transmitted to a distance, such as to underground haulage gears and pumps, was a long-established fact, but it was only now being recognised that its application to all purposes on the surface, including main winding engines, showed remarkable results in the saving effected in steam and coal consumption. Although nothing had been done in this country in the way of installing large electric winding engines, quite a large number were at work in Germany, and Mr. Scott described in detail the plant laid down at the chief mines in that country, the lecture being illustrated by lantern views.

Annual Dinner of the Day Students of Northampton Institute.—This annual event took place on July 8 at Anderton's Hotel, Fleet-street. The chair was taken shortly after 8 o'clock by one of the students, Mr. W. Stanley Lonsdale. Among the guests present were the Principal (Dr. R. M. Walmsley, M.I.E.E.), Dr. C. V. Drysdale, M.I.E.E., Mr. C. E. Larard, A.M.I.C.E., A.M.I.M.E., Mr. S. Field, A.R.C.Sc., with their respective senior lecturers and assistants. Altogether 42 were present. After the dinner a very good programme had been arranged, the toasts and musical items being interposed. In reply to the toast of the "Institute and Principal," Dr. Walmsley gave some very good advice to the leaving students, especially as to what could be learnt in works from practical men. Dr. Drysdale, in replying for the electrical department, corroborated Dr. Walmsley's remarks, and made some humorous allusions to the "self-induction and resistance" of students. Mr. Larard, for the mechanical department, was also very humorous in his remarks, and his advice, both as regards works and social instincts, should be carefully borne in mind by all those present. Mr. Field, in replying for the chemical department, pointed out the importance of a good knowledge of electro and metallurgical chemistry to the engineer, as a lot of metals, etc., important to him were now being largely produced by electrolytic means. He took aluminium as an example. With several very good songs, and pianoforte solos, by the students a very enjoyable evening was brought to a close.

A Telephone News Bureau.—A telephone bureau was recently inaugurated in Philadelphia by the *Evening Telegraph* of that city in conjunction with the Keystone Telephone Company, by which the 15,000 local subscribers to the company can be supplied with information gratuitously upon almost any imaginable subject. The scheme of distributing news by telephone which has been in operation for several years at Budapest entails the use of a separate telephone system, but the Philadelphia undertaking is served by a branch exchange. The switchboard for the bureau was installed under the direction of Mr John W. Kelley, superintendent of the Keystone Telephone Company. A few particulars concerning it are given in the *American Telephone Journal*. It consists of a horizontal central energy board, and is equipped with 20 incoming trunks and one outgoing trunk. The instrument equipment consists of seven portable desk sets and four breastplate transmitter sets, all having head band receivers. The board is so arranged that it can be operated with one or 20 operators, as needed, by means of switching keys. An enquirer calling for the exchange s c onnected with a trunk that is not busy, bringing up the lamp signal. When possible, a reply is given at once, but if it is necessary to look the answer up, a shunt key is thrown into circuit, holding the signals at the telephone office. On an average over 2,500 questions, which are of a very cosmopolitan character, are answered daily, and on some occasions the number has reached nearly 4,000.

Radial Emanations from Mineral Springs.—Some determinations of the radio-activity of gases given off by mineral waters have lately been made by M. Curie, samples of the gases collected at different mineral springs being sent to his laboratory in well-sealed flasks. After drying, the sample of gas is placed in a closed brass cylinder, which forms the outer part of an electric condenser. The inner part of the condenser is a brass rod placed in the axis of the cylinder and well insulated. The cylinder is given a charge of 200 to 300 volts, and the inner rod is connected to an electrometer. The gas, which becomes a conductor owing to the emanation it contains, allows a certain current to pass from the cylinder to the rod. The current is set up as soon as the gas is admitted. It increases somewhat rapidly for several hours, owing to the formation of an induced radio-activity on the inside surface of the cylinder. The current then decreases slowly, and this generally occurs about 24 hours after the introduction of the gas. The rate of decrease is the same as for the radium emanation. M. Curie made a table for the gases of different mineral springs of Europe. The numbers correspond to the current measured after leaving the gas 12 hours in the condenser. For the purpose of comparison,

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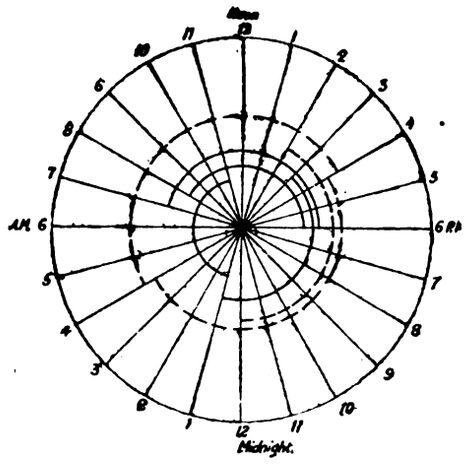
a solution containing 0·00001 grm. of radium bromide was used, from which the emanation which had accumulated was drawn off by means of a current of air. It was found that the water from Bad Gastein (Austria) has by far the strongest emanation, represented by the figure 360. Next come four samples of water from Plombières (France), at 47, 29, 28, 21 respectively. Banis les Bains and Luxeil (France) show 16 and 5·7. It is considered that at the actual springs the activity would be twice as strong.

The Use of Exhaust Steam for Generating Power.—According to the *Elektrotechnische Rundschau*, No. 17, a new process for utilising exhaust steam with a view to producing power in low-pressure steam-turbines, including an exhausted accumulator (Rateau patent), has been developed by Balcke and Co., Limited, Bochum, Germany. The device is especially intended for utilising the exhaust from intermittently working engines used in mining. While an ordinary condensation in most of these engines will have but a very slight effect (the vacuum in the cylinders being of no importance, and considerable condensation losses being caused by a high cooling of the steam cylinder during stoppages), the new outfit will allow of the exhaust from these machines being utilised to such an extent as to secure a better saving than, for instance, in the case of a satisfactory condensation in a high-class triple-expansion machine. The exhaust steam from a hauling machine will readily allow of 500, and that from a reversing machine of 1,000 electric horse-power being generated. Moreover, the first cost is much lower than the one of a high-tension steam plant of the same output, while there are practically no expenses for operation. The principle of the process consists of storing the exhaust steam issuing in very variable amounts from the intermittently working engines in an exhaust steam accumulator, and of transmitting same in a uniform manner to a low-tension turbine. The latter, after receiving the steam, as a rule at atmospheric tension, will give it off again at the condenser tension. In the accumulator the exhaust steam has a pressure ranging from ·15 to ·3 atmospheres higher, the pressure varying within these low limits along with the charging and discharging of the apparatus.

Rubber Production.—A recent report of the United States Consul at Mexico City discusses the outlook for rubber culture in Mexico. His conclusions do not encourage the idea that rubber can be cultivated profitably in that country. It was thought that the Castilloa elastica, which is being cultivated in Mexico as a shade tree for coffee plantations, might be used to produce rubber, but apparently the tree does not flourish in that clime; and even assuming that the tree could be cultivated successfully, it is considered that the expense of collecting the juice would be greater than that of obtaining it from wild trees. Plantations would have to be cleared and the trees planted and protected for a number of years, after which the milk would have to be carefully harvested by paid labour, instead of being collected by the natives in their unvalued time, as is done with wild trees. Further, it is said that as yet no satisfactory method of coagulating the milk of the Castilloa elastica has been discovered, and the experiments necessary to devise one would probably entail considerable expense. More optimistic is the report of the United States Consul at Bangkok, Siam, in which country rubber cultivation has recently been started, some thousands of plants of the Para variety having been set out as an experiment. These are said to be showing excellent progress, although they have had no special attention, and the United States Consul expects to be able to report before long that the venture has proved highly successful. He also calls attention to two rubber-producing plants indigenous to Siam, and known to be of commercial value—the Ficus elastica, and a plant considered to belong to the Urceola species. These plants, which grow with remarkable rapidity, yield very well, and it has been suggested that they could be profitably cultivated in the Philippines.

Circle Diagrams for Facilitating Economical Working.—In a recent number of *Electricity* (New York) some circle diagrams are contributed by Mr. R. Grieves to illustrate the arrangement of the different shifts of men in relation to the time of operating different machines and different kinds of apparatus, with a view to ascertaining whether the maximum efficiency is being obtained from the staff, by arranging the men's hours of working so that each man is at all times worked to the best of his ability. In preparing these diagrams, faint concentric circles are drawn, the number of such circles depending upon the number of men or the number of machines, engines, boilers, or generators under consideration, each man or machine being given one circle. From the centre 24 radial lines are drawn, representing the hours of the day. When several different classes of employés are to be considered, or when different kinds of apparatus, or the time of operating different kinds of apparatus, are to be shown on one diagram, different kinds of lines are used to distinguish them. Four diagrams are given in our contemporary, the first, which we reproduce, illustrating the arrangement of the staff. The solid lines



represent firemen, and the broken lines the time of working of the different engineers. For instance, starting at 1 a.m., it will be seen that one fireman is on duty until 11 a.m. At 8 a.m. another fireman starts to work, and is on duty until 6 p.m. Another fireman starts working at 3 p.m., and leaves off at 1 a.m., while one coal passer, whose labour is charged to the boiler-room as a generating cost, starts to work at 7 a.m. and leaves off at 6 p.m. Similarly the diagram shows one engineer coming on duty at 2 p.m. and working until midnight, another works from 4 p.m. until 4 a.m., while a third works from 4 a.m. until 4 p.m. Three other diagrams are given, showing respectively the time of operating the different engines the individual generators, and the boilers. With these charts before him, the station manager can see at a glance for any hour of the day the number of men who are on duty and the quantity of plant in operation, thus facilitating a suitable distribution of the work, due regard being had to the output of the station at different hours, and to such considerations as the cleaning and repairing required of station men operating a small plant.

Alternating-Current Power Transmission.—In the course of a series of papers on "Alternating-Current Working," contributed by Mr. W. B. Gump to the *Western Electrician* of Chicago, the author remarks, in regard to the question of frequency, that the cost of apparatus,

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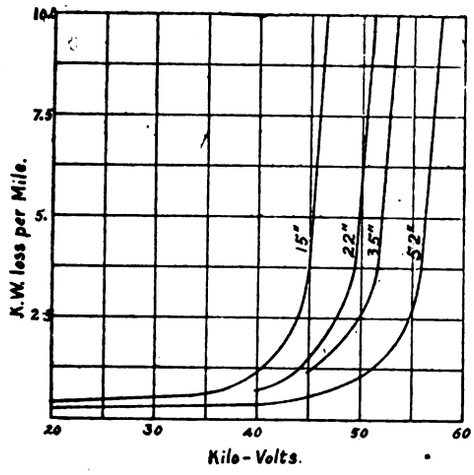
especially transformers, is often the determining factor, high-frequency transformers costing less than those for low frequency. Against this lower cost, however, he places the increased inductance both of the apparatus and transmission line, and also the increase of wattless currents due to inductance, causing a greater loss in the generator, line, and apparatus used, and the decreased efficiency of generators, synchronous motor, and rotaries, on high frequencies. The author observes that in practice a frequency of 60 cycles is seldom exceeded for power installations; 40 cycles is often used for a mixed load both for local use and on large distribution systems; and for power alone he recommends 25 to 30 cycles. On the question of voltage the author makes the general statement that the voltage for transmission within an immediate locality should be as high as safety will permit. On long transmission lines where step-up transformers are used the line pressure should be as high as the physical conditions of the case allow, together with due consideration for human life. For voltages up to 15,000 the difficulties of insulation are not serious, but when 20,000 is reached they begin to multiply greatly. As the voltage increases the leakage increases very rapidly. We reproduce a diagram given in illustration of this, a series of tests having been made upon an experimental transmission line. The curves are plotted between values of line voltage and line loss. The figures on the respective curves denote the distance between wires in inches. It will be seen that the loss decreases for a given voltage as the distance between wires is increased, a marked difference being shown between the first and last curve.



Junior Institution of Engineers.—Visits of this institution were recently paid to the Chelsea generating station of the Underground Electric Railways Company of London, Lots-road, Chelsea, and to the adjoining London County Council's pumping station. At the former the general manager, Mr. J. R. Chapman, and the resident engineer, Mr. J. W. Towle, were present, and the visitors were enabled to make a complete examination of the work so far as it had advanced. The station will supply current for working the trains of the District Railway from Whitechapel to the various western and southern termini, Richmond, Wimbledon, Hounslow, Ealing, etc., also the tube trains of the Baker-street and Waterloo Railway, the Great Northern, Piccadilly, and Brompton Railway, and the Charing Cross, Euston, and Hampstead Railway. The initial equipment of these lines will be about 150 trains. The station is designed for 10 units of 5,500 kw. each and one unit of 2,500 kw. The output of the station will be three phase, 33⅓ cycles, 11,000 volts, and will be distributed at this potential to 23 sub-stations. Attention may be called to the group system which has been followed throughout in both the mechanical and electrical installation—*i.e.*, eight boilers are grouped to one turbo-generator. These boilers have their own feed pump, and the generator supplies its own section of 'bus bar. No attempt is made to cross-connect the steam-piping of the different groups except at the east end of the building, where three groups are brought together in one small auxiliary header for supplying exciters, air-compressors, house pump, etc. The station is designed for turbines, and illustrates the reduction in floor area which can be secured with this type of engine as against the reciprocating type. At the London County Council pumping station Mr. H. M. Rounthwaite received the members. There are here four horizontal gas-engines, having each two 18½in. cylinders, with 2ft. stroke, both coupled to one crank (cylinders at opposite ends). On each crankshaft is a 7ft. 6in. rope pulley grooved for eight 1¼in. ropes, and these ropes lead down to similar pulleys of 6ft. 5in. diameter on the four centrifugal pumps. The pumps have suction and delivery pipes 23in. diameter, and impellers of 66in. diameter. These engines each indicate about 200 h.p., at about 150 revolutions per minute, and the pumps each throw about 44 tons per minute. There are also four similar engines, 18½in. cylinders, 2ft. 6in. stroke, 7ft. 6in. rope pulleys on crankshafts, grooved for 10 1¼in. ropes and 10ft. 4in. similar pulleys on pumps. The pumps have 32in. pipes and 72in. impellers. These engines each indicate about 240 h.p at about 160 revolutions per minute, and the pumps each throw about 85 tons per minute. The 200-h.p. engines pump from the low-level sewer, and the other engines from the higher level Counties Creek sewer. The whole plant works only during rainy weather, and pumps storm water only into the Thames. The average number of hours per annum during which it will be required to run is estimated at 60 or 70, though, of course, in exceptionally wet years it may be that the machinery will run as long as 100 hours.

The Telephone Service.—It will be remembered that at the conference of metropolitan local authorities held at the Guildhall on May 18, resolutions were passed to the effect that it would be inexpedient for the Government to acquire the undertaking of the National Telephone Company on any other terms than those set out in the agreement between the Postmaster-General and the company, dated Nov. 18, 1901, and also that the conference was of opinion that before any agreement was entered into with the National Telephone Company for the purchase of their system within the London telephone area, the terms of the proposed arrangement should be submitted for the consideration of the local authorities within that area. Copies of these resolutions were sent to the Postmaster-General, and on Tuesday the conference met to consider his reply, Mr. A. C. Morton presiding. Lord Stanley's latter, dated June 6, stated that he had carefully considered the resolutions, and, as the delegates no doubt were aware, the agreement with the National Telephone, dated Nov. 18, 1901, had reference solely to the London area, whereas the proposals which had been recently under discussion had reference to the acquisition of the company's exchange system in the whole of the United Kingdom at some date in the near future. He was in doubt as to the exact intention of the first resolution of the conference, but if it was suggested that the company's system, not only in London, but in the whole of the United Kingdom, should now be acquired on the terms agreed upon for the London system in 1911, he thought that the company could hardly be expected to accept at the present time, when they were at liberty to

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carry on their business for seven years more, the terms which they accepted as applicable on the termination of their license, when their plant could no longer be used by them for its present purpose. Lord Stanley expressed his conviction that the acquisition by the Government of the whole telephone system of the country in the near future, provided that the price to be paid was reasonable, would be more for the public advantage, and it was because he held this opinion that he consented to enter upon the negotiations now in progress. With regard to the second resolution passed by the conference, Lord Stanley had already stated in Parliament that full opportunity would be given for the consideration by Parliament of any agreement between the Government and the National Telephone Company which might be proposed. He did not see his way to promise that an agreement, which would be applicable to the whole of the United Kingdom, should be directly submitted to local authorities representing only a limited part of the country. In his view, the proper method of charge for an exchange service was that which was recommended by the Select Committee of 1898, under which the payments of the subscribers were fixed in proportion to their user. The message-rate system offered by the Post Office fulfilled this requirement, and its advantages had been proved by its acceptance by more than 90 per cent. of the subscribers to the Post Office London system. The Chairman remarked that the further expressions of Lord Stanley in the House of Commons on June 16 made it clear that nothing more would be done during the present session, and under the circumstances the best thing for the conference to do would be to inform him that the resolution of May 18 was intended to apply only to the London telephone area. This was agreed to, and it was then decided to adjourn the conference until the matter again came before Parliament.

The Electrical Congress.—We are informed that a number of national electrical bodies have already arranged to co-operate in the International Electrical Congress of St. Louis. In America, a number of these co-operating bodies are to hold simultaneous conventions in St. Louis during the congress week, and to hold joint sessions with specified sections of the congress on definitely appointed days. Other bodies are not going so far as to hold simultaneous conventions and joint sessions, but have accepted invitations to send delegates to the congress. Invitations to send delegates have been sent to 30 national electrical and scientific bodies all over the world. The following bodies have already promised to hold simultaneous conventions and joint sessions: the American Institute of Electrical Engineers, the American Electro-Chemical Society, the American Physical Society, the International Association of Municipal Electricians, and the American Electrotherapeutic Association. The following bodies have promised to send delegates to the congress: the National Electric Light Association and the Association of Edison Illuminating Companies. In Europe, the following bodies have promised to send delegates to the congress: the Société Internationale des Electriciens and the Sweizerischer Elektrotechnischer Verein. It is expected that the Institution of Electrical Engineers of Great Britain and the Elektrotechnischer Verein of Berlin will also send delegates. It is hoped that other European national electrical bodies will also co-operate. The delegates accredited to the congress from various co-operating bodies are not expected to be called upon to vote upon any questions of national importance. All matters concerning units, standards, etc., will lie within the province of the chamber of government delegates. All delegates of the co-operating bodies are invited to read papers before any section of the congress they select. Such papers will be printed in the congress *Transactions* as being offered by the delegate on behalf of the co-operating body. The paper and discussion thereon will subsequently be offered by the congress to the co-operating body for incorporation in its own *Transactions* if desired. In response to invitation, the following foreign Governments have appointed delegates: Switzerland (Profs. Ferdinand Weber and Francois Louis Schule), Norway and Sweden (Prof. G. Arrhenius), India (Mr. J. C. Shields), and Mexico (Mr. Rafael R. Arizpe). The appointments from Great Britain, France, Germany, Austria-Hungary, United States, Belgium, Italy, Denmark, Spain, Portugal, Australia, Japan, China, Brazil, Chili, and Peru have not yet been made. It is stated that appointments are being made. Up to the 23rd ult. 1,776 adhesions to the congress had been received. Programmes of Sections A, B, C, D, and E have already been published, and we now give those for Sections F and G. Of the former, which deals with electric transportation, Dr. Louis Duncan is the chairman, and Mr. A. H. Armstrong the secretary. The papers, with their authors, are as follows: "Theory of Compensated Repulsion Motor," by Ernst Danielson; "Electrification of British Railways," by Philip Dawson; "Single-Phase Electric Railways," by Herr F. J. Eichberg; "Alternating *v.* Direct-Current Traction," by Prof. Dr. F. Niethammer; "The Puffer Machine in Railway Service and its most suitable control," by Prof. Dr. Rasch; "The Electrification of Steam Lines," by A. H. Armstrong; "Electric Railways," by B. J. Arnold; "General Review of Railway Work," by Louis Duncan; "The Storage Battery in Electric Railway Service," by J. B. Entz; subject to be announced, C. O. Mailloux; "Some Qualifications of Electric Railway Equipment for Trunk Lines," by E. H. McHenry; "Braking High-Speed Trains," by R. A. Parke; "Electric Railways," by W. B. Potter; "The History and Development of the Electric Railway," by F. J. Sprague; "Notes on the Electrical Equipment of the Wilkesbarre and Hazleton Railway Company," by L. B. Stillwell; "Central-Station Economics and Operation," by H. G. Stott; and "Equipping the Central Terminal," by W. J. Wilgus. Section G, which deals with electric communication, will have as chairman Mr. F. W. Jones, and as secretary Mr. B. Gherardi. The papers and authors are as follows: "Electric Communications in Spain," by Senor Don Julio Cevera Baviera; "The Present State of Wireless Telegraphy, by Dr. J. A. Fleming, F.R.S.; "A New Danger to Lead-Covered Aerial Telephone Cables," by John Hesketh; "Simultaneous Telegraphy and Telephony," by Herr Joseph Hollos; "Telephony and Telegraphy in Japan," by Saitaro Oi; "System for Producing Continuous Electrical Oscillations," by V. Poulsen; "Questions Connected with Rates and Management in a Telephone Exchange," by G. de la Touanne; "Printing Telegraph Systems," by J. C. Barclay; "Rapid Telegraphy," by Dr. Albert C. Crehore; "Wireless Telegraph Receivers," by Dr. Lee De Forest; "Rapid Telegraphy," by Patrick P. Delany; "Telephony," by Hammond V. Hayes; "The Telephone Problem in Large Cities," by Franz J. Dommerque; "Wireless Telegraphy," by Reginald A. Fessenden; "Features of Two-Strand Common Battery Systems," by J. C. Kelsey; "Problem: Automatic *v.* Manual Telephone Exchange," by Kempster B. Miller; "Telephony," by F. A. Pickernell; "Printing Telegraphy," by Louis M. Potts; "Military Use of the Telephone, Telegraph, and Cable," by Colonel Samuel Reber; "Electrolysis of Underground Conductors," by Prof. George F. Sever; "Economical Features in Modern Telephone Engineering," by L. W. Stanton; and "The Theory of Wireless Telegraphy," by John Stone Stone. Contributors are again reminded that efforts are being made to secure as many as possible of the promised papers

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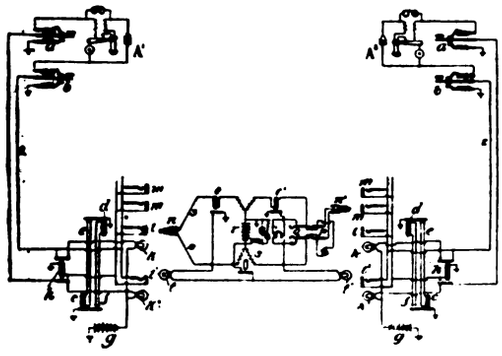
in advance, so that copies may be printed for circulation at the congress.

Cord Circuit for St. Petersburg Exchange.—The Russian capital is soon to have a new up-to-date telephone exchange, to be installed by the Western Electric Company of Chicago. The board will be of the divided-multiple type, as the exchange is to have accommodation for 40,000 subscribers, but the divided-multiple arrangement will probably not be utilised until an adequate number of subscribers is obtained. A feature to be introduced in this system is the circuit recently patented by Mr. E. H. Smythe, of Freeport, Ill., of which some details are given in the *Western Electrician*, of Chicago. The board will be divided into two sections (A and B) of 20,000 lines each. Every subscriber's line will have an answering jack in each section of the board, but half the lines will have multiple jacks in one section and half in the other, the subscribers' apparatus being provided with two buttons corresponding to the sections at the exchange. Hitherto in arrangements of this character no means of retracting a signal were provided if the subscriber depressed the wrong button, but Mr. Smythe's invention obviates this difficulty. The general arrangement of the circuits is the same as before, but some changes have been made, which allow of the subscriber, having given the wrong signal, to extinguish the lamp at the exchange, and call the right section without waiting for the operator to come in on the line.



The circuits of two lines to the exchange are shown in the accompanying diagram. The circuits and apparatus are arranged so that a subscriber, having caused the display of his line signal at one section by operating one of his signal keys, may, by operating another, efface the signal first displayed, and bring about the display of his signal at another section. Replacing the telephone on the hook acts to efface whichever signal is at the time displayed. These results are obtained by including a relay in each side of the line, which, when actuated in response to the control of its associated key at the sub-station operates to close a locking circuit for itself controlled by the telephone switch at the sub-station, to light a lamp at one of the switchboards, and to short-circuit or shunt the relay included in the other side of the line. The telephone station A^1 is provided with the usual apparatus. On depressing either key the limb to which it belongs is closed to ground, opening the line at the sub-station. On being released (the receiver being off the hook), the key completes the circuit before opening the ground connection. The relays *c* and *d* are provided in the circuits of limbs of the line. It will be observed that when either of the relays is operated, the corresponding circuit will be closed and grounded by the armature of the relay that is operated. If the subscriber at station A^1 desires to communicate with the subscriber at station A^2, both subscribers belonging to section A, the former, having removed the receiver from the hook, will depress his key, *a*, which will operate the line signal *k* at section A. The armature of relay *c* will be attracted and will close the contacts of the circuit *f* to ground. The key *a* having been released, and the receiver being removed from the switch, the circuit of limb (1) will be transferred from ground at station A^1, through station A^1 by the telephone switch to limb (2), thence to the central office, and thence to one of the wires of the circuit *f*, to the armature of relay *c*, and thence to ground—that is to say, the first impulse of the battery *g* will be to ground. Keys *a* and *b* are so constructed that one circuit to ground is completed before the other is broken, in order to prevent any intermission of the flow of current through the line relay which has been actuated. It should be remarked that the resistance of the circuit, including individual-line signal, k^1, is so great as to prevent the operation of the signal. The line signal *k* at section A, however, is included in a local circuit formed by the closing of the armature of relay *c*. Hence line signal *k* will be disclosed immediately on depressing key *a*, and will remain disclosed as long as the receiver at station A^1 is removed from the switch, or until the call is answered by inserting the plug in the answering jack, *l*, or until key *b* is pressed to display signal k^1. When relay *c* draws up its armature in completing circuit *f*, it short-circuits relay *d*, so that it is not excited by current flowing in limb (2) of the line. When plug, *n*, is inserted in response to the disclosure of signal *k*, current from battery *r* is directed over wire (4) through relay *h*, thus cutting off the signalling apparatus of the line, and the armature of repeating coil, *s*, is closed, connecting battery with the circuit of supervisory signals, $t\,t^1$. Lamp *t*, however, will not light, since its circuit will be open at the contact of relay *o*, the battery circuit being closed through the relay *o*, over limb (2), through sub-station A^1, and back over limb (1). Supervisory signal lamp t^1 will, however, be included in a circuit extending from the free pole of the battery *r*, through the armature and front contact of the repeating coil and the armature and back contact of relay *o* to earth. The lamp t^1 will then light. The operator, ascertaining that subscriber A^2 is called for, proceeds to test the line, make the connection, and signal subscriber A^2 in the usual manner. Assuming now that subscriber A^1 desires to be connected with a subscriber belonging to the other section (B), the former, having removed the receiver, will depress key *b*, thus completing circuit from battery through signal *k* and limb (2) to ground at the signal key *b*. The resistance of the circuit is so great that signal *k* will not be operated, but the relay *d* will be operated and the circuit *e* closed. The closure of this circuit completes the circuit of signal lamp k^1 directly to earth, and illuminates it and closes a short-circuit of relay *c* in the other limb of the line, thus rendering it inert to current returning over limb (1) of the line when key *b* is released. Releasing key *b* completes the locking circuit of relay *d* through both limbs of the line and the switches at sub-station A^1 to earth at the central office by way of conductor *e* controlled in contacts of relay *d*. The continued display of signal k^1 after the momentary depression of key *b* is thus effected. If, after the signal k^1 has been displayed, the subscriber should desire for any reason to withdraw signal k^1 and display signal *k* in its stead, he has merely to press key *a*. The depression of key *a* opens the locking circuit of relay *d*, permitting the relay to release its armature, upon which relay *c* is actuated to light lamp *k* and short-circuit relay *d*, as already described, or, if the subscriber, after having caused the display of one of the signals, desires to withdraw the call, he may do so by replacing his receiver on the hook, which breaks the locking circuit operating to effect the continued display of the signal.

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WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

(Continued from page 58.)

The Braun-Siemens and Halske System.—In this, one of the most successful and, in some respects, most novel and interesting of the Continental systems, a closed circuit is employed, in which oscillations are set up, which may by a proper choice of self-induction and capacity, be adjusted to a determined period. An open resonator is employed, and this transmitter sends out waves of a known length, the circuit of the receiver being tuned to respond better to this length of wave than any other. The inventor of the system is Prof. Braun, of Strasburg, and it has been

DR. BRAUN.

acquired by the great German electrical firm of Siemens and Halske. Symmetry is observed in both the transmitting and receiving apparatus, and—unlike some other systems—there is not any earth connection, this fact causing the apparatus to be very little affected by atmospheric disturbances. The transmitting circuit is shown diagrammatically in Fig. 62, where J is the inductor, S the spark gap at the secondary terminals of same, L the self-induction, C the capacities. It is not difficult to show that in a circuit of this kind the discharge sets up oscillations of which the periodic time T is, according to Lord Kelvin =

$$\frac{2\pi\sqrt{LC}}{\sqrt{1-\frac{CR^2}{4L}}}$$

and, if $\frac{CR^2}{4L}$ is small in comparison with 1, as is usually the case; then $T = 2\pi\sqrt{LC}$, very nearly; or $L = \frac{T^2}{4\pi^2 C^2}$ which enables the self-induction to be calculated if the

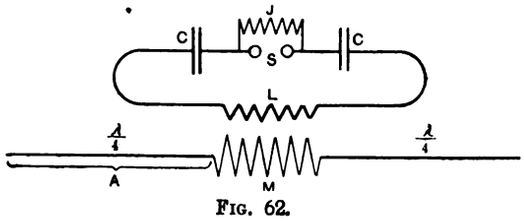

FIG. 62.

other quantities are known; or C to be obtained if L and T are determined. If λ is the wave-length since $\frac{\lambda}{T} = V$ (the velocity of light); then $T = \frac{\lambda}{3\times10^{10}}$ where λ and the velocity are in centimetres and centimetres per second respectively.

Referring to Fig. 62, the oscillations of the closed circuit of the resonator are forced upon the secondary coil M, and in order that the intensity may be a maximum an amount of wire or capacity must be added to each end of M to put this secondary circuit in resonance with the closed circuit. The length of this secondary circuit on each side of M is found to be $\frac{\lambda}{4}$ if the best results are to be obtained. One of these lengths includes the aerial; the other may be coiled into a coil (but shortened owing to increased self-induction), or it may be replaced by a suitable capacity. The receiver circuit, shown in Fig. 63, is very similar to that of the transmitter, but the action is reversed, the etheric oscillations being received in the open circuit, A, and forced on the closed circuit, which in this case affects through M the circuit containing the coherer, relay, and indicator or Morse machine.

Referring more fully to the apparatus, the inductor or induction coil (Fig. 64) differs considerably from others in use, since the aim is not so much the high pressure necessary to produce sparks across the gap as a large current output. This is attained by the use of a special iron core, a larger primary and a shorter and thicker secondary

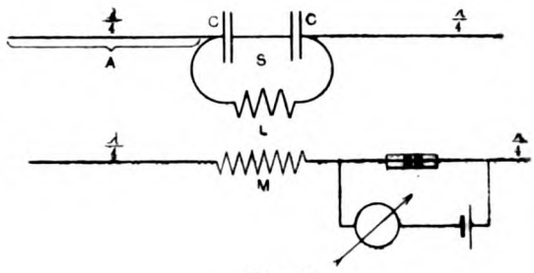

FIG. 63.

winding than is usually employed. The insulation is also double that of the ordinary coil, and hence it will work well even in damp places. The primary has three terminals, giving different lengths of primary for different interruptors. With these inductors large capacities can be charged in a short time. The interruptor is of the "Wehnelt" electrolytic type. This electrolytic break, brought out in 1899, employs for one electrode a lead plate immersed in dilute acid, and a platinum wire passing through the bottom of a porcelain tube for the other. In a circuit containing inductance the current passes intermittently from the platinum to the lead, the interruptions being very rapid, as high as several thousand per second in some cases, and being to some extent variable, depending on the amount of protrusion of the platinum wire. It has been found to work best at a potential difference of 60 to

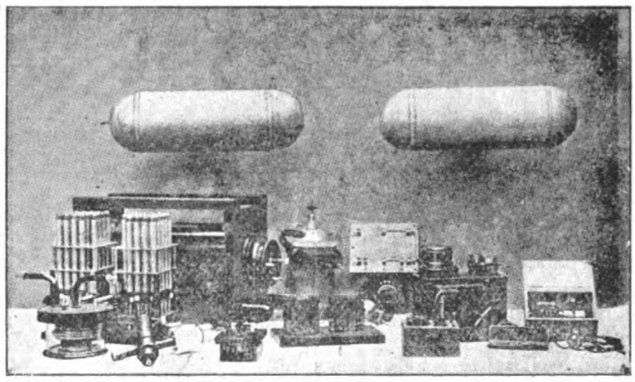

FIG. 64.

80 volts, and gives usually from 100 to 2,000 interruptions per second. The interruptions are not, however, under such exact control as in some of the other breaks already referred to. In the form shown the upper part of the platinum pole above the surface of the liquid is also protected from acid vapours by the porcelain tube. A peculiar form of Morse key is necessary to take the heavy currents—as much as 50 amperes. A magnetic blow-out is fitted, which quickly extinguishes the spark. The Leyden jar capacities are of elongated cylindrical form. To provide a capacity to balance the aerial in the secondary wire of the transmitter, round-ended cylinders are employed.

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Two of these are shown suspended above the apparatus in Fig. 64, where the inductor with three projecting terminals is seen to the left, with the Leyden jar capacities in front of it, and the transformer, M, already referred to, in front of that again. The interrupter is distinguishable (in the centre) by the peculiar inclined hoop with which it is surrounded, the remaining apparatus being the Morse key, etc.

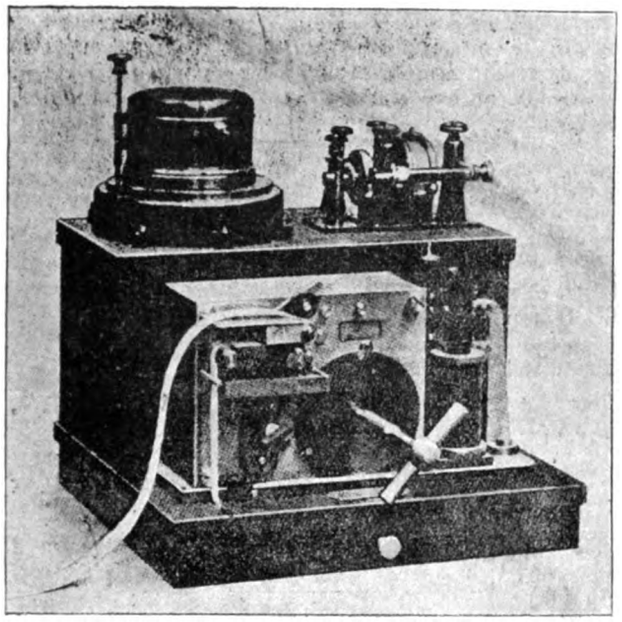

FIG. 65.—Receiving Apparatus.

The receiving apparatus is shown separately in Fig. 65, the coherer consisting of an ebonite tube containing hardened steel particles of a uniform size between two polished steel electrodes. It is known that a coherer becomes magnetic by use, and whilst this to a certain extent aids the coherer in the performance of its functions, too much magnetisation renders it unreliable. To obtain the requisite amount of magnetisation, and to render the coherer adjustable as to sensitiveness, a permanent ring magnet is fitted to it. Where a *record* is not wanted, where syntonising is not of importance, and for great distances, a telephone receiver with microphonic attachment is employed. The microphone consists of a steel disc pressed against a carbon or steel point. By means of a screw the pressure of the disc on the point, and hence the sensitiveness of the receiver, can be varied at will. The microphone telephone and dry cell are shown in Fig. 66. A view of the installation in one of the principal stations in Berlin fitted up with the apparatus of this system is shown in Fig. 67.

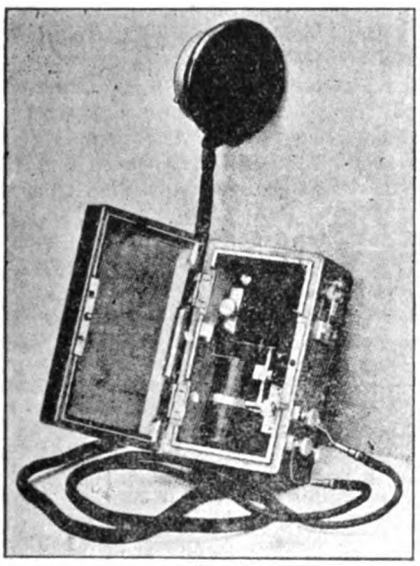

FIG. 66.

Wireless telegraphy is destined to play a very important part in modern warfare, and the field equipment shown in Figs. 68 and 69 is interesting in this regard as showing what is being done in the German army.

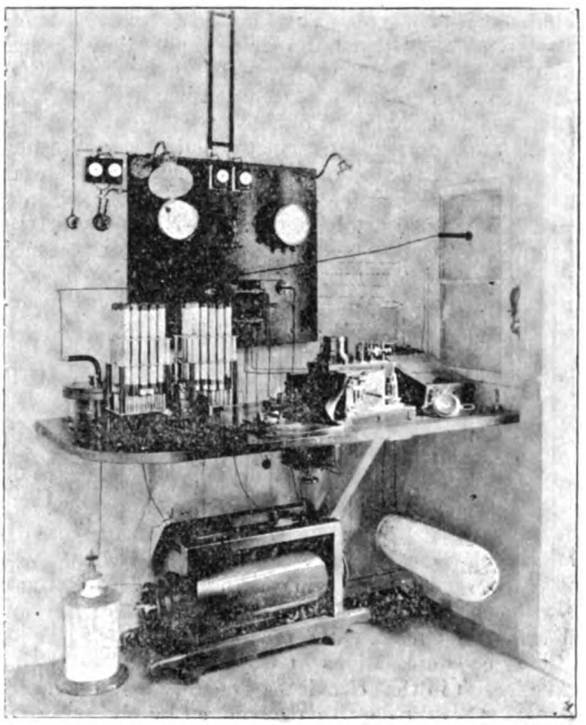

FIG. 67.—Braun-Siemens and Halske System. Interior of the "Hochbahn" Station, Berlin.

The New Wave Meter (*Arco-Rendal System*).—Early in the history of wireless experiments inventors set to work to improve the effects due to electric waves, using the well-known laws of electric resonance. But new difficulties accompanied the new improvements, definite dimensions and dispositions were necessary to suit each wave-length. Hence the difficulty of tuning, say, a dozen stations so as to properly respond to the same wave-length, though their installations may be quite different. The wave-meter, therefore, becomes a necessity.

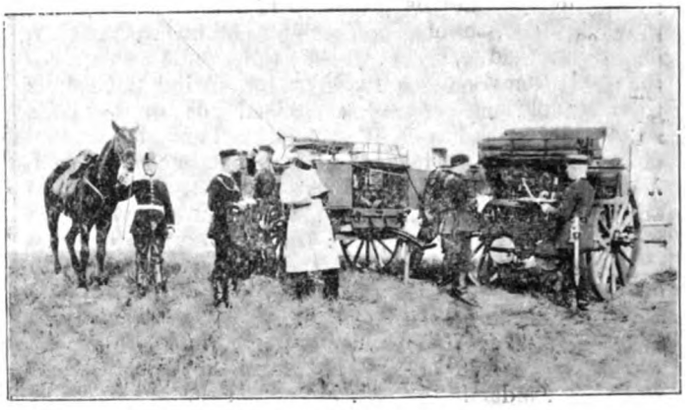

FIG. 68.—German Army Wireless Field Equipment.

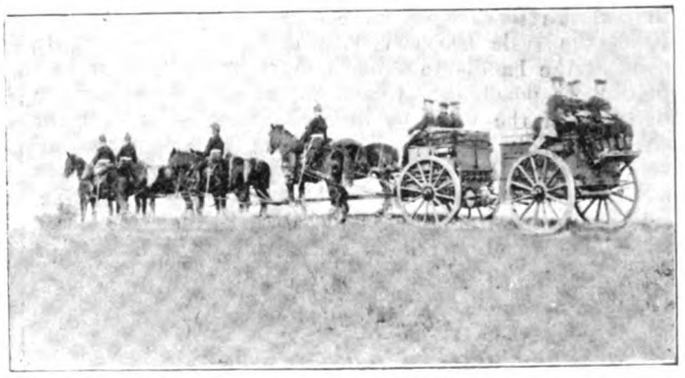

FIG. 69.—German Army Wireless Field Equipment.—Detachment on the March.

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The principle of this apparatus consists in establishing a normal open or closed system, in which the inductance and capacity are both variable. The variations are indicated on a scale, and the scale may be calibrated to directly indicate lengths of waves. The simplest form consists of a coil covered with one layer of wire. The number of turns put in circuit can be easily regulated by a slider, which allows the short-circuit of a certain number of turns. The principle was initiated by Count Arco and developed by Mr. Rendal. The apparatus is attached to the system to be indicated, and the number of windings put in circuit changed until the coil comes into resonance, which is recognised by observing the maximum rise of potential at the terminals of the coil, which in turn may be measured by the length of spark obtainable. The number of turns in circuit being noted, the wave length is found from a curve. This apparatus, though simple, is not exact enough for up-to-date technical work.

The precision of a measuring operation depends essentially upon the damping conditions as well of the wave meter as of the oscillating circuit to be indicated. The measuring coil shows less damping than a long conductor, because it emits less of its oscillating energy, but more than a closed circuit. The closed circuit form of the apparatus was originated by Herr Dönitz and Dr. Franke, and is patented by the Braun, Siemens, and Halske Company. A closed circuit has a very definite time period, as already noticed, this time period being defined by the inductance and capacity of the circuit. By modifying one or other of these the electric oscillations of the circuit, and through it the wave length in that circuit can be altered. In the coil apparatus the resonance was determined by observing the highest potential, as shown by the spark length. In the closed circuit apparatus, however, resonance is recognised by observing the current intensity by means of a hot-wire ampere meter. The circuit is composed of an inductance and a plate condenser, the latter being adjustable. It is composed of two series of metallic half-round plates equidistant from each other, one of the series being fixed, the other movable round a spindle. If the spindle is turned, the movable plates come into the spaces between the fixed ones. The half circle described by the handle which turns the plates is divided into 180deg. By putting the handle to, say, 160deg., a capacity is obtained four times as large as that when the handle is at 40deg. Thus by variation of the capacity only, it is possible to obtain a range from λ to 2λ. The inductance can also be altered, three coils are added to every apparatus, so that the ratio between the inductances may be as $\frac{1}{4} : 1 : 4$. To every one of these coils a special scale is fixed, from which the wave length can be read directly, for lengths varying between 140m. and 1,120m. (460ft. and 3,674ft.). In using the apparatus it is placed near the circuit to be indicated, in such a way that the field of the latter excites the coil of the wave-meter inductively. Having chosen the most suitable of the three coils, the capacity is varied till the ampere-meter shows maximum current. The wave-meter is then in perfect resonance with the circuit under examination. From the scale the wave-length is read directly. By shifting the handle to the left or right of the resonance point it is possible to form an idea of the clearness or damping of the wave by observing whether the current changes rapidly or slowly. To permit the measurement of the natural oscillations of a simple aerial, auxiliary coils are added. Accuracy within 1 or $1\frac{1}{2}$ per cent. is obtainable, and the instrument is portable and convenient. These particulars have been kindly furnished by the *Gesellschaft für drahtlose Telegraphie*, Berlin.

(To be continued.)

VOLTAGE DROP IN THREE-PHASE SYSTEMS.

BY W. W. WOOD.

A quick and practical method of calculating the voltage drop in three-phase conductors is seldom given in articles on three-phase work, most writers confining themselves to a discussion as to the relative merits of various systems of distribution. Such a method, however, is constantly required in the preparation of estimates for power installations where motors have to be supplied at moderate distances from the distributing centre. In these systems it is seldom necessary to consider the capacity or inductive effect of the cables themselves, but what is required is a rule for finding the lost volts and power with any given current density in the conductors.

For continuous currents the want has been long supplied by the well-known approximate law that five volts are lost per 100 yards of transmission (200 yards single conductor) with a current density of 1,000 amperes per square inch. This also gives the percentage loss of power in transmission, which is the ratio $\frac{\text{lost volts}}{\text{voltage of supply}} \times 100$.

A law of similar form for three-phase work is the easiest both to remember and apply, and can be readily deduced from first principles as follows. Considering the case of a balanced three-phase system,

Let R ohms be the resistance of each lead;
Let C amperes be the current in each lead;
Then the loss per conductor $= C^2 R$.
The total loss = loss in three conductors $= 3 C^2 R$.

Now, the power input to the line $= C \cdot V_1 \cos \phi \sqrt{3}$, where V_1 = voltage of supply, $\cos \phi$ = power factor, or cosine of angle of lag of current behind voltage; also if V_2 = the voltage at the distant end of the line, the power output $= C V_2 \cos \phi \sqrt{3}$.

(*Note.*—V_1 and V_2 are the virtual volts measured between any two conductors. C the virtual amperes per conductor.)

Now, since the power input = power output + the loss in transmission, we get the equation

$$C V_1 \cos \phi \sqrt{3} = C V_2 \cos \phi \sqrt{3} + 3 C^2 R$$

$$C \cos \phi \sqrt{3} (V_1 - V_2) = 3 C^2 R$$

$$\text{Lost volts} = V_1 - V_2 = \frac{C^2 R 3}{C \cos \phi \sqrt{3}} = \frac{C R \sqrt{3}}{\cos \phi}.$$

When $\cos \phi$ = approximately ·87, the expression

$$\frac{C R \sqrt{3}}{\cos \phi} = 2 C R,$$

which is the voltage drop which there would be on a similar continuous-current system.

We thus get the rule that "with a power factor of approximately 87 per cent., 5 volts are lost per 100 yards of transmission (three-core) when the current density in the conductors is 1,000 amperes per square inch." It is, moreover, obvious from the above expression that the loss is inversely proportional to the power factor, and directly proportional to the current density; thus, with power factor of 1, the drop = 4·33 volts per 100 yards of transmission, density 1,000 amperes per square inch. At 500 amperes density the lost volts would be halved.

The percentage loss of power (or with direct currents) is simply $\frac{\text{lost volts}}{\text{volts of supply}} \times 100$.

This is proved as follows:

$$\text{Percentage loss of power} = \frac{\text{watts lost}}{\text{watts input}} \times 100$$

$$= \frac{3 C^2 R}{C V_1 \cos \phi \sqrt{3}} \times 100$$

$$= \frac{C R \sqrt{3}}{V_1 \cos \phi} \times 100$$

$$= \frac{\frac{C R \sqrt{3}}{\cos \phi}}{V_1} \times 100$$

$$= \frac{\text{lost volts}}{\text{volts of supply}} \times 100.$$

The above rule is equally applicable whether the system is star or mesh connected, since only the current per line conductor and voltage between these conductors has been considered.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Ninth Annual Convention.

On Thursday the convention was resumed at Nottingham, where the Mayor (Councillor A. PAGE, J.P.) extended a warm welcome to the members. Alderman Sir JOHN TURNEY, the chairman of the Electric Lighting Committee, also welcomed the association to Nottingham. He said that a good deal was made of the exceedingly cheap supplies of electrical energy given from Corporation station, but he was not quite sure that it might not be a good policy to slightly increase the selling price and to make more profit.

Mr. WILMSHURST thanked the two previous speakers on behalf of the association for their kind welcome. Nottingham was to be congratulated on the unbroken continuity of the management of its electrical undertakings. The gentlemen in charge of these were highly esteemed by the members of the association, and he knew of no municipal undertaking more remarkable for reliable, economical, and excellent management than the electrical department of the city of Nottingham.

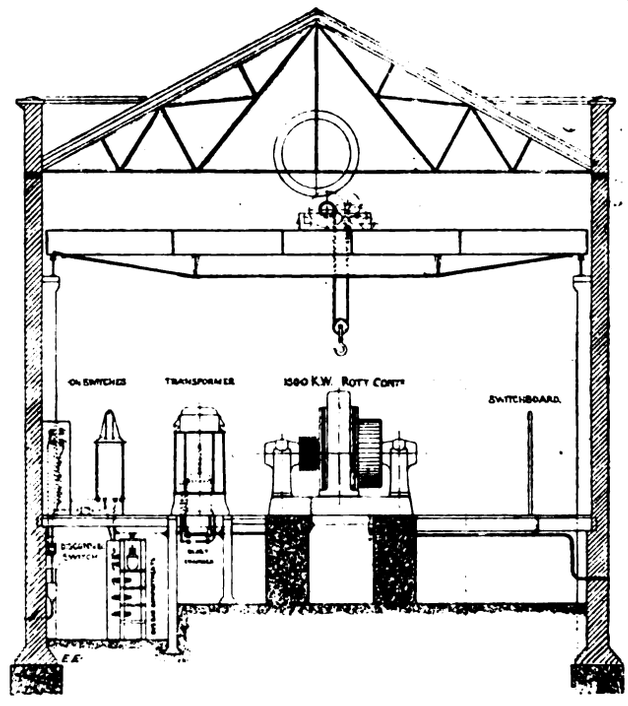
Mr. S. L. PEARCE then read his paper on "Polyphase Sub-Stations," the opening portion of which appeared in our last issue.

Polyphase Sub-Stations: Their Equipment and Working.

BY S. L. PEARCE, CHIEF ELECTRICAL ENGINEER, MANCHESTER.

(Continued from page 53.)

Fig. 4 show another typical general arrangement for a large capacity rotary sub-station, very similar to the foregoing.



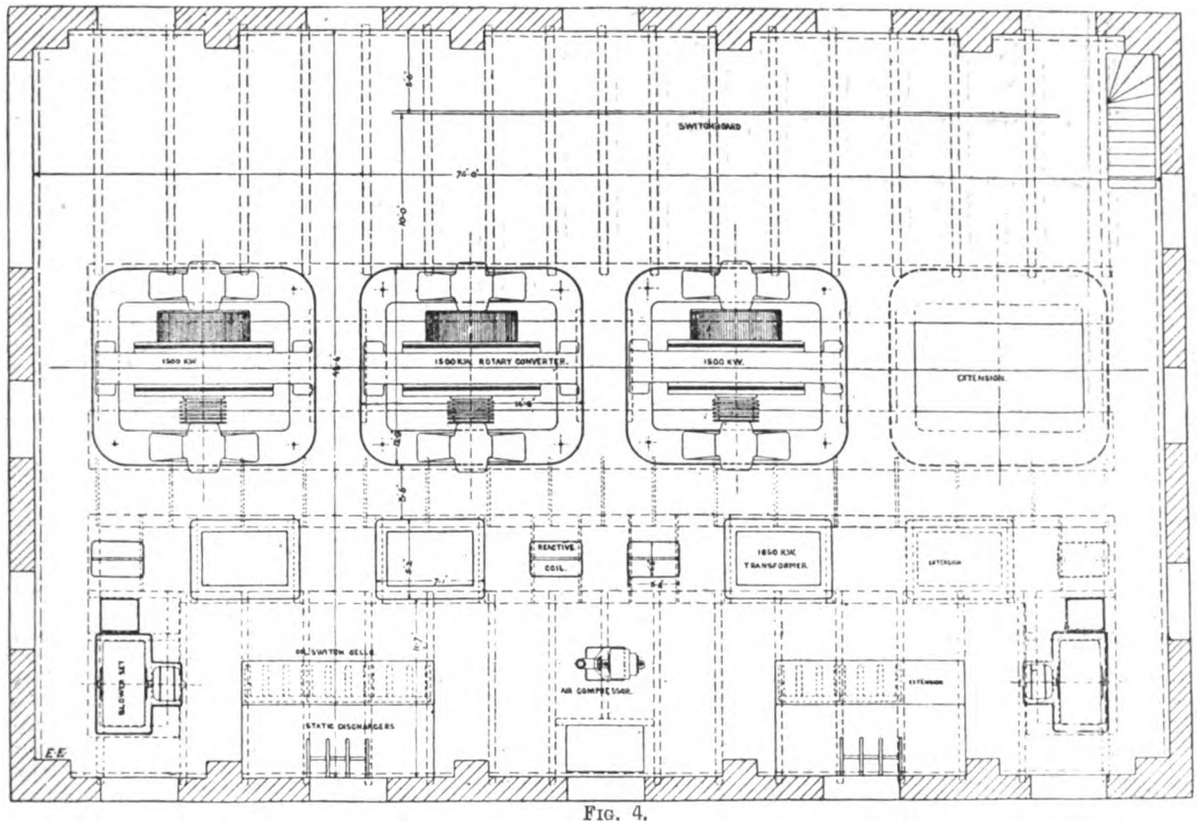


FIG. 4.

The main high-tension 'bus bars are, however, placed below ground floor, single three-phase transformers are employed, and the cooling of the latter is effected by means of a separately driven blower set. Reactance coils are used in conjunction with the rotaries for traction purposes to obtain the compounding effect; these reactance coils would be replaced by induction regulators (which enable the impressed E.M.F. on the rotary slip-rings, and consequently the direct-current voltage, to be varied at will), if the machines were used for lighting purposes. The low-tension switchgear is similar in all respects to that of an ordinary direct-current station. In the case of a purely traction system the switchboard proper would only contain one pole, the remaining switches and 'bus bars being placed in the vicinity of the machines themselves in the same way that equaliser switches and bars are now placed in many large direct-current traction stations. The negative pole of the rotary being directly connected to the negative bar and earth without introducing any switch, the secondary of the transformer is permanently earthed through the machine, and forms a safeguard in case the high-tension winding of the transformer should break down on the secondary. This arrangement very much simplifies the switchgear, as the equaliser switch is mounted on the rotary itself, the equaliser bar and negative bar being placed in a pit close below the rotaries, leaving only the positive single-pole switch and 'bus bar to be placed behind the switchboard proper. It is preferable that the high-tension transformers in sub-stations of this type should be placed in the same room as the rotary converters themselves. The great advantage of having them continually under observation, in the author's opinion, outweighs the argument that the safest position for the high-tension apparatus of this nature is under lock and key. It is quite possible for a serious fire to start without the fact being known when the transformers are contained in a separate compartment, whereas when they are readily seen, they can be cut off from the line on the slightest indication of a fault.

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Fig. 5 show the general lay-out of one of the sub-stations for the Liverpool and Southport line of the Lancashire and Yorkshire Railway Company, the equipment consists of four 600-kw. six-phase rotaries operating at 25 cycles, and producing direct current at 600 to 650 volts. Three single-phase transformers of 200 kw. capacity connected up in "mesh" are employed for each unit. They are of the air blast cooled type, the rotaries are arranged down one side of the building, with the corresponding static transformers down the other side—the switchboard being situated at one end. The high and low tension switchboards are placed together in one long line. Beneath the high-tension portion of the gallery is a fireproof chamber, in which the oil switches and other high-tension gear are placed, the whole being worked mechanically by operating levers from the panels above. All instruments are low tension, being worked through transformers.

Examples of Motor Generator Equipments.—Figs. 6 and 7 show two typical equipments for the sub-stations of the Manchester Corporation. The Polygon is one of 10 stations, the general design in each case being the same, although the size and arrangement are modified to suit local conditions. The building is divided into two bays, the larger containing at the one end the traction motor generators, also the separate high and low tension switchboards. At the other end are placed similarly the lighting motor generators and balancing sets, and the corresponding high and low tension switchboards. In the second bay provision is made for extension sets. Each traction set consists of a synchronous motor operating direct at 6,500 volts, and coupled to a 220-kw. continuous current compound wound generator, the exciting current for the motor field being obtained from an exciter mounted on an extension of the shaft, or as an alternative from the lighting 'bus bars. Each lighting set similarly consists of a synchronous motor direct coupled to a 220-kw. continuous-current shunt-wound generator to give 420 to 430 volts across the outers of a three-wire system, and they are also so arranged as to give 210 volts on either side of the middle wire. The exciting current for the motor is taken from the terminals of the low-tension generator, or as an alternative from the lighting 'bus bars. The balancing sets, one of which is provided in each sub-station, consist of a 125-kw. three-phase induction motor direct coupled to two 52-kw. continuous-current shunt-wound generators, placed one at each end of the motor shaft, supplying current at about 205 volts, as balancers on the lighting system, or for starting or exciting the traction motor-generators. Two high-tension switchboards are placed on galleries, one at each end of the main bay, and two low-tension switchboards are placed on galleries along the front side of the main bay, both being used for traction and lighting respectively. The high-tension boards are arranged in three tiers. On the lower or basement level are placed the sealing and dividing boxes, into which are brought the high-tension feeders from the power station, the spark-gaps, feeder and motor duplex fuses, field-regulating resistances, liquid starters, and stator transformers for the induction motors. On the main platform are placed the switch panels with all the necessary instruments. The third or upper gallery carries the duplicate high-tension 'bus bars and selector switches. Means are provided for interconnecting the 'bus bars of the two boards, so that traction sets can be run from lighting feeders and *vice versâ*. The low-tension boards are arranged in two tiers, the various resistances and starters being placed on the basement level, but, as in the case of the high-tension boards, they are operated from the main gallery. The high-tension cable work in the station is almost entirely three-core, armoured throughout, cleated to the floor, and run in earthenware pipes through the beds where necessary, suitable tail-end boxes being provided at the terminals.

The second type of sub-station is represented by "Oldham-road," which is typical of the second 10 stations. With the exception of two, all are arranged for both lighting and traction. Each station is arranged in one bay, with the high-tension switchboards on one side and the low-tension on the opposite side, the machines being placed in pairs down the centre, provision being left at one end for considerable extensions. The equipment, consisting of synchronous and induction-motor generators, is very similar to the previous type, their outputs varying from 250 kw. to 104 kw. The low-tension generators of each set are, however, compound wound, and are, therefore, available for either lighting or traction purposes. A saving in spare plant and space is thereby affected, as against the use of separate sets for each purpose. The main switchboards are placed on galleries 9ft. above floor level. The high-tension board controls the incoming and outgoing feeders and the synchronous motors, and is provided with two sets of 'bus bars, to which the lighting and traction feeders are respectively connected. But as each motor is provided with a change-over switch, and can therefore be run off either set of bars, the arrangement is practically equivalent to a "duplicate set." Frequently lighting and traction sets are run off the same 'bus bars, and the varying load of the latter has not been found to interfere with a steady voltage being obtained from the former. This would appear to raise the question as to whether separate lighting and traction 'bus bars are really a necessity. Under the main gallery and on the floor level are placed the various resistances, starters, and feeder chargers, the latter consisting of three separate water tanks, forming a non-inductive resistance. This arrangement has been found preferable in every way to the choking coil or separate motor-generator type. A cable subway runs the whole length of the building on each side, and receives the high and low tension cables as they come in from the streets, and also carries the machine leads. The latter are single conductor cables throughout, drawn through Doulton ducts between the machines and the subways.

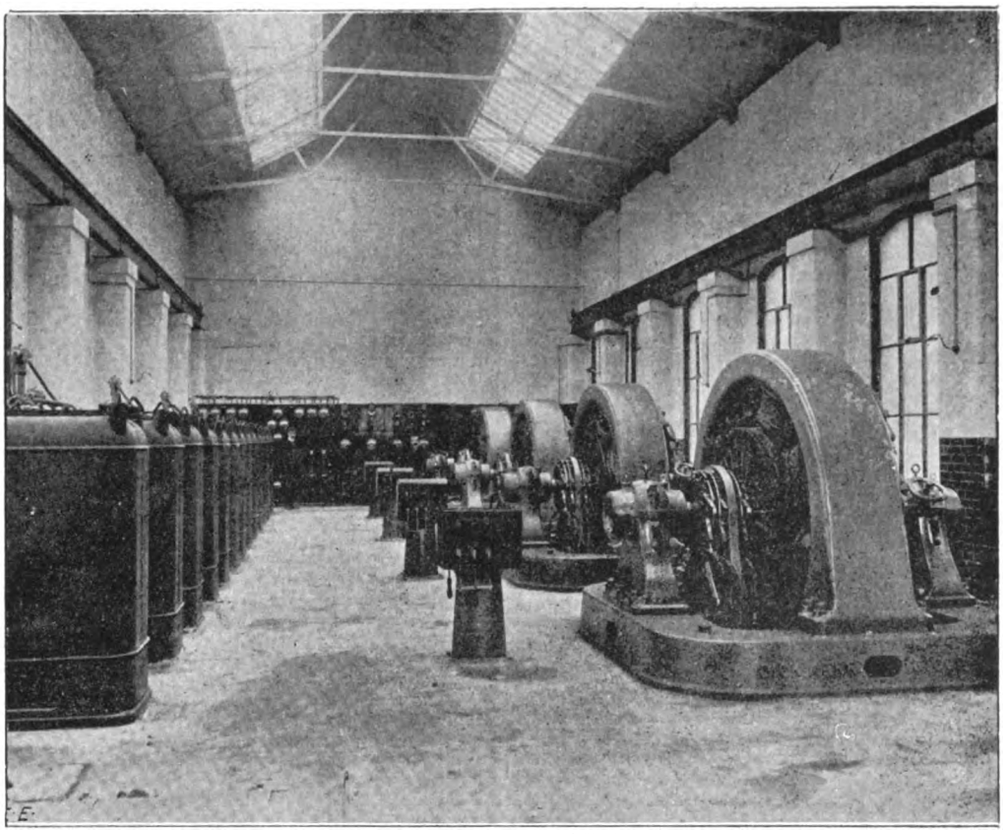

FIG. 5.—Interior of a Sub-Station, Lancashire and Yorkshire Railway Company.

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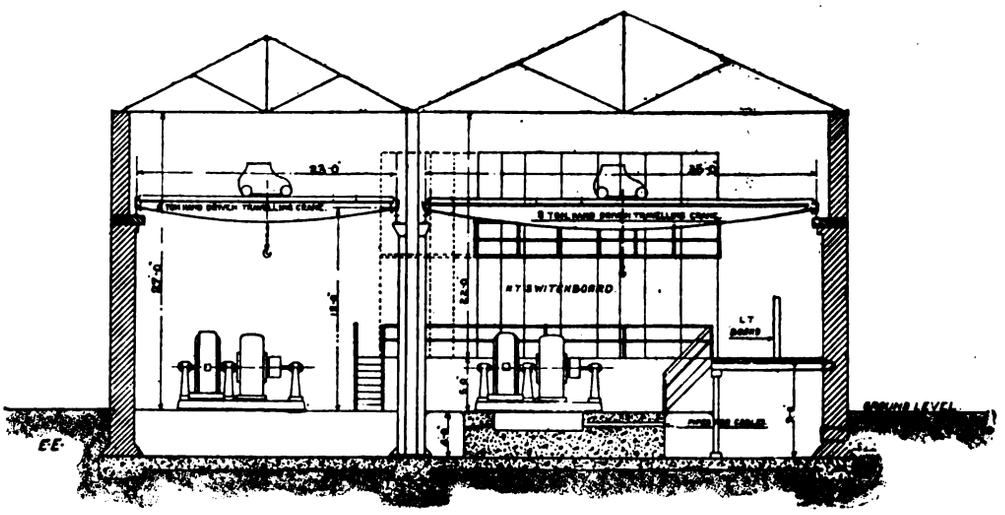
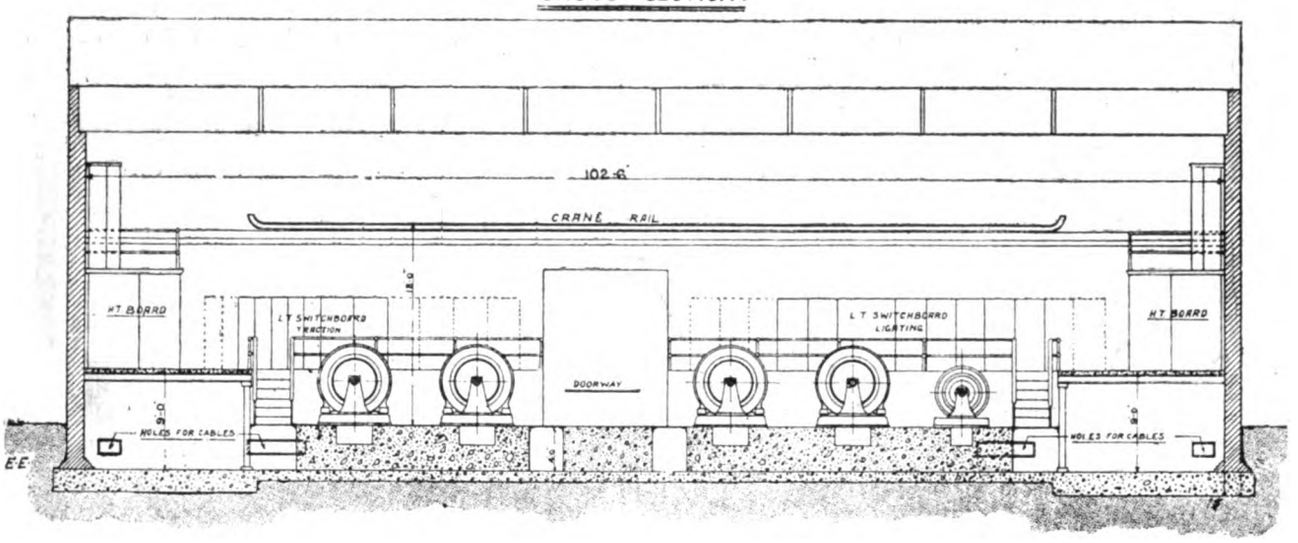
Static Transformer Equipments (Beyer Peacock's).—Fig. 8 shows the general arrangement and diagram of connections of a sub-station recently equipped for Beyer, Peacock, and Co., Gorton, Manchester. The transformers are of 60 kw. capacity, six of these being banked together in "mesh" to form two groups of 180 kw. each. The ratio of voltage is 6,500-220. They are of the natural ventilation type. The switchboard is of the multi-frame order, and has panels controlling the two high-tension feeders, two high-tension transformer panels, and two low-tension distributing panels. The current is metered



CROSS SECTION.



SECTIONAL ELEVATION.

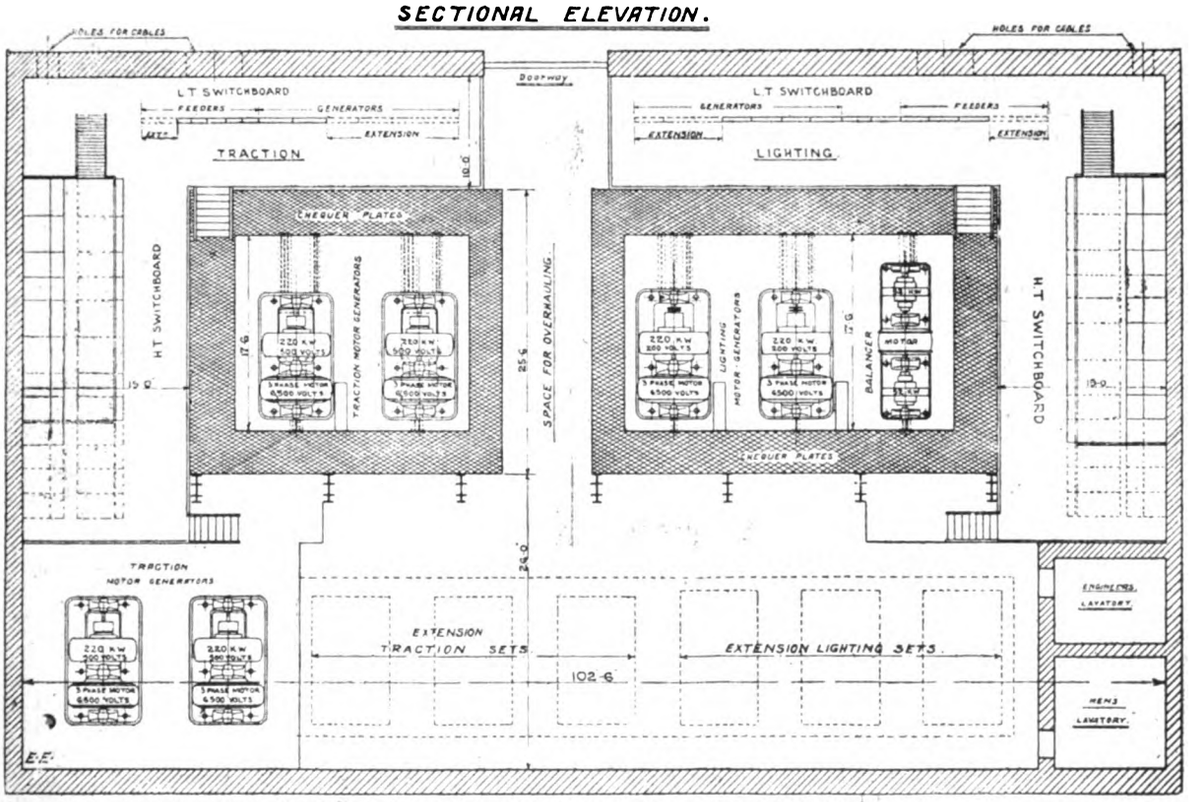


FIG. 6.—Manchester Corporation Electricity Works—Polygon Sub-Station.

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on the primary side of the transformers, and a recorder is fixed on the low-tension panels reading direct in horse-powers. Provision is made for extension, the above instalment representing rather more than one-third of the capacity of the works. The efficiency of the transformers has been guaranteed for 98·5 per cent. at full load, with a drop of not more than 4 per cent. when working on any power factor.

WORKING OF SUB-STATIONS.—STARTING UP.

(*a*) *Rotary Converters.*—There are three possible ways of starting up a rotary converter: (1) From the alternating-current side by switching it straight on to the supply lines. This method was adopted and as far as the author knows is still in vogue on the Central London Railway system, and on the Liverpool and Southport line, in the case of the first rotary to be started up each day. It is necessary to have a field-splitting switch in order that the shunt winding may be opened before starting, otherwise they would break down owing to the excessive E.M.F. induced at the moment of closing the alternating-current main switch. Further, if the rotary be compound-wound, the series field windings must be open-circuited. All switches on the direct-current side must be left open before switching the rotary on to the line. By reason of the hysteresis lag in the poles, and in a lesser degree due to the eddy currents set up, the rotary will start as soon as the alternating-current switch is closed, and will immediately run up to synchronous speed. As soon as synchronism is attained, the field-splitting switch and direct-current field switch can be closed. With self-exciting sets care must be taken to see that the latter is closed as the machine is building up on the right polarity, which can be done by closely observing the direct-current voltmeter. If this is not done, the polarity on the direct-current side of the rotary will be reversed. The rotary will now be running in synchronism with the main generators, and can be paralleled on the low-tension 'bus bars in the usual way. Although this method may be unavoidable in some cases, it has serious disadvantages, chiefly on account of the large current at low power factor which it draws from the supply lines, and the possibility of the rotary building up on the wrong polarity. For traction work this method may be employed, but not for lighting purposes. (2) Starting up from the direct-current side is a far simpler operation, and presents no difficulties of operation, and can usually be followed in most instances where a supply of direct current in the sub-station is available. In the case of the Central London Railway this method was always adopted for all sets after the first. For lighting systems the starting current required for large units might occasion a heavy drop on the distributing mains, and it will become necessary either to provide an induction motor-generator set to supply the necessary direct current, or, better still, the following third method may be usefully employed. (3) This consists in coupling on to an extension of the rotary shaft a small three-phase, low-pressure induction motor, the capacity of which should be approximately one-tenth of the full load output of the rotary. By means of this starting motor the whole set may be brought up to synchronous speed, the alternating-current and direct-current fields adjusted, and then synchronising the alternating-current side of the rotary on to the line, afterwards cutting out the starting auxiliary unit.

(*b*) The starting up of synchronous motor sets presents no difficulties, and is usually from the direct-current 'bus bars, and synchronising on the alternating-current side in the usual manner. It is, however, absolutely necessary that provision be made in every sub-station for the plant to be started up from the alternating-current side in the event of a possible shut-down of the lighting or traction systems. Such means are to hand in the employment of induction motor sets, which in lighting sub-stations are frequently coupled up to the balancers. Their value in this respect forms an additional reason, in addition to those previously set forth, why a combination of induction and synchronous motor sets is desirable. If battery power is available this will provide the alternative direct-current supply, but it rarely happens that battery stations and polyphase sub-stations are combined.

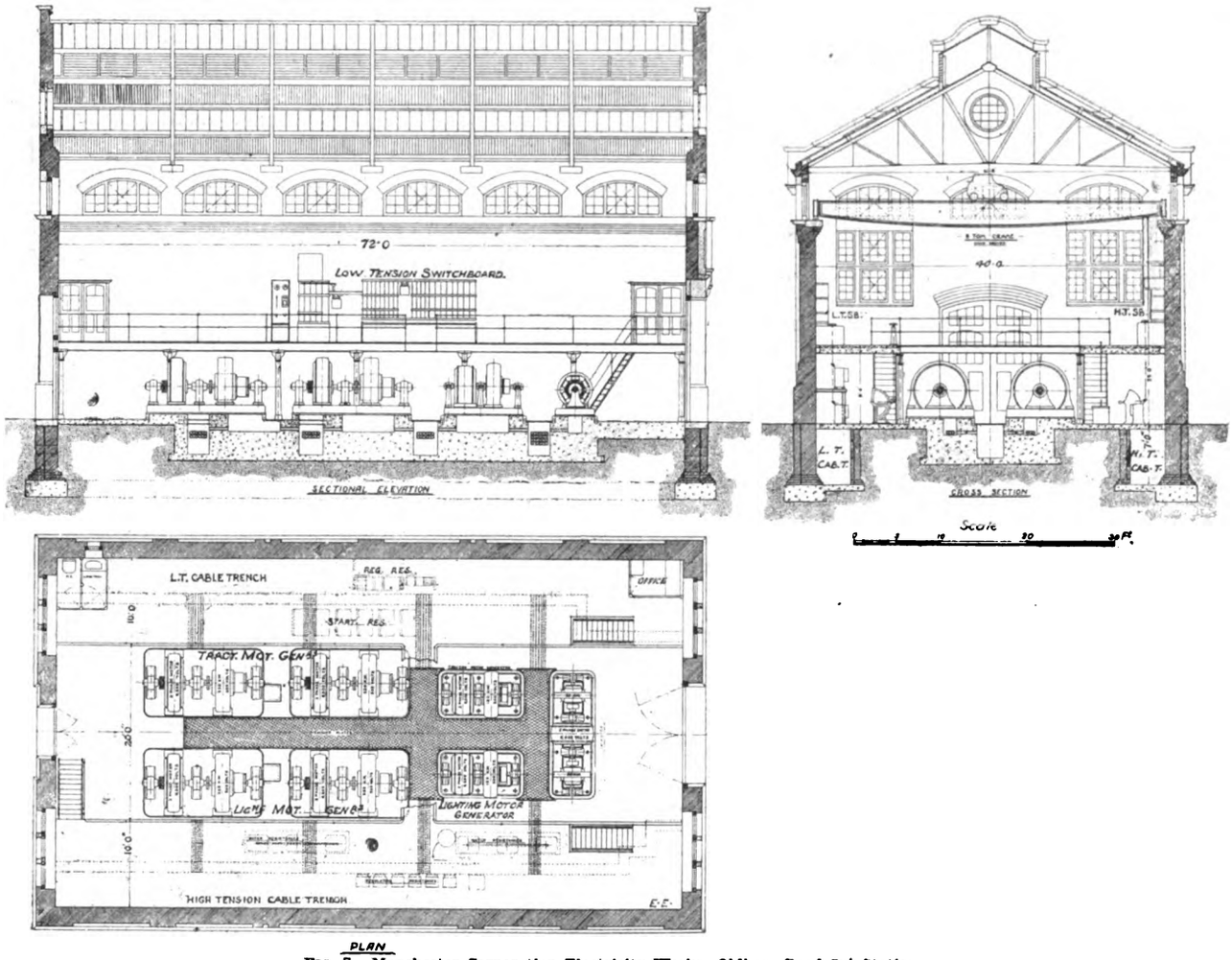

FIG. 7.—Manchester Corporation Electricity Works Oldham Road Sub-Station.

(*c*) A method of starting up applicable to both rotaries and synchronous motor-generators is shown in Fig. 9, and is a slight modification of the first method described for the starting up of the former. The compensator shown reduces the primary voltage to one half. The double-throw oil-switch, which is fitted with an overload device, is thrown down on to the bottom contacts. Half voltage is thus impressed on the rotary or synchronous motor, and the field switch being left open, the machine runs up on an induced field. When full speed is attained, and the field built up in the right direction, the field switch is closed, the oil switch is thrown over on to the top contacts—*i.e.*, on to the full-voltage bars—and the starting high-tension oil switch is withdrawn. The motor-generator with induction motor is the simplest of all types of sub-station equipment to start up. With long feeders it is desirable that the pressure on the feeders should be applied gradually

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to the stator of the induction motor, as any throw-up in the voltage due to the capacity of the feeder at the moment of switching in might break down the insulation of the motor. A suitable design of three-phase stator starter to be used for the purpose is shown in Fig. 10. It consists of three coils arranged in a triangle, and carefully insulated by cylinders of mica. Each coil is provided with an adjustable core consisting of a large number of iron sheets 1-50in. thick. The three iron cores are attached to a round disc, which is held by a three-armed cast-iron holder, through the middle of which runs a screw, and the three iron cores can thereby be raised and lowered. The three coils are switched in series with the corresponding phases of the motor which is to be started up. Before switching in, the iron cores are lowered into the coil, so that on first switching in only a small current goes into the stator of the motor. The cores are then gradually raised out of the coils, the inductive resistance being thereby gradually lessened, and finally the coils are short-circuited. A water resistance or other suitable form of starter is inserted between the slip-rings of the rotor, and short-circuited as soon as the set is up to speed, when the machine can be paralleled in the usual manner on the direct-current side. On account of the heavy rotor cables with large units, it is desirable, to avoid expense, that the rotor starter should be placed as near the machine as possible, and a

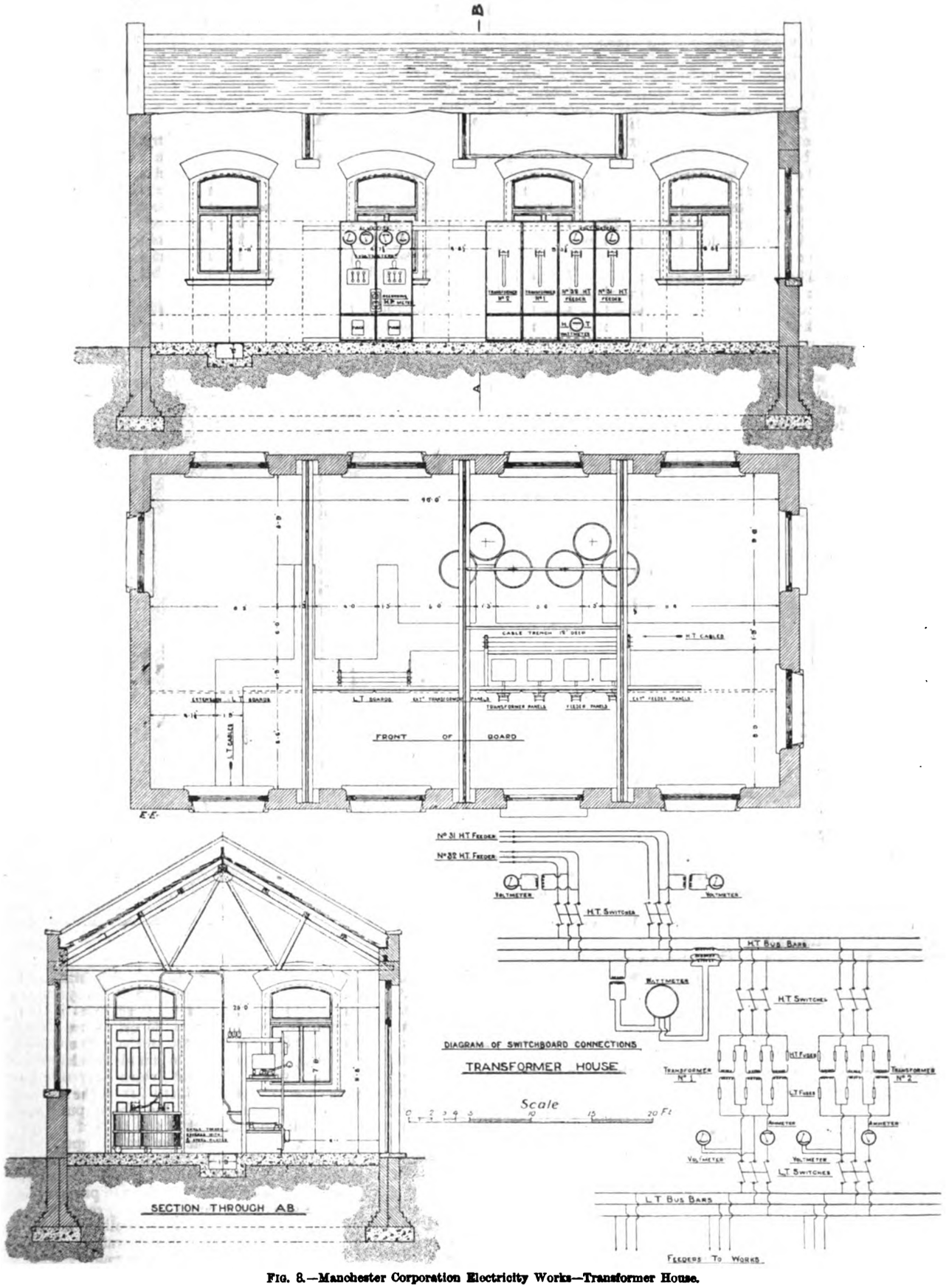

FIG. 8.—Manchester Corporation Electricity Works—Transformer House.

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convenient arrangement is to operate it by means of bevel gearing from the front of the switchboard platform.

Exciting.—Rotaries are invariably self-excited for obvious reasons. There is one strong disadvantage, however, with this method, consequent on the possibility of the rotary reversing whilst under load. This happened on two or three occasions on the Central London Railway system, and is a possibility to be reckoned with. If the rotaries are excited from the 'bus bars, then a battery connected across the bars becomes imperative. For synchronous sets employed on traction circuits, a separate exciter mounted on the end of the shaft is probably the best method of exciting the high-tension motor fields. Although it occupies extra space, it provides an alternative method of excitation from the lighting 'bus bars where a mixed system is supplied. In any case it is desirable that the excitation for the traction sets should be independent of the lighting system, and this can best be obtained by the use of a separate exciter, or a method to be described later on under "Balancing." For synchronous sets on lighting networks, excitation from the direct-current terminals or low-tension 'bus bars will probably be found sufficient. The author considers that the question of excitation is of importance, and should be well considered.

(*d*) *Balancing.*—The effective balancing of a three-wire lighting network from sub-stations can be secured by the use of an induction motor coupled to two generators giving about half the pressure across the outers, the whole combination forming an auxiliary set for the supply of direct current necessary to start the larger synchronous units. It is, however, desirable that additional means of balancing should be provided, either by the use of double-wound armatures with the synchronous sets or other methods. An alternative arrangement has been used extensively in the Manchester sub-stations, and emanates

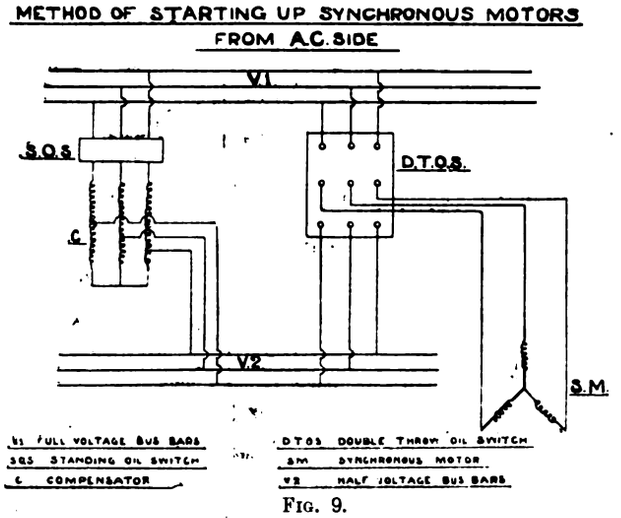

FIG. 9.

from the Allgemeine Company. This apparatus is essentially a choking coil, the ends of which are connected up by means of two slip-rings to the armature of the continuous-current dynamo. The slip-rings are connected up to the armature at such points that a normal alternating current at the frequency corresponding to the number of pole-pieces and the revolutions is circulating in the equaliser. The middle wire of the system is connected up to the middle point of the choking coil. If the load on each side of the two net halves is unequal, the overload on one will pass through the middle wire into the respective side of the equaliser, and through the slip-ring belonging to it back into the armature. This method also provides another supply for exciting current, and if all the synchronous plant in each sub-station is so arranged, it is evident that each set will be self-excited. An out-of-balance current up to 25 per cent. can be dealt with under this arrangement without the difference in voltage exceeding 2½ per cent. of the mean voltage.

(*e*) *Hunting.*—To ensure satisfactory parallel running and immunity from what is known as "hunting," it is necessary that every detail of the system should be very carefully considered. Troubles from this source are almost entirely associated with rotary equipments. If the frequency of the supply system be not uniform—that is, if the variations in the velocity of the main generators during one revolution exceed a definite and certain limit—the rotary converters tend to follow, and vary in accordance with the power-house generators. If these variations occur rapidly, it is impossible for the converters to keep in step, and "hunting" ensues. But this trouble can be set up independently of the power-house engines. Oscillations may be set up from a variety of causes within the rotaries themselves, which if not checked will spread over the whole system. It is necessary, therefore, in the first place, to provide suitably but not too well-governed engines in the power-house; and secondly, to attach special devices to the rotaries themselves to check any oscillations that may be set up. For this purpose "damping coils" are used, which usually take the form of copper plates which bridge over the space between the pole tips. The eddy currents produced in the latter tend to restrain or counteract the distortion of the magnetic field due to the armature oscillations. This tendency to instability of rotaries, however inappreciable for traction work, has, in this country at any rate in the past, placed them at a disadvantage for lighting work. With synchronous machines the author has never experienced any trouble from this source, and given suitable engines at the power-house, there should be no possibility of hunting. The armature reaction of the high-tension motor is considerable, the fields being excited at a constant pressure, and independent of the feeder pressure.

(*f*) *Synchronising.*—It is of greater importance that the machine should be as nearly as possible in phase than at the same voltage. A synchroniser so arranged as to indicate the relative speeds of the incoming machine and those already on the load will be found a useful and time-saving device, and may be combined with the ordinary method of voltmeter and lamps. By the adoption of this type of synchroniser the machine can be synchronised in the shortest possible time, and with the smallest interchange of current between the various machines.

(*g*) *General Conclusions.*—It may be said at once that the majority of sub-stations are required for one or other of the

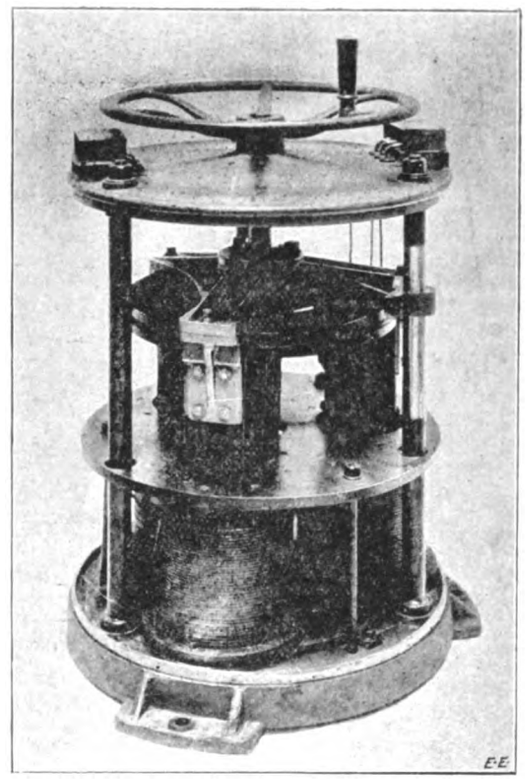

FIG. 10.

following purposes: (1) traction system; (2) mixed lighting and traction systems; (3) direct-current lighting and power systems. For the first of these very strong reasons must exist if the claims of the rotary converter operating at 25 cycles are overlooked. They are at least 5 per cent. more efficient than either of the other equipments, their ability to stand considerable overloads, and the high power factor at which they can be operated, outweigh the disadvantages pointed out in the earlier part of this paper. For the second of the above purposes lighting considerations will probably settle the type of equipment, and for this synchronous motor-generators operating at 50 cycles appear to best fulfil the majority of conditions required—viz., ease of regulation of direct-current pressure, satisfactory parallel running, little or no variations in pressure—in short, they are not so sensitive as rotaries, and they can also be worked at an equally high power factor. It is possible that the disadvantages of the rotary are sometimes exaggerated. Their large use in the States and increasing use in this country point to the fact that under special circumstances their adoption may be deemed warranted. The third class is the one in which, perhaps, most difficulty will be experienced in deciding on the respective merits of synchronous *v.* induction motors. As mentioned before, the drawback to the latter is the fact that the current is always a lagging current, and the smaller sizes have a relatively low power factor. There is also a gain of 1 to 2 per cent. in efficiency in favour of the synchronous type, to

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balance which may be placed the extra complications in switchgear. For units of 500 kw. and over the author considers that either type might be usefully employed, the increased cost of the induction type being balanced by the increased cost of switchgear with the synchronous type. For units of less than the above output a combination of both types has worked with advantage, the leading currents of the one compensating for the lagging currents of the other, while the induction motors provide the necessary means of starting up the sub-station from the high-tension side in the event of failure on the direct-current side of the system.

In conclusion, the author would take this opportunity of expressing his thanks to those representatives of the British Thomson-Houston Company, the British Westinghouse Company, the Electrical Company, and Dick, Kerr, and Co. who have kindly placed data at his disposal.

Discussion.

Mr. Ruthven Murray, of Willesden, opened the discussion, and expressed the thanks due to the author for treating such important subjects at great length. In such matters one was apt to draw conclusions from one's own practice; and in this respect he (the speaker) proposed to follow the author's example. He was surprised to see the old fable, that rotary converters were not satisfactory, was still quoted. He had used them at Willesden on the electric lighting circuit for the last 12 months without the slightest trouble. There might be cases in which the two-phase system was advantageous, but it lowered the output of the rotary converters. He had found it advantageous to connect up the primary windings of the transformers on the mesh system and the secondary windings as a star. He then obtained any regulation required by means of cutting in or out coils in the secondary windings. With respect to the working of rotary converters at 50 frequency, this had been done on the Isle of Thanet tramways system for some years, and the North Metropolitan Tramways Company had adopted the same for their power distribution work. Working with motor-generators, he questioned the advisability of having 10,000-volt stator windings. With such a machine he did not think it good to start up from the high-voltage side. Mr. Ruthven Murray then enlarged on the advantages of the induction motors, and held that the power factor of these was not so disadvantageous as some people held. He pointed out that the tables of cost of the various equipments and the curves of these costs did not agree. He called attention to the importance of the most careful designing of the wiring in high-tension sub-stations, and held that, with the exception of the cable insulation, no combustible material should be used at all.

Mr. S. Z. De Ferranti said that the impression left on him by the paper was that there were too many complicated details in the systems described for them to be adopted as standard practice. There was, he feared, a great tendency to adopt complicated arrangements and to introduce instruments to give readings which frequently were of little use. If equal facilities could be arranged for checking the boiler-room staff, considerable economies might be effected. He, as they knew, believed that the single-phase system would survive as the most fit. If they compared an electric light station to a gasworks, they would be struck by the simplicity of the latter; and in the competition for giving cheap power, simplicity and low first cost must be studied. Since his remarks on the same lines at Huddersfield, four years ago, there had been many advances made in the design of single-phase motors—they were now being used even for railway work on a commercial scale. As regards converters, he thought the mercury lamp type might be the final form.

Mr. C. H. Wordingham, of the Admiralty, also referred to the prejudice which existed against rotary converters. Against this, however, it must be remembered that they were on an average 5 per cent. more efficient than other machinery for converting three-phase current into direct current. The author showed also that their cost per kilowatt was only £3·8 as against £5·5 for the motor-generators. As regards the frequency, he thought a good many approached this question in the wrong direction. They ought first to decide on the equipment to be used, and then fix the frequency to suit their requirements. He would like to ask the author if he found the connection of the centre of the star of the three-phase system on to the zero wire of the three-wire system had any disadvantages. As regards transformers, he was surprised to see a great difference between the cost of a three-phase transformer and of three single-phase transformers to give the same output. He doubted the advisability of connecting heavy feeders direct on to 'bus bars without the interposition of either fuses or circuit breakers.

Mr. Highfield, of the Metropolitan Electrical Supply Company, remarked that, as regards standard frequency, it was a pity the Standardising Committee had not got to work years ago. They had decided to recommend 50 and 25 as the standard. At Newcastle-on-Tyne the power company had adopted 40, and his own company used 60. He thought that reliability should be considered much more than the efficiency. They found, for instance, if the lights went out even for a few minutes in an area where there was a competing supply, a certain number of consumers changed over. In the same way, in such an area, if consumers demanded a direct-current supply, it must be given, and he found they could get ½d. per unit more for the direct current. They could, however, give the alternate-current supply more economically, and did so where there was no competition.

Mr. A. E. Hadley, of the Electrical Company, said that a flexible system was wanted. By adopting 50 frequency they had a larger number of manufacturers to draw their supplies of standard machinery from. He thought, however, that this frequency gave more trouble with the rotaries than a lower one. One point against the motor-generators with asynchronous motors was the noise which they made.

Mr. J. H. Rider, of the London County Council, advocated the induction type of motor for motor-generators as being more simple and reliable. These motors would not give trouble owing to a short-circuit, as did rotary converters. In transmitting three-phase current to be used as direct current, they should make the link between the two as strong as possible. With rotary converters, a slight hitch in the generating station or a short-circuit on the mains lasting only a few seconds might shut down the whole system. In starting up again, all the low-tension mains at the sub stations had to be disconnected, and he found that it took about 10 minutes to get the cars started up again on the London County Council system. He believed in replacing fuses with automatic oil-break switches arranged to go at overloads. He did not see why the author advocated earthing the centre of the star through a resistance—his machines would well stand a short-circuit current without any damage. He thought that the synchronoscope for paralleling alternators had removed all trouble which existed in this work. As regards cables, he advocated specifying for 12,500-volt cables for a working pressure of 10 000 volts. The extra insulation did not cost much, and it guarded against breakdown. He had never found the rise of voltage when switching on to exceed twice the normal voltage, and the cables with the above proportion would well stand this.

Mr. S. L. Pearce, in reply, said that there was only limited experience with the use of rotary converters for lighting circuits—there was, he thought, with a frequency of 50 a tendency to instability. There was no difficulty in putting the full pressure of the high-voltage supply direct on to the stators. The curves of cost were correct for the various equipments, and these did not agree with the table because transformers had been left out of the latter. In reply to Mr. Wordingham, the connection of the zero wire of the three-wire system on to the centre of the star was good. They also coupled together the electric lighting and electric traction omnibus bars with success. The noise of the induction motors was most objectionable, and they were unable to use 50 per cent. of their motor-generators for this reason, as the neighbours objected. He did not agree with Mr. Rider as to the duration of a shut-down if the machine got out of step. They could get their station running in three minutes, and all their sub-stations started up again within seven or eight minutes of the stop. He called attention to the over-all efficiency of from 75 to 76 per cent. between the generating station and a consumer.

The following paper was then read.

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Some Notes on the Bristol Electricity Works Fire.

BY H. FARADAY PROCTOR, CITY ELECTRICAL ENGINEER, BRISTOL.

Having been asked by your council to introduce to this meeting the question of the Bristol fire, the author does so with the view of affording an opening for considering the possibilities of electricity works fires in general and the Bristol fire in particular. Since so much has been published in the technical Press and elsewhere, there is little or no scope for originality in the following notes, which at best must be looked upon as a bald statement of facts, but which a few months ago in the hands of an artistic story-teller would have been converted into interesting and sensational matter. A fire occurred at the Temple Back electricity works belonging to the Corporation of Bristol at 5.15 on Wednesday evening, Dec. 23, 1903, resulting in the destruction of the 2,000-volt high-tension "Ferranti" switchgear, and damage to portions of the roof and windows of the engine-room. The machine switchboard, wattmeter switchboard, trunk feeders from the Avonbank electricity works, and the whole of the 44 feeder panels were destroyed, as well as all the cables leading up to them from underground.

It may be well to remind you that at Bristol there are two generating stations—viz., Temple Back (the old), and Avonbank (the new). The Temple Back station, occupying the more central position, is at present used as the distributing centre for the whole of the high-tension energy, the current from Avonbank being delivered to Temple Back through six ·30 square inch, two-conductor, concentric, paper-insulated, lead and steel-tape armoured cables, and from Temple Back the energy is delivered by similar feeder cables (of varying sections) (·1 square inch to ·05 square inch) through 44 feeder panels to about 60 transformer sub-stations in different localities. The only generators that need be considered in connection with this matter are the four 750-kw. to 1,000-kw. steam alternators at Avonbank, all of which were running at about two-thirds of normal full load, and two 400-kw. steam alternators, which were running (at two-thirds of full load) at Temple Back in parallel with the foregoing, the total alternating-current load being 2,700 kw. The remaining plant, whether alternating or direct current, does not affect the subject under consideration. The voltage at the generating station at the time was 2,300, and the periodicity 93 ⁓ per second.

There were present at the Temple Back works at the time of the outbreak Mr. H. H. Couzens (deputy city electrical engineer), the stations' superintendent, mains superintendent, and others, and on the switchboard gallery two charge engineers, an improver, and a switchboard boy. The seat of the trouble was evidently in the panels of the two alternators running at Temple Back (Nos. 8 and 10). A considerable arc started on these, and it is reported that some seconds elapsed before the fuse pots burst and scattered oil, which immediately caught fire, and in turn caused all the other fuse pots to crack and let their oil run out. The handles of the machine and trunk main switches were burnt so rapidly that they could not have been operated even could they have been approached. The flames from the burning oil shot up to the roof 20ft. above the switchboard floor, and the matchboarding on which the slates rested was soon ablaze. Curiously, the amperes output only increased by about 200 for the first two or three minutes; hence the plant at Avonbank was kept running until after the lapse of about eight (?) minutes, when the load having increased by about 800 amperes some of the trunk main fuses at Avonbank gave way, and the station was then shut down. The damage done by fire may be said to have been limited to the high-tension Ferranti switchboards, one of the arc lighting boards, the connecting cables from the switchboards to the machines, and from the switchboards to the mains in the streets; and also, as far as the building is concerned, to damage to the roof, teak window frames, and a portion of the switchboard gallery. A slight amount of damage was also done to the stone window sills and glazed brickwork. The total amount of the claim paid by the insurance company was £8,225.

The remains of the old board were very carefully examined, and several consultations have been held to endeavour to ascertain the source of the breakdown, but there is not sufficient evidence to point conclusively to special features constituting the primary cause. It is most improbable that a fault on the external system is to blame, since all of the trunk mains and feeders were protected by fuses, and some minutes after the arc was formed, the ammeters registering the entire output from the Temple Back works were examined and showed a normal current. After the fire it was found that one of the trunk mains, that remained loaded to the last, had fused for a length of about 3ft. to 4ft. in the ground outside the Temple Back works, but as the arc had apparently sufficient resistance to keep the current within the limits of the fuses at the Avonbank end, these did not operate. The fuses at the Temple Back end of this trunk main were not situated where the arcing commenced, and could not, therefore, have been the cause of the same. This cable is ·3 square inch section two-wire concentric, paper-insulated, lead-sheathed, and steel-tape armoured, and was provided with fuses at each end, and probably carried nearly 1,000 amperes before Avonbank was shut down. It would appear that the origin of the trouble is to be found from amongst the following: Firstly, by leakage from the metal work of the board "charged at high pressure" over the surface of the insulators and slate to "earth," or, in other words, to the other pole of the board, in which case it is further possible that this may have been in a measure caused by the presence of moisture or by a crack in one of the insulators due to the jar of operating the switch. Secondly, by the breakdown of one of the cable receivers, in which the cables from the machines to the switchboard are jointed up. In the event of such a fault occurring, however, it is most probable that, owing to the proximity of the two conductors, a "dead short" would have resulted, causing the engine to pull up, the mass of metal being too great to allow of the fault clearing itself, and the machine fuse would have operated, due to the current from other generators. Since the machine in question (No. 8 alternator) did not pull up, and since the fault was not a dead short, as evidenced by the fact that the load on the Avonbank station did not run up to more than about 1,374 amperes—viz., say 200 amperes above the normal load for the time in question—it appears that the fault did not originate at the cable receiver. Thirdly, by the abnormal action of one of the machine fuses, the blowing of the fuse causing an arc and breaking the porcelain pot filled with oil in which the fuse is placed.

Although some engineers who have examined the board since the accident seem to favour the opinion that the improper action of the fuse was the first cause of the trouble, none of the members of the staff hold that view. The fuses were examined by the engineer in charge just a few minutes before the accident, and their temperature was normal. There was not even a full load on the machines corresponding to the switch panels wherein the trouble commenced, and no switching operation was being carried out. Whilst the fault was still "on" and the Avonbank works was still delivering energy to Temple Back, the stop valves of the two running machines at Temple Back were closed and their fields shut off although the machine switches were closed and could not be approached. These machines would thus have formed two dead shorts across the system unless their fuses acted, and since the machines on examination showed no signs of having passed excessive currents, the inference is that these fuses acted in a proper manner and were not the source of trouble. It is very certain, however, that when once the fault commenced the whole of the cause of the spreading of the trouble was attributable to the oil used in the fuse holders and switches, of which there would be about 22 gallons. The fault was very much augmented by the fact that it was impossible to get the Avonbank supply cut off till after the lapse of a few minutes, as all private telephones were rendered useless by induction on the wires, and owing to the great number of calls from consumers, it was impossible to immediately get into telephonic communication over the National Telephone Company's system. It was therefore not until the load at Avonbank became very excessive that those in charge shut down the supply at that station. It was also impossible to get at the switches on the trunk mains from Avonbank owing to the conflagration, though what would have happened at Avonbank had the full load been suddenly and totally removed without explanation or warning is perhaps a matter for speculation; the alternators would probably have run out of phase, and the boilers would certainly have blown off steam. Whether the plant would all have remained in thorough order ready to take up the load as soon as the mains were joined across is difficult to say. Apart from the oil, there was a small amount of wood on the oldest portion of the switchboard floor, which contributed somewhat to the fire. All portions of the flooring, excepting that first installed, were formed of iron chequer plating covered with linoleum, and this withstood the test perfectly, the linoleum within a few feet of the place where the most extreme heat occurred remaining intact. The window frames are of teak, and they were much charred, but these in themselves did not add to the trouble. In the roof the slates were laid upon matchboarding, and this formed one of the most serious features, as the fire reaching this spread rapidly along a considerable length of the engine-room, and necessitated the use of a great amount of water, this water doing a considerable amount of temporary damage to the electrical machinery. The cables contributed largely to the flames, although they were all encased in lead and further protected with steel armouring. The steel armouring, however, was served over with impregnated jute, and this getting soaked with oil was, of course, very inflammable.

In reconstruction it has been considered desirable to avoid: (1) The use of oil in porcelain holders. (2) The use of wood anywhere about the structure of the switchboard floors, unless it is in such form as to be proof against fire. Hardwood blocks set upon a concrete foundation probably form the best and safest description of switchboard flooring, as, whilst it is practicably unburnable, it affords a good insulation from an electrical point

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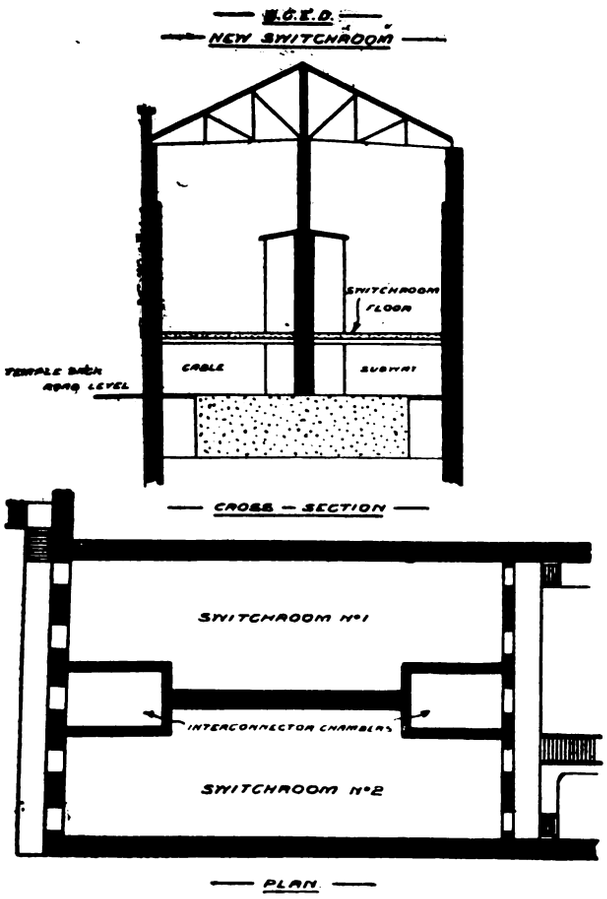
of view, and does not appear to be open to the objections that have been found to exist in the case of glass. (3) Cables, although armoured with lead or steel armouring, must be further protected by being either buried or run in metal casings. (4) The roof must have in its construction no wood unless it be thoroughly protected, as in the construction of fireproof doors. Ferranti switchboards of the type whereon the accident occurred have been very generally accepted as being of the most suitable form for use under the particular conditions of the Bristol system, but it seems imperative that boards constructed on this principle should not be built into any external wall of a building, for, although the walls of the generating stations at Bristol are formed of most excellent bricks set in cement, and are 2ft. thick, there is no doubt that with continuous wet weather and strong winds, damp has found its way through, and the back slates supplied with the board afford no



protection. A drawing of the proposed fireproof switchroom is appended hereto.

(*To be continued.*)

PERSONAL.

Mr. Gallinagh has been appointed borough electrical engineer at Limerick.

Mr. Gwillam, late of Messrs. Thompson's Steamship Company, has been appointed assistant engineer at Crewe.

The Barnsley Council have increased the salary of Mr. Colbrun, an assistant of the borough electrical engineer, by 5s. per week.

The Greenock Law and Finance Committee of the Corporation have recommended that the salary of Mr. J. Robertson, burgh electrical engineer, be increased to £350.

Mr. F. J. Hughes, late clerk in charge of H.M. Posts and Telegraphs, Gold Coast Colony, West Africa, and formerly of the Great Western Railway Company telegraph staff, has been appointed H.M. Inspector of Telegraphs, Southern Nigeria.

The Ealing Electricity Supply Committee have granted Mr. J. Douglas Knight, the borough electrical engineer, leave of absence for the purpose of visiting America.

Mr. R. R. Williams, of the Manchester Corporation, has been appointed charge engineer at Bristol.

Mr. J. Tinsley, St. Helens, has been appointed electricity clerk, and Mr. A. Wrigley, Walsall, tramway clerk at Swindon.

Mr. John McMillan, chief electrical engineer to the Falkirk Corporation, on Tuesday received from the assistants and staff at the Corporation electricity works a drawing-room spirit kettle as a marriage gift. The presentation was made by Mr. Wm. Drysdale, A.M.I.E.E., the chief assistant engineer, who spoke of the kindly feelings which existed between the chief and his staff.

The Harrogate Council have increased the salary of Mr. McCourt, mains superintendent, by £15 for 1904 and £15 for 1905, to £180.

ST. PANCRAS ELECTRICITY ACCOUNTS.

The accounts of the St. Pancras electricity department for the year ended March 31, 1904, show a total expenditure on capital account to that date of £460,368. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr.	£	s	d.
Generation of Electricity.			
Coal or other fuel, including carriage	12,019	10	4
Oil, waste, water, and engine-room stores	1,166	15	8
Proportion of salaries of engineers	587	9	0
Wages at generating stations	3,863	4	6
Sundry expenses	273	6	8
Repairs and maintenance of buildings, plant, etc.	2,818	5	9
Distribution of Electricity.			
Proportion of salaries of engineers, etc.	291	5	9
Wages of outdoor staff	1,137	12	6
Repairs, etc., buildings	141	9	6
Repairs, maintenance, etc., of mains	1,449	15	10
Sundry expenses	209	7	10
Alterations in changing pressure on mains, etc.	517	5	9
Repairs, etc., of meters, switches, etc.	524	11	3
Repairs of apparatus at distributing stations	16	11	0
Oil, water, etc., at distributing stations	31	7	7
Wages at distributing stations	237	10	6
Public Lamps.			
Carbons	403	12	0
Repairs	706	16	5
Attending	1,026	19	0
Management Expenses.			
Salaries—engineer and clerical staff	2,112	14	3
Stationery and printing	208	1	6
General establishment charges	390	15	5
Law and parliamentary charges	1,533	12	0
Licenses and wayleaves	27	4	0
Rents, rates, and taxes	2,335	1	10
Special Charges.			
Insurances, etc.	373	6	8
Fees, testing meters	3	0	0
Expenses obtaining loans	247	12	6
Compensation claims	15	19	2
Mains department buildings, Pratt-street	345	12	2
Sundry charges	11	19	6
Rearranging switchboard cables	116	2	9
Sundry chargeable works	542	12	9
Total expenditure	35,686	11	4
Balance carried to net revenue account	40,087	8	11
	£75,774	0	3

Cr.	£	s.	d.
Sale of current per meter at 6d. per B.T.U.	23,547	12	0
Ditto at 5d.	12,706	13	4
Ditto at 4d.	2,633	7	8
Ditto at 3d.	19,990	0	0
Ditto at 2d.	4,266	0	9
Sale of current (minimum charges)	6	8	2
Public lighting (sale of current, etc.)	11,367	7	6
Indicator rentals	194	0	0
Sundry chargeable works	624	17	2
Fees for testing installations	8	0	0
Rents receivable, less repairs, etc.	279	13	8
Office expenses chargeable to Gas Department	150	0	0
	£75,774	0	3

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	447,675	0	0
Bank overdraft	14,776	1	10
Sundry creditors	8,667	19	11
Net revenue account	21,113	14	1
Reserve fund	22,797	2	9
	£515,028	18	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	460,368	8	10
Stores in hand	6,591	4	0
Debtors for current supplied	22,890	16	10
Sundry debtors	939	1	8
Due on account of public street lamps	1,374	13	2
Reserve fund investment account	22,614	16	9
L. and S.W. Bank, interest due on above	182	6	0
Cash in hand	67	11	4
	£515,028	18	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		5,613,170
Quantity sold: Public lamps	909,390	4,730,341
Quantity sold: Private consumers by meter	3,820,951	
Quantity used on works		18,900
Total quantity accounted for		5,505,456
Quantity not accounted for		756,215
Number of public lamps		461
Total maximum supply demanded (kilowatts)		3,193

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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FROM LITTLE CAUSES.

If anything goes wrong with electrical work, the most is made of it in the local and even in other papers, hence it is often of advantage to trace to its source the cause of an accident. By accident we do not necessarily allude to personal injuries, but more especially to the stoppage of current. It may be mentioned, however, that personal accidents have happened upon the electrified railways because people have been where they ought not to have been. Many years ago, discussing casually the question of very high pressure currents, Mr. Ferranti remarked they would probably be less liable to personal accident than lower pressure currents, because people would feel certain that an accident would be fatal, and not merely might give a nasty shock, though not necessarily fatal, and thus every care would be taken to remain in a safe place. There is a good deal of truth in that point of "certainty." A wise schoolmaster once said that both with boys and men it was the certainty and not the severity of punishment that kept them from wrongdoing; but probably, like electrical contacts, the certainty of fatality would be much more restraining than the "may survive again and again." Probably upon electrified railways it will be made compulsory to have a guard against accidental contact with a live conductor. The mere fact that accidents have occurred will lead to the recognition that "prevention is better than cure." The other night a simple act caused cessation of lighting in a small district at Rochdale, and as a similar act might occur anywhere attention may be called to it. Some men were laying tramway lines, and, wishing to fence off a certain place, iron stakes were driven between the flags so that a rope fence could be made. One of these stakes happened to be driven through an electric lighting cable laid some foot and a half to two feet below the surface, and immediately there were ructions. The cable fused and a sheet of flame immediately sprang up, while the workmen, under the impression that there was a leakage of gas, commenced to throw buckets of water and a quantity of sand on the flames. The firemen turned out, as smoke could be seen issuing from between the flags for a considerable distance, and the borough electrical engineer (Mr. Atchison) was soon on the spot. On being correctly informed as to what had occurred, he cut the cable where he concluded the fault was, thinking he would clear the fault, but on telephoning to the works he found he was mistaken. He then decided to cut off the whole of the current. One of his assistants opened the feeder box, when an explosion occurred owing to gas having been formed. Fortunately, the assistant (Mr. Wilkinson) was not much injured, though his hair was singed by the flames. Ultimately the current was shut off throughout the town for about twenty minutes until the fault was cleared, and it was found that the feeder cables for a distance of five or six yards were burnt out. This, then, is an accident which is liable to occur in many places unless care is taken to watch all workmen who have to interfere with the streets, and it shows also the necessity of carefully mapping the position of all wires. In this particular case, fortunately, there was little personal injury, but it is quite conceivable that, had the circumstances been different, there might have been what is sometimes called "a calamity." A century hence engineers may look back and wonder why with the engineers at the beginning of the twentieth century simple precautions were not taken to avoid these difficulties. It ought, upon the face of it, to be impossible that any ordinary workman should be able to drive an iron stake through an electric cable, and the probability is largely

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against such a result; but the inevitable comes along, and everybody wonders that it is so. We must congratulate the electrical engineer of Rochdale that the result was no worse, and we trust the accident which has occurred in his system will be noticed, and care taken that no similar accident can occur at any other place.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

The report of the annual meeting of the above association from our special correspondent (a portion of which has already appeared in these columns) shows that no endeavour is being spared in Germany to establish the electrical industry on an enduring basis. Much of the work of the Verband is of universal interest. Take, for example, the question of first aid in case of electric shock. Medical practitioners having called into question the efficacy of the instructions hitherto observed, an enquiry is to be held into the matter, the outcome of which will doubtless be a fresh set of rules calculated to ensure better results. Nor are the Verband satisfied that everything possible has been done to protect persons from electric shocks, and statistics are being obtained with a view to the ultimate improvement of the safety rules now in force. It is recognised that it lies in the interests of the electrical industry to reduce the danger from electric shocks to a minimum, and the statistics referred to will no doubt throw valuable light upon the causes to be most guarded against. The question of compulsory wayleaves for transmission lines is also of more than local importance. It will be interesting to have the report of the special committee appointed to consider this matter. Conditions, of course, vary in different countries, and the solution found in Germany might not be acceptable here, although the interests involved are similar. It is suggested that legislation should recognise the principle of compulsory wayleaves for transmission lines over all lands irrespective of ownership, leaving only the amount of compensation to be adjudged in each particular case. If anything, this means that the shortest route for a projected line could be selected and enforced. It is no longer consistent with the requirements of to-day that transmission lines should be practically restricted to public ways, and legislation designed to enforce wayleaves over private and public property, while safeguarding all interests, is no less essential in this country than in Germany to enable the problem of economical distribution to be solved, both in regard to new schemes impossible of success under existing conditions, and the further development of old-established undertakings.

A NEW RULE FOR BELT CALCULATIONS.

BY YRREB.

After a new machine (either electrical or mechanical) has been fixed and the belt attendant summoned to measure for the length and width of band required, one of the greatest difficulties the average belt man has to contend with is as to the width and thickness the band is required to be in order to transmit sufficient energy to obtain the maximum rated output from the new machine. The length is easy enough to measure, but the width and thickness is quite another matter altogether; so that, generally speaking, the only guide the non-technical man has to help him in deciding the width of band he will use is the width of the face of the pulley, or the band guide which is usually supplied with the machine. Then, if by some mistake or other, the pulley supplied with the machine is rather wider than is necessary, the purchaser or employer of the belt man is put to the extra expense of buying an unnecessarily wide band owing to the man's inadequate knowledge of belt tensions or of belt driving generally. On the other hand, should the pulley supplied with the machine be too narrow or too small in diameter for the full or rated amount of work the machine is guaranteed to perform, the man whose duty it is to attend to the banding is being continually called upon to either use some band solution or again tighten up the band every time the machine is being worked up to its rated output. In the case of having to be continually tightening up, the band eventually reaches its breaking strain, and so causes a complete stoppage. This bad practice not only causes an excessive tension on the band, but it very considerably reduces the life of the shafting, loose pulleys, bearings, etc., which causes a loss of time, money, and temper, and is altogether unsatisfactory.

After many years' experience of belt driving and general engineering the writer has found that a good all-round and easily-remembered rule for belt calculations is that 1ft. per minute of belt speed per inch width of belt is safely equal to transmitting one watt of electrical energy. So that if we multiply the band speed in feet per minute by the width in inches, the result will be the total energy in watts or (dividing by 1,000) in kilowatts that the band can be safely relied upon to transmit without any undue tension being brought upon any part of the band or excessive friction on any part of the machinery. It must be strictly understood that this data only applies to single leather belting or woven belt of equal thickness. If a light double leather band be employed, then 25 per cent. more energy may be calculated upon, or for a heavy double leather band as much as 60 per cent. more may be added. The great advantage in adopting this rule is that it fixes a constant for working tensions, so that the working tension becomes directly proportional to the width in inches, the constant being 44·24lb. full per inch width of belt. Therefore if it is required to know what is the difference in the pull of the tight side over the slack side of any belt, all we have to do is to divide the total output of the machine measured in watts by the velocity of the belt measured in feet per minute and multiply the result by 44·24, and the product will be the extra pull in pounds of the tight side over the slack. It also conveys some idea to the average man when he is deciding upon a belt as to what amount of stress is likely to be brought upon the band when being fully worked up to its maximum load, thus obviating all troubles arising from bands being either worked excessively tight or ridiculously slack. The above working tension per inch width of belt is fairly low, being one that any class of banding should stand. It would also tend to increase the life not only of the banding itself, but of all loose pulleys, shafting, bearings, etc.

As this article is written chiefly for non-technical men, perhaps it will not be out of place to briefly explain the meaning of some of the mechanical and electrical terms that will be used in some of the examples about to be taken. "Mechanical energy," or rate of doing work, is always measured in foot-pounds per minute, which means that in the case of raising a weight, if the total weight in pounds be multiplied by the height measured in feet to which the weight will be raised in one minute, the result will give the rate of doing work expressed in foot-pounds per minute, and 33,000 foot-pounds per minute is equal to 1 h.p. For instance, a 1,000lb. weight raised 33ft. in one minute is just equal to 1 h.p., as $1,000 \times 33 = 33,000$ foot-pounds per minute; or one ton weight raised 10ft. in one minute $= 2,240 \times 10 = 22,400$ foot-pounds per minute $= \frac{22,400}{33,000} = \cdot 679$ of 1 h.p. Electrical energy is usually measured in watts; one watt is equal to 44 24 foot-pounds of work per minute, and is also equal to 10,000,000 ergs per second, 746 watts being equal to 1 e.h.p. If we wish to measure the electrical energy in watts we multiply the volts by the amperes; therefore the total output for any dynamo is amperes × volts = watts, or $\frac{\text{amperes} \times \text{volts}}{746}$ = E.H.P. (electrical horse power). Then, turning back to our rule, which teaches us that 1ft. per minute of belt speed per 1in. width of belt is equal to one watt of electrical energy, we find that if we

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divide the total output (of any dynamo or motor) given in watts by the velocity of the belt measured in feet per minute, the result will give us the width of belt required for that dynamo or motor.

Another item that might be worth while explaining is circumferential speed of pulleys, and velocity or belt speed. To ascertain the circumferential speed of a pulley, we must multiply the diameter of the pulley in inches by 3·1416 (which is a constant usually denoted by π), and then by the number of revolutions per minute at which the pulley runs, and dividing the product by 12 we get the circumferential speed of the pulley in feet per minute. For example, a 12in. diameter pulley runs at 1,000 revolutions per minute; find the circumferential speed of the pulley in feet per minute.

$$\frac{\text{Dia} \times \pi \times \text{revs. per min.}}{12} = \frac{12 \times 3{\cdot}1416 \times 1{,}000}{12}$$

$$= 3{,}142\text{ft. per minute.}$$

The circumferential speed of a 20in. diameter pulley running at 400 revolutions per minute $= \frac{20 \times 3{\cdot}1416 \times 400}{12}$ = 2,094ft. per minute. Now, when calculating the belt velocity or speed of belt in feet per minute, to be correct we must add the thickness of the leather band to the diameter of the pulley and proceed as before But we must remember that there is a percentage of slip and creep going on continually with every belt that is doing work. So that having to consider these small factors when making calculations, somewhat complicates matters and yet does not materially affect the net results one way or the other. In the writer's opinion, therefore, these might be neglected altogether, and consider the circumferential speed of the pulley as being the belt velocity, which will simplify the method considerably without any serious errors arising from doing so.

Then formulating the rule, letting

W = width of belt in inches;
T = driving tension per inch width of belt;
V = velocity of belt in feet per minute; and
F = total driving tension of belt; we have

(1) $W \times V$ = output of machine in watts.

(2) $\frac{W \times V}{746}$ = E.H.P. (electrical horse-power.

(3) $\frac{\text{Amps.} \times \text{volts}}{V} = \frac{\text{watts}}{V}$ = width of belt required (W).

(4) $\frac{\text{H.P} \times 746}{V} = \frac{\text{watts}}{V}$ = width of belt (W).

(5) $\frac{\text{H.P.} \times 746}{W} = \frac{\text{watts}}{W}$ = velocity of belt (V).

(6) $\frac{\text{H.P.} \times 33{,}000}{W \times V}$ = driving tension per inch width of belt (T).

(7) $W \times T$ = total driving tension.

Example I.—A dynamo runs at 1,000 revolutions per minute with an 8in. diameter driving pulley. The output of the machine being 100 amperes at 50 volts, what width of belt is required to drive it?

Since speed of band = circumferential speed of pulley

$$\therefore \text{speed of band} = \frac{8 \times 3{\cdot}1416 \times 1{,}000}{12} = 2{,}094\text{ft. per minute.}$$

then by (3) width of belt $= \frac{\text{Amperes} \times \text{volts}}{V}$

$$= \frac{100 \times 50}{2{,}094} = 2{\cdot}4\text{in.}$$

So that a belt 2·4in., or, say, 2½in., wide will be required.

Example II.—A 20-h.p. motor has a 14in. diameter pulley running at 850 revolutions per minute; what width of belt will be required for the motor in order to transmit the full output of the machine?

$$\text{Velocity of belt} = \frac{\text{Dia. of pulley} \times \pi \times \text{revs. per min.}}{12}$$

$$= \frac{14 \times 3{\cdot}1416 \times 850}{12} = 3{,}116\text{ft./min.}$$

Then by (4)

$$\frac{\text{H.P.} \times 746}{V} = \text{width of belt} = \frac{20 \times 746}{3{,}116} = 4{\cdot}788\text{in. or say } 4\tfrac{7}{8}\text{in.}$$

Example III.—A steam-engine with a 7ft. diameter driving pulley running at 90 revolutions per minute is capable of developing 30 b.h.p. at the driving pulley; what width of belt will be required, and what will be the difference in tension in pounds pull of the tight over the slack side of the belt?

$$\text{Velocity of belt} = \frac{7 \times 12 \times 3{\cdot}1416 \times 90}{12} = 1{,}979\text{ft./min.}$$

$$\text{Width of belt} = \frac{\text{H.P.} \times 746}{V} = \frac{30 \times 746}{1{,}979}$$

$$= 11{\cdot}31\text{in., or, say, } 11\tfrac{3}{8}\text{in. wide.}$$

Then by (6) $\frac{\text{H P.} \times 33{,}000}{W \times V}$ = driving tension per inch width, and $\frac{\text{H.P.} \times 33{,}000}{W \times V} \times W$ = total driving tension or difference in tension in pounds pull of the tight side over the slack

$$= \frac{30 \times 33{,}000 \times 11{\cdot}31}{11{\cdot}31 \times 1{,}979} = 500\text{lb } \textit{pull.}$$

The simplicity of this rule, and the easy way in which calculations of this kind can be performed, will at once be apparent from the foregoing examples.

Convexity of Pulleys.—All pulleys, as far as possible, should be slightly convex or rounded on the face for the purpose of maintaining the band in the middle of the pulley, but as to what amount or extent they should be rounded is a point which engineers do not generally agree upon. Therefore it is no uncommon thing to see a band running upon two pulleys with a wide difference of convexity or roundness of face. In fact, one can see at times a band running from one pulley (probably the driving pulley) with a very much rounded face to another which has a perfectly flat face, which, to say the least, would not be considered good practice, and would be very injurious to the band, especially where dry resin is freely used. In order to adopt a universal convexity for all pulleys, the writer would suggest that to square the width of the face in inches and add 10in. would give us a radius in inches for striking the arc of convexity, from which sheet steel gauges could be made. For example, take a pulley with a 6in. face, then by the rule $6 \times 6 + 10 = 46$in. radius, an amount which will be found to be thoroughly consistent with good practice, and one that will give very satisfactory results for any reasonable width of face or diameter of pulley. But to speak to an average workman about squaring the width of the face in inches to find a radius for striking the arc of convexity would probably sound like so much Greek; therefore, for the sake of completeness, it may be added that the square of a number is the number multiplied by its own value, which process would be spoken of as raising a number or quantity to its second power, and is usually denoted by placing a small figure 2 over the quantity to be raised.

As 7^2 = 7 squared = the second power of $7 = 7 \times 7 = 49$, or 6^2 = 6 squared = the second power of $6 = 6 \times 6 = 36$, or $10^2 = 10$ squared = the second power of $10 = 10 \times 10 = 100$. This is called the process of involution. Therefore, the square of the face in inches of a pulley with a 10in. face equals 100in., and adding the extra 10in., the sum, 110in., would be the radius in inches for striking the arc of convexity.

Centrifugal Force.—When belts are in motion, they are subjected to a stress arising from the action of centrifugal force, in addition to that due to transmission of power. But this only need be taken into account when belts are running at a very high velocity, such as 4,000ft., 5,000ft., or even 6,000ft. per minute. At the ordinary speeds which are usually adopted for long lengths of line shafting, and, in fact, general machine driving, the effect of centrifugal force does not materially affect our calculated results. Therefore, this force need not be considered in any case when the belt velocity is below 3,000ft. per minute. But in anything

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above 3,000ft. per minute the effect of centrifugal force tends to impair the general efficiency. It is often remarked that a good long belt drive is far more efficient than any short one, and also that all belts run to the highest point of the pulley. Both of these statements are apt to be somewhat misleading, and should therefore never be accepted as a general rule, because there may exist certain conditions which would render a long drive less efficient than a reasonably short one. It can be shown that in the case where both driving and driven pulleys are of the same diameter there is no particular advantage in having a good long drive (whatever that means), for precisely the same results can be obtained with a reasonably short (say 8ft.) drive as with an 80ft. one without any extra tension on the short band or machinery, both bands being the same width and thickness. But if we take a case where the diameters of the two pulleys differ, say, with a ratio of 4 or 5 to 1, then it is an advantage to have a fairly long drive of belt. But here, again, it can be shown that it is utterly impossible to get the lengths of the two band arcs or band grips in the same ratio as the two diameters of the pulleys, however long that belt drive may be.

SOME ACTUAL RESULTS OBTAINED DURING THE USE OF VARIOUS ELECTRIC WIRING SYSTEMS.

BY A. H. M.

Amongst the large amount of information which has lately been forthcoming in the Press with regard to the above problem, there appears to be a singular lack of report as to *actual experience* resulting from an extended use of the various systems. Electric wiring is far from being in its infancy, and a sufficiency of time has certainly elapsed to enable the seeker after definite information to find some sure ground to walk upon. The writer has been conversant with the principal forms of wiring in use for the past 15 years, and ventures to think that the merits and demerits of each are not difficult to define in the light of actual results obtained in practice.

Undoubtedly the basis of all decisions as to which type to adopt must be a careful consideration of the conditions under which they are expected to give satisfaction. It is scarcely possible to lay too much stress upon the above point, seeing that one system will give excellent results when used in surroundings where another would prove a lamentable failure. The writer was recently asked by a friend, who is an architect and surveyor by profession, what class of protection he recommended for electric light wiring, as he (the architect) had just had a lot of trouble with an installation in which the wires were run in metal tubes. As anticipated, the tubes proved to be of the cheap close-joint variety, and after a short length of time so much moisture had collected in the system that the insulation had completely broken down and rendered re-wiring necessary.

There is ample confirmation on every hand that the above class of tubing is quite unsuitable unless the position is an extremely dry one, and certainly should never be buried in plaster. Careful inspection of a breakdown such as mentioned above, constantly reveals the fact that both the surface of the insulating covering on the wire and the interior surface of the tube are covered by beads and films of moisture, partly caused by condensation and partly by water entering the crevice of the tube by capillary attraction. The actual wire carrying the current is therefore only separated from the earthed metallic tubing by the thickness of the insulating covering, and this soon becomes saturated by the moisture, causing such a strain upon the insulation that breakdown is inevitable.

Now let us suppose that in the place of the ordinary close-joint tubing a type had been used provided with an insulating and *non-absorbent* lining. By the adoption of this class of tube we obtain the advantages of a large decrease in the amount of moisture forming by condensation, and a complete absence of water introducing itself through the longitudinal joints. There is also an immense increase in the insulation resistance between the conductor and the earthed tubing. As the result of actual experience the writer has no hesitation in saying that a light form of close joint tube, provided with an insulating and non-absorbent lining, will give excellent results wherever great mechanical strength is not required.

Where great mechanical strength is necessary a solid drawn or brazed tube must be employed, but this must also be fitted with an insulating and non-absorbent lining, or trouble is certain to ensue. An ideal form of lined tubing would consist of a tube of whitewood, thoroughly saturated with paraffin wax and protected by an outer tube of thin enamelled steel. The above should not be expensive to manufacture, and would give excellent results in all respects, and would have the great advantage that the wiring could be easily and safely drawn in.

The question of satisfactorily earthing a system of metal tubing when the joints are not screwed has recently received considerable attention. A very satisfactory plan is as follows: The interior of the socket and the entering end of the tube must be roughly cleaned by passing a rasp over them, and when in position a thin strip of hard copper is driven in between the tube and socket. The copper strips should be about 1in. long and ½in. wide, and cut from different gauges of sheet metal in order to meet all cases.

So far no mention has been made of our old friend wood casing, but the writer nevertheless holds it in the highest esteem. Where it affords a sufficient mechanical protection, and is not objected to on account of appearance, it should be used, and will prolong the life of the cables to a greater extent than any metallic tubing in existence. The writer recently saw some wiring removed from wood casing, where it had lain for 17 years, and the condition was excellent. This has been proved by practice countless times, and there cannot be the slightest doubt that wood casing is a most excellent and satisfactory device, and may be used with absolute confidence where not subject to rough usage.

NEW X-RAY TUBE.

In a communication to the *Electrical Review* of New York, Dr. J. Mount Bleyer, of that city, claims that he has discovered a new composition of glass which admits of the combined generation and transmission of X-rays and bi-ultra-violet rays of the highest quality and quantity in one tube. Dr. Bleyer states that he is not yet prepared to give the exact chemical formula of this glass, because the analysis is not yet ripe for publication. The tube is constructed upon the same principles as any ordinary X-ray tube, except that the main bulb is made entirely of this new glass, and the ends which hold the metallic anode and cathode are made of flint glass and sealed into the main bulb. Experiments are stated to have shown that this type of tube, placed in circuit, gives X-rays and bi-ultra-violet rays a perfectly free passage through its walls in a combined state. The exposure of platino-cyanide or willimite to these rays caused them to exhibit a vivid fluorescence at short or long range, and the application of the electric test to the bi-ultra-violet rays showed their presence in great quantity, Dr. Bleyer remarking that they were the most powerful he had ever witnessed. The colour of both rays viewed in the new tube partakes of a bluish opalescent hue instead of the greenish hue perceived in the ordinary type of tubes. The flint glass which is blown into this new glass tube can be seen, when the tube is generating the rays, to give off the green colour which is the fluorescent property of the flint glass. Dr. Bleyer opines that the new tube will prove a great acquisition to therapeutics. In a footnote he credits Mr. G. J. Monahan, of New York, with the construction of the first tube. The issue of the *Electrical World* of New York dated the 2nd inst, just to hand, contains a letter from the latter stating that it was he who made the discovery some three months ago, and that he exhibited it to Dr. Bleyer. He adds that the tube has no special features, except that it fluoresces blue, and does not absorb or cut off so much of the rays as flint glass is likely to do.

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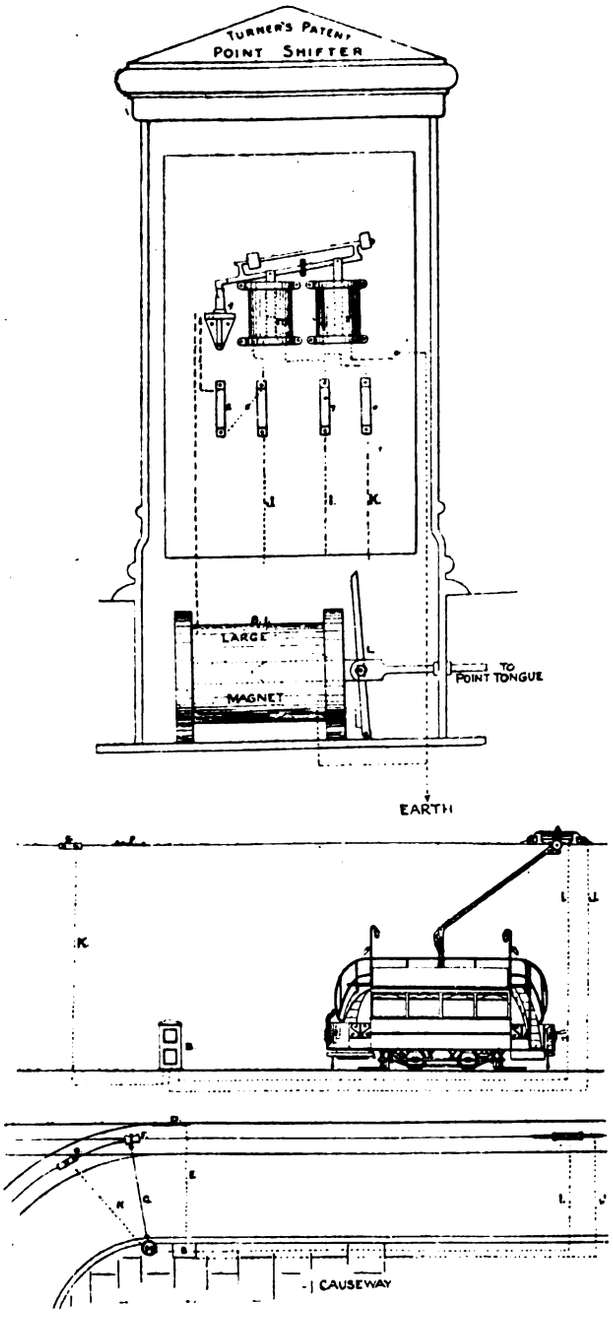
TRADE NOTICES AND NOVELTIES.

Electric Tramway Supplies.

Messrs. S. Dixon and Son, Limited, Swinegate, Leeds, have recently published a well-printed catalogue of their various specialities in the way of electric tramway supplies. An apparatus for automatically controlling the overhead and rail points of electric tramways is illustrated and described as follows: The cast-iron box, B, contains a powerful electro-magnet or solenoid, B 1, wound to suit the line voltage, having a core of suitable size and stroke to pull over both the rail points and that of the overhead wire. The core, B 2, is connected to rail point tongue, D, by rod, E, and also to a lever projecting upwards, L, so that when desirable the points



may be actuated by hand. A flexible steel cable, G, connected to this lever, L, is carried to the overhead point, F, and adjusted so that the necessary movement is obtained at each when the lever is thrown over either by hand or by the electromagnet, B 1. The working of this magnet is controlled by an electrically-operated switch, mounted in the same street box. This switch consists of two electromagnets, M and N, mounted, as shown, side by side, the cores of each being connected to a pivoted lever forming the moving portion of the switch, at one end of which are the switch contacts, which are, however, well insulated from the lever, while at the other end is fixed an adjustable balance weight, so that when the core is attracted into the magnet M the switch is closed, and when attracted into magnet N, opened. The closing of this switch completes the circuit thus: from the overhead trolley wire, by means of cable, J, main fuse, 1, connecting wire, 2, fuse, 3, to switch, 4, to magnet, B 1, to earth or rails, thus causing the core of magnet, B 1, to be attracted and the points pulled over. On the switch being opened the core is released, and the points resume their original position by the tension of a powerful spring. The necessary current for working the magnets, M and N, is derived from the line as follows: At a position some convenient distance short of the rail point a section insulator, A, is fixed on the overhead cable. This insulator is of the pattern known as the "Air-Gap." An insulated cable, J, is connected through the main switch and fuse, 1, to magnet M, from there to the return fuse, 7, back through wire 1 to insulated piece of section insulator, A. A cable, K, is also run from hanging switch, C, to box, B, and on to the switch and fuse and connected to magnet N, and then to the rails. The motorman on nearing a junction, and not wishing to turn on to a branch route, will, on nearing the insulator, A, switch his motor controller off, and coast through the insulator, thereby not interfering with the points in any way. Should he, however, wish to turn on to the branch line, he would, on approaching the section insulator, A, keep his controller on. Current would then flow from the line by means of wire 2 to switch and fuse 1 through magnet M, through return fuse, 7, wire 1, to insulated piece, A, down the trolley to the motor, S, and thence to rails. The large magnet would then become energised by means of the switch, 4, being closed and pull over the points. The car, having passed the points, now comes to the hanging switch, C, and the trolley head, making contact, sends the current through wire, K, to switch and fuse 6 through magnet N, and thence to rails, thus opening switch, 4, and releasing core of magnet B 1, thereby allowing the points to resume their original positions. We understand that the Leeds, Bradford, and Sheffield Corporations have adopted this automatic point shifter after 12 months' trial.

"Stellite" S.D. Telephones.

The Electric and Ordnance Accessories Company, Limited, Stellite Works, Birmingham, are issuing a new catalogue, containing 32 pages, dealing with "Stellite" S.D. telephones, which are claimed to be especially suitable for use with existing electric bells and general short-distance or domestic work. The S.D. telephone in its simplest form consists of a hand set with receiver and transmitter, and fitted with a special speaking key. This key is a very important item, as it obviates the danger of conversations being overheard through the telephone being inadvertently left off the hook. With the Stellite instrument, no matter in what position it is left, it is impossible for any conversation to be transmitted unless the speaking key is depressed. A further advantage is that immediately the hand is removed from the hand set the key automatically breaks the battery circuit, thus preventing the cells unnecessarily running down or wasting. Very concise directions are given for fitting this telephone to any existing bell circuit. The instrument for the kitchen end is similar to that just described, but without the speaking key. It is supplied with a switch hook on wall rosette and a length of flexible twin bell wire for convenient attachment to the bell. The pair of telephones retails at 15s., and should find a ready market. The list shows numerous other patterns, including portable telephones which may be carried from room to room and used wherever a special bell push has previously been fitted, portable table sets, special sets for ringing in either direction, isolation sets, etc. The last-named would appear to be exceedingly useful in any case of emergency where it is desired to establish immediate communication between two rooms, a very likely contingency in the case of contagious disease. Several pages are given up to describing a special intercommunication telephone. The same hand set is used as already described. After a conversation the hand set is hung on the hook, causing the selector to return to its normal position, and the instrument is then ready for a further call. In the table set the bell is fitted at the back of the circular base, and the whole is mounted on a metal pedestal. After a dozen or so diagram connections, several pages are devoted to views of large public buildings recently fitted throughout with the Stellite long-distance telephones, mention being also made of the electrophone transmitter which was used to transmit many of Mr. J. Chamberlain's fiscal reform speeches direct to London.

THE SUPPLY OF ELECTRICITY BILL.

Lord Wolverton's Select Committee of the House of Lords on the 7th inst. resumed consideration of the Supply of Electricity Bill.

Mr. Coward, K.C., on behalf of the London County Council, expressed agreement with most recommendations, but objected to the proposed exemption of the "bulk companies" from the purchase terms of the Electric Lighting Acts. He thought that the fact of these electrical undertakings having been to some extent altered in their character should not be used to the advantage of the companies and to the disadvantage of the local authorities, and in that way upset the statutory bargain which Parliament established in 1882 and 1888. In these Acts of 1882 and 1888 both the date and the terms on which the companies should be purchasable had been clearly enunciated, and the

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companies would have no ground for complaint if at the time specified in the Acts of Parliament they received the amount which it was ordained they should receive, and it did not seem to the Council that it mattered whether that amount was given piecemeal by this or that authority provided they received the amount specified at the time Parliament specified—namely, 1931. Of course, they admitted that it would be impossible in many parts of London for them to purchase electrical energy undertakings self-contained, but, at any rate, they asked that they should not be put in any worse position than they now were in to purchase.

Mr. Pelham, on behalf of the Board of Trade, pointed out that the Bill did not propose to exempt from purchase any company which was now purchasable.

Mr. Coward said his remarks applied to bulk companies supplying in different areas from that in which their generating station was established, and he submitted that, while it was clearly the intention of Parliament that such companies should be purchasable, at present there was no body that could buy them, because they ran into different areas. He hoped the Board of Trade would amend the Bill, so as to remedy what was obviously a defect in it.

Mr. Balfour Browne, K.C., who appeared for 18 electric light companies in favour of the Bill, said Clause 2 enabled the Board of Trade by provisional order to empower the breaking up of any road, tramway, or railway for the purpose of enabling electricity to be brought into an area of supply from a generating station situated outside that area. He thought the veto by local authorities, which had stood in the way of the development both of electric lighting and tramways, ought never to have been given, but at the same time it was most important that everybody interested should be heard by the Board of Trade, as was provided by Clause 6. As to the question of purchase, as applied principally to bulk companies, he contended that the Act of 1888 did not apply. The local authorities wanted to supply power even outside their own districts and become traders in electricity. That was going further than the Acts of 1882 and 1888 contemplated.

Mr. Baggallay, K.C., for the gas companies, objected to the grant of compulsory powers to the electrical companies to purchase land by provisional order, as it would put those companies in a preferential position compared with gas companies.

Lord Robert Cecil, K.C., for the borough councils, objected to the removal of the veto, and urged that the proposal to increase the facilities of competition with the metropolitan boroughs in regard to the supply of electrical power was not justified by any facts which had come to light since the Act of 1888.

The **Chairman** announced that the committee had agreed to pass the preamble of the Bill subject to modifications of the clauses.

The committee subsequently discussed the amendments which have been submitted by the Department itself and by the London County Council, the County Councils' Association, the Association of Municipal Corporations, and other bodies.

On July 11 Clause 3 ("Supply in Bulk") was dealt with.

Mr. Fitzgerald, K.C., moved an amendment, the object of which was to secure that, in regard to the supply of electricity in bulk, a local authority should be in the same position as a company.

Lord H. Cecil, K.C., also had a similar amendment.

Mr. Morse (in the absence of Mr. Balfour Browne, K.C.) opposed the amendment on behalf of the electric lighting companies.

Mr. Hutchinson, on behalf of the Gas Companies' Protection Association, associated himself with the arguments of Mr. Morse.

Mr. Rostron also opposed the amendment for the metropolitan gas companies.

Mr. Pelham, assistant secretary to the Board of Trade, informed the committee that the proposal brought forward by Mr. Fitzgerald was not recommended by the Joint Committee, on whose report this Bill was largely based. In reply to Lord Stanley of Alderley, who asked why it was more dangerous for a local authority to give a supply to a company than to another local authority, he said it would raise difficult issues for a department to decide. It would put upon the Board of Trade the decision of what is and what is not municipal trading, and he preferred to leave that decision to Parliament.

Finally, the **Chairman** said that the committee were of opinion, by four to one, that the amendment must be struck out.

FORTHCOMING EVENTS.

MONDAY, JULY 18.

York Corporation.—At 4 p.m., opening of the extensions of the electricity works.

WEDNESDAY, JULY 20.

Industrial Freedom League.—At 4 p.m., Westminster Palace Hotel. Address by Lord Brassey.

THURSDAY, JULY 21.

Heating and Ventilating Engineers.—(July 21-22). Meeting at Liverpool.

Institution of Mechanical Engineers.—Conversazione.

FRIDAY, JULY 22.

Junior Institution of Engineers.—At 3.15 p.m., visit to Messrs. Bryant and May's factory, Fairfield Works, Bow.

Institution of Mechanical Engineers.—At 11 a.m., general meeting. "Design and Test of a Modern Steam Power Plant," by Mr. E. G. Hillier.

The Institution's Visit to America.—The complete programme has been received from the American Institute, and copies may be had on application to Mr. Lloyd. Particulars will appear in our next issue.

British Association.—At Cambridge, week commencing Aug. 17.

LEGAL INTELLIGENCE.

TRAMCAR OBSTRUCTION.

An appeal from the decision of the Leigh (Lancs.) magistrates came before the Lord Chief Justice, Mr. Justice Kennedy, and Mr. Justice Phillimore last week.

The driver of a cart had, it was alleged, wilfully obstructed a tramcar. The Leigh magistrates refused to convict, and the appeal was from their decision. The cart-driver had insisted on keeping on the left side of the road. At one part of this Leigh line the distance between the tramway and the kerb was insufficient to admit of a vehicle passing between the tramcar and the kerb. The cart-driver might have passed by going to the other side of the road, but instead of doing that he insisted in going on his right side of the road, with the result that both vehicles stood facing each other for about 50 minutes, neither of them giving way. At the end of that period, however, the tramcar backed to the loop.

Counsel contended that the magistrates ought to have convicted under the circumstances.

Counsel on the other side argued that the magistrates could not have found the respondent guilty of wilful obstruction unless the law required that all vehicles should get out of the way of the tramcars in every case, but he submitted that the law did not say so.

Their Lordships were of opinion that the case ought to go back to the magistrates, with the direction that there was no absolute right on the part of the driver of any vehicle to put a tramcar to any amount of inconvenience. But there was a duty on a driver to act reasonably towards the tramcar. On the other hand, the tramcar driver had no right to say he would go on and make the cart cross the road, if by acting reasonably he could avoid putting the driver of the vehicle to this inconvenience.

AN ELECTRIC SHOCK.

At Dudley County Court last week **Mrs. Rose Annie Law** brought an action against the British Electric Traction Company to recover £50 damages for injuries sustained.

Plaintiff stated that on May 16 she travelled from Brierley Hill on an electric car, and when near her home she asked a young man, who was descending from the top deck, to stop the car. For the purpose of assisting her to step off the car she laid hold with her right hand, from which she had removed her glove, of the brass rod in the middle of the step, placed there to assist passengers in boarding and alighting. She immediately experienced an electric shock which rendered her semi-conscious, with the result that on stepping into the road she fell, tearing her costume, which had cost five guineas and was quite new. In consequence of the shock and injuries sustained by the fall she had to keep her bed for over a week, during which she was under medical treatment. She was still suffering from the shock.

It was stated for the defence that directly after the accident the car was examined by a policeman, the motorman, and conductor, but neither could detect that any part of it was "alive" with electricity, and no other passengers complained of having felt any shock. The car was subsequently subjected to several tests, and was found to be perfectly satisfactory. It had been used on many occasions since, but no complaint as to an electric shock had been made by any passenger. It was contended that it was impossible for plaintiff to have experienced a shock in the manner described.

The jury gave a verdict for the plaintiff, awarding her £10.

ELECTRIC TRAMWAYS CONSTRUCTION COMPANY.

The petition of Mr. A. J. Pain for winding up the Electric Tramways Construction and Maintenance Company, Limited, came before Mr. Justice Buckley. The petition had been directed to stand over by Mr. Justice Byrne in March, for 14 days, pending an action by the company being decided for rectification of the register by striking out the petitioning shareholder's name. There had been repeated postponements of the trial of the latter, which was finally set down for trial before Mr. Justice Kekewich on Monday next.

Mr. Wilkinson said that when the case was last mentioned to Mr. Justice Kekewich, Mr. Martelli applied for an adjournment till certain other proceedings, which involved the whole question, had been concluded. It was impossible to complete the evidence, by reason of certain papers being in the custody of the Solicitor to the Treasury for the purpose of the criminal proceedings. On Monday when he (Mr. Wilkinson) brought his motion before Mr. Justice Kekewich, the learned judge intimated that he did not think it would be right to go into the civil proceedings, having regard to the fact that the criminal proceedings were still pending.

After hearing Mr. Martelli and Mr. Ware, all parties assented to the petition standing over till the second petition day next sittings, and in view of the uncertainty of the termination of the criminal prosecution

THE AUTOMATIC TELEPHONE COMPANY (1903).

A summary of accounts and some observations on the affairs of this company, which is in liquidation, have been issued by Mr. G. S. Barnes, senior official receiver and liquidator. A total deficiency of £10,051. 10s. 4d. is disclosed as regards the contributories, after payment of the creditors in full. The assets mainly consist of shares in patents, as to the value of which the official receiver has not at present any definite information. The statement of affairs has been filed by Mr. Max Margowski, the late managing director. Dr. H. G. Sworn, the other director, and Lieutenant E. G. Festing, R.N., the late secretary, have declined to concur in the statement, on the ground that they are not in possession of sufficient information to enable them to express an opinion as to the accuracy of the figures. The official

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receiver adds that certain effects have been sold by auction under an order of Court, but the proceeds, about £500, will not be dealt with until a decision has been given on the validity of a claim made by Mrs. Margowski as mortgagee.

COMPANIES' MEETINGS AND REPORTS

BRITISH ELECTRIC TRACTION.

The eighth ordinary general meeting of the British Electric Traction Company, Limited, was held on Monday at Winchester House, Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman of the Company), presiding.

The **Chairman**, in moving the adoption of the report (which was published in our issue of the 1st inst.), said that the net profit for the past year, before paying interest on the debenture stock, was £249,517, as against £232,836 for the preceding 12 months. The increase in the profits was entirely represented by the increased productiveness of their investments in the associated companies; in fact, this source of their profit was increasing while the other sources of profit were, in the aggregate, diminishing. This was a satisfactory feature, for it was mainly in this direction that they would have to look for their future profits. After paying the interest on debenture stock, the preference dividends, and the interim dividends on the ordinary shares, they had available for further distribution a sum of £78,138. They proposed a further dividend of 6 per cent., making 6 per cent. for the year, and to carry forward the balance of £38,148, which was £13,236 more than last year. The dividend on the ordinary shares was 2 per cent. less than last year, and the reason why the smaller dividend was recommended was that there was a large proportion of capital which had not had time to become revenue earning. It was important to recognise, however, that very decided progress had been made by the Company. They were operating nearly 400 miles of tramway, light railway, and omnibus routes, as against 200 miles five years ago, and were carrying about 220,000,000 passengers per annum, as against 55,000,000 in 1899, and the total traffic receipts were £1,162,000, as against £315,000 in 1899. These figures, although large, did not show the real progress made. The best figure for comparison was to take the number of passengers carried and the receipts per route mile, and this showed how substantial the progress had been. In 1899 they carried per route mile 250,000 passengers, and the receipts were £1,455 per mile. For the past year the passengers numbered 554,000 per route mile, and the receipts were close on £3,000 per route mile. The improvement was largely the result of the adoption of electric traction. In 1899 the majority of the lines were worked by steam and horses, but in 1903 the majority were worked by electricity. The conversion of the lines had involved a large increase in the capital accounts of the associated companies, but the original idea was not only to enormously increase the receipts, but also to reduce the cost of working, and this had been done. The chairman alluded to the important work which had been done during the year in consolidating the Company's various interests in the Birmingham and Midland district. They had now secured an Act of Parliament enabling them to convert the Brighton and Shoreham tramways to electric traction, and to extend them to Worthing, and had obtained a prolonged tenure for 42 years, with a favourable purchase clause. They had also obtained Acts of Parliament enabling them to complete the important network of tramways and light railways in the vicinity of Croydon. They hoped soon to make a commencement with the work of construction. In the case of the Hove and Worthing tramways, they had till 1908 to complete them, and in the case of the Croydon district tramways the period allowed for construction was close upon them in regard to some of the lines, but extended to 1907 in regard to others. The present policy of the directors was to limit, as far as possible, further capital commitments. They were not promoting or entering upon new schemes, but desired to complete what they had undertaken, and he was glad to inform the shareholders that they had made financial arrangements which would enable them to proceed with what they had in hand, so that it would be unnecessary to make any public issue for some time to come.

Mr. Emile Garcke, M.I.E.E., seconded the motion.

The report was unanimously adopted.

On the motion of the **Chairman**, seconded by **Mr C. Shirreff B. Hilton**, the retiring director (Sir Charles W. Freemantle, K.C.B.) was re-elected.

The proceedings terminated with a vote of thanks to the chairman and directors.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The half-yearly meeting was held at the Company's offices, Sir R. G. W. Herbert presiding.

The **Chairman** remarked that the accounts were made up to the end of last year, and there would be no advantage in entering on the consideration of the intermediate position of the Company's accounts at this period. During the half-year they had not been able to announce any important development in their works; they had not made any considerable contracts for the construction or laying of cables, but they had taken advantage of the opportunity afforded by the comparative cessation of work to continue the renovation and readaptation of their factories, and getting everything into very good condition. The whole of the ships of their fleet were in excellent condition, and they were ready for any work that might present itself at very short notice. Having alluded to the progress being made in the pension fund, to which he was glad to say no application had been received as yet, the chairman concluded by moving that a dividend of 5 per cent. for the half-year, making 10 per cent. for the year, be approved of.

This was seconded and carried unanimously.

NEW GENERAL TRACTION.

The general meeting of this Company was held on the 6th inst., Baron d'Erlanger presiding. Particulars of the report were given in last week's issue.

In moving the adoption of the report, the **Chairman** pointed out that the directors were doing everything in their power to reduce expenditure. The total saving to be effected from June this year would amount to over £800 in management charges. While the directors could in certain limited measure reduce expenditure, they were powerless to accelerate the Company's source of revenue, which was dependent upon the receipts and dividends paid by the companies in which their capital was invested. There was a slight increase in the dividends received for 1903 compared with those for 1902, and, judging by the gross receipts to date of the Coventry, the Philadelphia, and the Norwich tramways, they were led to believe that a further slight improvement would be shown for the year 1904. It was only, however, in a couple of years' time that they would be able to draw accurate conclusions of the earning capacity of the Philadelphia line and of the altered tramway system of Coventry. For some time they could not expect the revenues of the Traction Company to cover the latter's full fixed charges. Recent cables from Philadelphia advised them that at last the entire system had been connected up, and that the cars were to be running over it this week. They had spent £3,000 upon the system since the date of the balance-sheet, and they would have to spend another £4 000 on street paving and various items. Additional cars would have to be provided, and if the traffic at all responded to their hopes, the power station would require further extension. Underground lines were now in construction, which, when complete, would give a certain strategical importance to the line. The £60,000 subscribed on the prior lien bonds had been taken entirely by the directors and their friends, and the Board would probably invite tenders from the shareholders for the remaining prior lien bonds.

The motion was carried.

ELECTRIC AND GENERAL INVESTMENT.

The ordinary general meeting was held on the 6th inst. at Winchester House.

Mr. G. Herring presided, and, in moving the adoption of the report and accounts (particulars of which appeared in our issue of the 24th ult.), stated that the net profit for the year amounted to £15,804, and out of this the directors recommended a further dividend of 1s. per share, making, with the interim dividend already paid, a total of 10 per cent. for the year. This would absorb £1,000, and, in view of the market depreciation of the investments held by the Company, they had decided to place £5,813 to the reserve fund. Although the dividend of 10 per cent. was smaller than that paid in previous years, he reminded the shareholders that for every £1 share held by them they had received in dividends the sum of £3. 18s. 1d.

The motion was carried unanimously.

METROPOLITAN ELECTRIC SUPPLY.

An extraordinary general meeting of this Company is called for Tuesday next, when the distribution of the purchase money received from the Borough Council of St. Marylebone is to be considered. A bonus at the rate of £6 per £10 share is to be proposed, and also an honorarium to the directors. At the same time the chairman will explain the views of the Board as to the best method of dealing with the balance of the purchase money.

CHILI TELEPHONE.

The report states that the aggregate number of subscribers at all centres at the end of the year was 5,814, as compared with 5,371 at the beginning, or a gain of 443 for the year. The gross revenue in Chili from all sources was 916,542dol., against 841,193dol. in 1902-1903, and the expenditure in Chili was 422,409dol., against 401,519dol., leaving the net income from all sources of 494,133dol., against 439,674dol. The average rate of exchange for the year was 16·36d., as compared with 15·68d. in the previous year. The balance to the credit of the revenue account, including £2,637 brought from the previous year, is £31,207, of which £14,010 has been carried to reserve for renewal of plant, etc. An interim dividend of 3s. per share, less income tax, was paid on Jan. 14 last, and the directors now recommend a final dividend of 4s. per share, less income tax, making 7 per cent. for the year, and leaving a balance of £2,502 to be carried forward. Of the debentures which matured on March 31 this year, £21,000 has been paid off, and arrangements have been made to extend the remainder, amounting to £35,000, until such time as the finances of the Company will permit of their being also paid off.

EDMUNDSON'S ELECTRICITY.

The report for the year ended March 31 last, to be presented at the meeting on the 21st inst., states that, including £11,734 brought forward from last year, the net profit, after payment of debenture and other interest, amounts to £64,406. After deducting dividends on preference shares paid and accrued, and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares, there remains a balance of £40,111. The directors recommend a final dividend on the ordinary shares at the rate of 9 per cent. per annum, making 7 per cent. for the year; to be written off goodwill account £5,000, added to reserve fund £5,437, and carried forward £13,923. During the year 20,000 preference shares, 20,000 ordinary shares, and £92,196 debenture stock have been issued. The premiums received in respect

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of these issues, less expenses, amount to £24,562, and have been added to the reserve fund, which, with the contribution proposed to be made from revenue account, will be thereby increased to £70,000. The large increase in the capital has been necessary for the completion of central stations in new towns and large extensions to many of the older works, and will bear fruit in due course in the form of increased revenue.

NATIONAL TELEPHONE.

The report for the half-year ended June 30 last, to be presented at the meeting on 22nd inst., states that the income accrued in respect of the business of the half-year amounts to £984,600, an increase of £90,017. Working expenses for the half-year amounted to £567,072, an increase of £57,658. The net result for the half-year (after deducting the Post Office royalties, amounting to £90,703) is a profit balance of £326,825, an increase of £23,668. The rentals carried forward for unexpired terms of running contracts amount to £937,297, an increase of £62,913. Out of an available balance of £258,286 the directors recommend a dividend at the rate of 6 per cent. per annum on the preferred stock and 5 per cent. per annum on the deferred stock, transferring £100,000 to reserve fund and carrying forward £9,370. The sum of £394,654 has been expended on capital account during the half-year in the erection of 19,615 additional exchange and private stations and in the construction of underground works.

ELECTRICAL POWER STORAGE.

The profit for the year to May 31 last, including the balance of £594 brought forward, is £10,360. Out of this sum the directors have carried £3,500 to the reserve fund and £1,000 to the contingent fund. They recommend again the payment of a dividend of 6 per cent. on the ordinary share capital, which will absorb a further £5,389, and leave £470 to be carried forward. The buildings, plant, tools, etc., have been maintained in thorough repair and condition at a cost of £4,297, which sum has been provided out of revenue. The Company's products continue to give satisfaction to its customers, the volume of orders increasing steadily year by year.

NEW COMPANIES REGISTERED.

R. H. Longbotham and Co., Limited.—Capital, £10,000. Objects: to acquire and carry on the business of R. H. Longbotham at Ings Foundry, Wakefield, and at Newcastle-on-Tyne, as R. H. Longbotham and Co.; to manufacture and deal in machinery, implements, rolling-stock, instruments, tools, apparatus, and hardware of all kinds; and to carry on the business of electrical and mechanical engineers, etc. Registered office: Ings Foundry, Ings-road, Wakefield.

Hunter Electric Candle Lamp Company.—Capital, £800. Objects: to acquire certain inventions relating to electric incandescent lamps and fittings, and letters patent and benefit of application relating thereto; to adopt agreements with N. Burt and Co. and C. C. Regnart; and to carry on the business of manufacturers of and dealers in electric candle lamps and fittings, etc. Registered office: 17, Newman-street, Oxford-street, W.

Kingsbridge and South Devon Electric Lighting and Traction Company, Limited.—Capital, £2,000. Objects: to carry on at Kingsbridge, Salcombe, and elsewhere in Devonshire, the business of an electric lighting and power company in all its branches, and to construct, fix, and maintain any necessary generating stations, cables, wires, lines, accumulators, lamps, works, and conveniences, etc. Registered office: 25, Victoria-street, S.W.

Dean and Burden Bros., Limited.—Capital, £3,800. Object: to acquire the business of motor manufacturers and engineers carried on at Friary-lane, Salisbury, as Burden Bros., and to carry on the business of engineers, manufacturers of motors of all kinds, etc. Registered office: Friary-lane, St. Aun-street, Salisbury.

APPOINTMENTS VACANT.

Rolling-Stock Superintendent, London County Council Tramways Department. Salary, £400 per annum. Applications by 10 a.m. on July 16.

Resident Engineer, Mains Superintendent, and an Installation Inspector, a Meter Superintendent, and an Accountant, St. Marylebone Electricity Department. Applications by 3 p.m. on July 20. See advertisement in last issue.

Clerk of Works, Handsworth, Birmingham, during the erection of the electric supply station. Salary will be 3½ guineas per week. Applications to the Clerk by noon on July 19.

Electrical Engineer, as test-room assistant in large Midland factory. Apply, Box No. W 9, *Electrical Engineer* Office. See advertisement.

Storekeeper, Carliale Electricity Works. Wages, 25s. per week. Applications by July 25.

Mains Assistant, West Ham Electricity Works. Salary, £2. 5s. per week.

New Issue.—The list of subscriptions for the issue of 46,600 ordinary shares of £5 each at par by the Electric Supply Corporation, Limited, will close to-day.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Worksop.—Tenders are to be obtained for cables, etc., for mains, and additional feeder, estimated at £1,000.

Rhyl.—The Urban District Council invite tenders for 1,400 yards of ·2 concentric feeder cable. Tenders by 18th inst.

Murcia.—The Post and Telegraph Department, Madrid, require tenders for an urban telephone system at El Dano del Beal. Tenders by 27th inst.

Belmez (Spain).—The Municipality require tenders for electric lighting by 20th inst. Particulars from Secretary to the Ayuntamiento, Belmez (Cordoba), Spain.

Batley.—The Corporation invite tenders for one 350-kw. steam dynamo and switchboard extension for same. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by July 16.

Keighley.—The Corporation invite tenders for machine tools for the workshop at the car depôt in South-street. Particulars may be obtained from Mr. J. M. Smyth, Electricity Works, Keighley. Tenders by July 18.

Plymouth.—The Education Authority invite tenders for electric light installation at the Municipal Technical School. Specifications, etc., can be seen at 11, The Crescent, Plymouth. Tenders by 12 noon on 21st inst.

Bromley.—The Council invite tenders for the provision of a 15-kw. electric light installation at the refuse destructor works. Specifications, etc., may be obtained at the office of the Borough Engineer. Tenders by 3 p.m. on July 26.

Stockport.—The Gas and Electricity Committee invite tenders for supply of 3in. and 4in. cast-iron mains and for irregulars from 3in. to 4in. Specifications, etc., can be obtained from the engineer, Mr. S. Meunier. Tenders by July 20.

Devonport (Tasmania).—The Town Board invite tenders for the supply and delivery of alternatively 50 or 100 smallest-size meters to read direct in B.O.T. units on 220-volt direct-current circuits. See advertisement in former issue.

Glasgow.—The Trustees of the Clyde Navigation invite tenders for two electric 32-ton coaling hoists for Clydebank Dock. Specification, etc., may be obtained from Mr. Geo. H. Baxter, 16, Robertson-street, Glasgow. Tenders by noon on July 25.

Whitby.—The Urban District Council invite tenders for (a) distributor and street-lighting cables; (b) network and service-boxes. Specifications, etc., may be obtained from Mr. H. S. King, electrical engineer. Tenders by 10 a.m. on July 18.

Walthamstow.—The Urban District Council invite tenders for supply, delivery, and laying cables, troughing boxes, etc. Specifications, etc., may be obtained from Mr. J. Enright, 68, Lincoln's-inn-fields, W.C. Tenders by 5 p.m. on July 22.

Rochdale.—The Electricity Committee invite tenders for erection of the buildings in connection with the extension of the engine-room. Particulars may be obtained from Mr. C. C. Atchison, Electricity Works, Rochdale. Tenders by noon on July 18.

Preston (Lancs.).—The Corporation invite tenders for supply and delivery at their power station of machine tools. Specifications, etc., may be obtained from Mr. Walter H. Tittensor, Tramway Power Station, Holmrook-road, Preston. Tenders by July 18.

Suakim.—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

Dartford (Kent).—The Metropolitan Asylums Board invite tenders for installation of fire-alarms at Darenth Asylum, Dartford. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C., on and after 9th inst. Tenders by 10 a.m. on 20th inst.

Hackney.—The Guardians invite tenders for fitting up a system of electric fire-alarm bells at their Homerton establishments. Specification, etc., can be obtained from Mr. Frank R. Coles, Clerk's Offices, Sidney-road, Homerton, N.E. Tenders by 2 p.m. on July 27.

Wimbledon.—The Urban District Council invite tenders for extensions to the present refuse destructors at their electricity works. Particulars may be obtained from the Engineer and Surveyor to the Council, Council Offices, Wimbledon. Tenders by 10 a.m. on 25th inst.

Ashton-under-Lyne.—The Guardians invite tenders for the supply and fixing of telephones at new hospitals and nurses' home at the union. Specifications, etc., may be obtained at the office of Messrs. J. Eaton and Son, Stamford-street, Ashton-under-Lyne. Tenders by July 20.

Plymouth.—The Corporation invite tenders for (25) steam alternator, etc.; (26) Lancashire boilers, with mechanical stokers; steam, exhaust, and other piping; ejector, condenser, valves, etc. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by Aug. 15.

Aston Manor.—The Corporation invite tenders for the supply, delivery, and erection complete of pipework, etc. Specifications, etc., may be obtained from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on July 28. See advertisement in former issue.

Homerton.—The Metropolitan Asylums Board invite tenders for installation of telephones at the Eastern Hospital, Homerton, N.E., and Western Hospital, Fulham, S.W. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C., on and after 9th inst. Tenders by 10 a.m. on 20th inst.

Radcliffe.—The Urban District Council invite tenders for the construction of permanent-way, including copper bonding, of about 5 miles

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1 furlong of route length line, being 6½ miles single line with passing places. Specifications, etc., may be obtained from Mr. W. L. Rothwell, engineer to the Council. Tenders by 16th inst.

Wigan.—The Corporation invite tenders for (1) hand reversible three-wire battery, booster, and switchboard; (2) compound-wound double-field balancer; (3) cables. Specifications, etc., may be obtained from Mr. J. Slevin, borough electrical and tramway engineer, Bradford-place, Wigan. Tenders by 12 noon on July 19.

St. Pancras.—The Borough Council invite tenders for the supply and erection of main switchboard at the King's-road power-house, Camden Town, N.W. Specifications, etc., may be obtained at the offices of the Electricity Department, 57, Pratt-street, N.W. Tenders by 12 noon on July 19. See advertisement in former issue.

Manchester.—The Tramways Committee invite tenders for the supply of the following: (a) 350 steel tramway poles; (b) 20 miles of hard-drawn copper trolley wire; (c) 6,000 yards of 2in. steam tube, together with the necessary fittings. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders by 5 p.m. on July 18.

Dartford.—The Urban District Council invite tenders for carrying out an extension of underground and pilot cables drawn into existing spareways, and for the laying of private and public lighting cables, together with all necessary roadwork, junction boxes, etc. Specifications, etc., may be obtained from Mr. W. Kay, clerk to the Council. Tenders by 12 noon on the 19th inst. See advertisement in former issue.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the Electricity Works, Rochdale, Lancashire, of two steam turbines direct connected to two 3-phase alternators, or alternatively for alternators connected to high-speed triple-expansion engines (Contract No. 7); and also for one motor-driven 3-phase alternator (Contract No. 8). Specifications, etc., may be obtained at the offices of Messrs. Lacey, Siller, and Leigh, 2, Queen Anne's-gate, Westminster. Tenders by July 18. See advertisement in former issue.

Lerida, etc. (Spain).—The *Gaceta de Madrid* of June 22 contains notices calling for tenders for the construction and working of telephone systems in Lérida and in El Llano del Beal, in the province of Murcia. In each case tenders are to be presented either to the Dirección-General of Telegraphs, 10, Calle de Carretas, Madrid, or at certain local offices within 30 days of publication of the notice in the *Gaceta*. In each case the concessionaire will have to pay to the State 10 per cent. of all receipts; the maximum period of the concession will be for 20 years, and the adjudication will turn on the reduction of this period. A provisional deposit of 2,000 pesetas (or about £57) is required in the case of the Lérida telephone service, and of 500 pesetas (or about £15) in the case of the El Llano del Beal telephone service.

Berga, etc. (Spain).—The *Gaceta de Madrid* for June 26 publishes a Royal decree calling for tenders for the installation and working of a telephone system and central stations at Berga and sub-stations at Gironalla, Puigreig, Balsareny, Sallent, Castelladral y Cardona. Tenders will be received within 30 days' date of publication at the office of the Dirección-General of Posts and Telegraphs, 10, Calle de Carretas, and at the office of the Civil Governor, Barcelona, a provisional deposit of 2,000 pesetas (or about £57) being required from persons tendering. The maximum period for the concession is for 20 years, and the adjudication of tenders will turn on the reduction of this period. The *Gacetas* may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between 10 a.m. and 5 p.m. (Saturdays 10 a.m. to 1 p.m).

Reichenberg (Austria-Hungary).—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

RESULTS OF TENDERS.

Batley.—The contract for steam-piping and superheater for the electric lighting station has been let to J. Spencer, Limited, Wednesbury.

Dover.—The Corporation have accepted the tender of G. Lewis and Sons, Dover, at £1,222. 10s., for additions to Corporation electricity works.

Radcliffe (Lancs.).—The Urban District Council have accepted the tender of Ferranti Limited, Hollinwood, Manchester, for the supply of direct-current electricity meters.

Southport.—The following tenders have been accepted: Procter and Co., stoker, £73; Dick, Kerr, and Co., 200-kw. alternator, £608. 10s.; Bellias-Morcom, alternators, £41. 9s..

Stepney.—The Borough Council have accepted the tender of the Electric Motor Supply Company, Nottingham, at £237. 8s., for wiring and fitting the Whitechapel public baths for the electric light.

Croydon.—The Electricity Committee recommend for acceptance the tender of Babcock and Wilcox, at £997, for supply of materials and erection of steam-pipe in connection with extensions at the electricity station.

Colchester.—The Council have accepted the tender of Davey, Paxman, and Co. to supply one Peache 550-h.p. engine for £1,320; and Henley's Telegraph Works Company for cables for main extensions at £1,360. 10s.

Exeter.—The Electric Lighting Committee have recommended the acceptance of the tender of the British Westinghouse Company to erect a reciprocating engine for generating the tramway supply for £2,260, which is the lowest in its class.

Exeter.—The Corporation have accepted the tender of the British Westinghouse Electric Company, London and Manchester, at £2,260, for one 200-kw. triple-expansion engine and traction generator, with condenser steam, exhaust, circulating water pipes, etc., or, alternatively, one 200-kw. steam turbo-generator, with condenser, pipes, etc.

Warrington.—The Town Council have accepted the following tenders: J. A. Ewart, at £2,935. 15s. 8d., for the construction of the permanent way of light railway No. 1 from Stafford-road to Victoria-square, Stockton Heath; Babcock and Wilcox, at £957, for the supply of four mechanical stokers; and that of Bell Bros., at £450, for the supply of water-softening plant.

Derby.—The following tenders have been accepted: Rawlinson and Sons, at £19. 15s., for the supply of a telescopic trimming ladder; C. Potter, at £12. 10s., for painting the engine-room at the electric lighting station; E. Buxton, at 5s. per post, for painting the street electric light lamp-posts; Radford and Greaves, at £30. 10s., for the construction of an underground transformer chamber; Derby Coal Company, T. and G. Walker, and G. L. White for coal.

London.—The London County Council Education Committee have received the following tenders for installation of electric light, etc., at the Poplar Technical Institute:

Alliance Electrical Company, 137, Regent-street, W.*	£666
Electrical and General Engineering Company, 17, Gracechurch-street, E.C.	718
Wenham and Waters	770
Drake and Gorham, 66, Victoria-street, S.W.	787
J. H. Holmes and Co., 17, Soho-square, W.C.	790
Mossop and Co., 52, Queen Victoria-street, E.C.	940
Peacock and Jessop, 329, Goldhawk-road, W.	950

* Recommended for acceptance.

Loughborough.—The Town Council have received the following tenders for the five steel roof principals required for the boiler-house at the electricity station:

W. Hayward and Sons, Wolverhampton	£184	0	0
A. Faulks, Loughborough	171	0	0
Drew-Beer and Co., Westminster *	138	15	0

* Accepted, plus £25 on agreement to complete work in five weeks.

Switchboard.

J. G. Statter and Co., Birmingham	469	0	0
J. E. Spagnoletti and Co., London	470	0	0
Electrical Press Supply, Limited, Birmingham	500	0	0
Electrical and Ordnance Accessories Company, Birmingham	510	0	0
Johnson and Phillips, Old Charlton, Kent	560	0	0
Dorman and Smith, Salford	580	0	0
General Electric Company, London	592	0	0
Ferranti Limited, Hollinwood (accepted)	596	0	0
Consolidated Electrical Company, Canonbury	596	0	0
Cowans Limited, Salford	609	0	0
Electrical Company, London	640	0	0
Crompton and Co., London	645	0	0
Siemens Bros. and Co., Westminster	660	0	0
Brush Electrical Engineering Company, Loughborough	665	0	0
Kelvin and White, Glasgow	673	0	0
J. Fowler and Co., Leeds	696	0	0
Electric Construction Company, Wolverhampton	823	0	0
British Westinghouse Electric and Manufacturing Company, Manchester	1,090	0	0

Piping, feed pumps, tanks, etc.

Aiton and Co., Willesden Junction	595	0	0
E. Le Bas and Co., London	620	0	0
J. Spencer, Limited, Wednesbury (accepted)	627	10	0
Clarke, Chapman, and Co., Gateshead-on-Tyne (Hopkins's valves £50 extra)	705	0	0
R. W. Blackwell and Co, London	745	0	0
Babcock and Wilcox, London	820	0	0
Blake-Knowles Steam Pump Works, London	843	0	0
Sir Hiram Maxim's Electrical and Engineering Company, Westminster	880	0	0

Electric cables.

W. T. Henley's Telegraph Works Company, London—maintenance 1½ per cent. (accepted)	6,515	2	5
Western Electric Company, North Woolwich—1 per cent.	6,563	14	10
British Insulated and Helsby Cables, Limited, Prescot—1½ per cent.	6,698	4	5
St. Helens Cable Company, Warrington—2½ per cent.	6,701	11	9
Callender's Cable and Construction Company, London—1½ per cent.	6,942	9	10
W. T. Glover and Co., Manchester—2 per cent.	6,996	6	2
Siemens Bros. and Co.—1 per cent.	7,212	10	0

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Stourbridge.—The Urban District Council have received the following tenders for the supply and laying of electric mains:

Midland Electric Corporation for Power Distribution, Wolverhampton	£1,136	19	11
British Insulated and Helsby Cables, Prescot *	1,136	19	11
W. T. Glover and Co., Trafford Park	1,170	2	3
Siemens Bros. and Co., London	1,176	16	6
Callender and Co., London	1,197	6	10
W. T. Henley and Co., London	1,200	5	2
Western Electric Company	1,215	5	6
St. Helens Cable Company	1,239	14	4
Johnson and Phillips	1,283	0	0

* Recommended for acceptance.

Swindon.—The following tenders have been recommended for acceptance: Frisby and Stubbs, Liverpool, for advertising on the tramcars for a period of three years, at £30 per car per annum, and on the tramway time-tables for a period of three years, at £6 per annum; A. E. Bromley, London, for advertising on the tramway tickets for a period of three years, at £7. 10s. per half million tickets; Glasgow Numerical Printing Company, Glasgow, for the supply of the tramway tickets for a period of three years, at 3½d. per 1,000 tickets; Ticket Register and Punch Company, for letting on hire the ticket punches at 15s. each, with the option of purchasing the same at the end of 12 months at £4 each. The tender of Dick, Kerr, and Co.'s motors for the tramcars has been accepted subject to a three years' guarantee being given, instead of a one year's guarantee as provided in the specification.

BUSINESS NOTES.

TRACTION.

Paisley.—The company's line from Paisley Cross to Johnstone has been opened.

Leicester.—The Narborough-road, Hinckley-road, and Fosse routes have been opened.

Tarperley.—A meeting of the inhabitants have pledged themselves to support the light railway scheme.

Southend.—The Board of Trade have confirmed the Southend-on-Sea and District Light Railways (Extensions) Order, 1904.

Light Railways Act.—The Light Railways Bill, introduced by Lord Wolverton, was last Friday read a third time in the House of Lords and passed.

Halifax.—The Town Council have instructed the borough engineer to commence the construction of the line from Brighouse to Bailiffe Bridge at an estimated cost of £12,746.

Tientsin.—It is stated that the Compagnie Internationale de l'Orient has obtained a concession from the Chinese Government permitting it to instal electric street car lines and electric lighting.

Batley.—The Corporation have decided to communicate with the British Electric Traction Company with a view to ascertaining what the company are doing in reference to the Bradford-road tramways.

Tyneside Tramways Co.—The company's traffic returns for the week ending July 6 were £381. 3s. 8d., this amount showing an increase compared with the corresponding period of last year of £67. 1s. 4d.

Lancaster.—The receipts for the past year up to March last amounted to £4 184, the total revenue being £4,687. The working expenditure totalled £4.653, and the interest and debt redemption charge £2,867, making £7,520. This leaves a deficit of £2,833.

Darlington.—The report of the Electric Lighting and Tramways Committee, remarking upon the fairly favourable results of the tramway working, the system having been gradually brought into operation during the past month, was adopted at the last meeting of the Town Council.

Parliamentary Bills.—In the House of Lords on Wednesday the Charing Cross, Euston, and Hampstead Railway Bill was read a third time. In the Commons the Bristol Tramways (Extensions) Bill and the Manchester Corporation Tramways Bill were read a second time.

Croydon.—At the last meeting of the Corporation the Tramways Committee presented a report recommending that several additional extensions be provided for in the Bill about to be promoted by the Corporation. Ultimately it was decided only to include a route along Grange-road.

Swindon.—A 200-kw. set for the new tramways has been installed, and is ready for supplying current for working the service. This set will be capable of supplying current not only for the seven cars now about to be delivered, but will be sufficient to supply current for 12 or 13 cars if required.

Warrington.—At a meeting of the Town Council, a discussion arose as to the mechanical stokers ordered by the Tramways Committee, on the recommendation of the engineer, certain members criticising a statement that the mechanical stokers were economical. Ultimately the action of the committee was confirmed.

Workington.—The Town Council have decided to ask the Whitehaven Town Council and the Maryport and Cleator Moor Urban Councils to discuss the question of forming a joint committee to consider the advisability of jointly taking over the parliamentary powers of the West Cumberland Tramways Company.

Ayr.—An enquiry under the Private Legislation Procedure (Scotland) Act into the Ayr Corporation tramways draft provisional order, was held at Glasgow on Saturday. The Commissioners found the preamble proved on condition that work A be confined to a loop line. They refused the powers asked under Section 23 to run omnibuses.

Derby.—A trial trip was made on Monday on the Osmaston-road section. The result is reported to have been fairly satisfactory. It is stated that another effort is being made to float the Derby and Ashbourne light railway scheme, the powers for which will expire under the Board of Trade license if they are not utilised within the next few months.

Lincoln.—At a meeting of the City Council, it was stated that the Electricity Works Committee had taken over the undertaking of the Lincoln Tramways Company. After full consideration of the matter, the committee had decided that it would be too expensive to make temporary arrangements for carrying on the traffic while the tramways were being converted.

Airdrie.—The Town Council have arranged with the Airdrie and Coatbridge Tramway Company for lowering certain footpaths to harmonise with the previous lowering of the road, in accordance with arrangements with the company, to enable the latter to carry out the suggestions of the Board of Trade, and to run double-decked cars, the expense of the lowering to be borne by the company.

Bradford.—At Tuesday's meeting of the Corporation a resolution was submitted that application be made to the Board of Trade for sanction to borrow the amount required for the construction by the Corporation of the Baildon section of the Mid-Yorkshire tramways. The cars last week beat their record for Saturday and weekly receipts. On Saturday £1,280 was taken, and the week's receipts totalled £4,965.

Stockport.—The Hazel Grove Urban District Council have approved heads of an agreement with the Corporation, leasing the tramways to the latter in the event of their purchasing the company's undertaking. It is reported that the company have decided to run a service of motor 'buses to Hazel Grove, the negotiations with the Corporation having, apparently, been abortive. It is also stated that a rival company is to be formed for the same purpose.

Bootle.—At a meeting of the Highways Committee a letter was read from the town clerk of Liverpool, requesting the construction of tramways in Breeze-hill and Merton-road to connect with Stanley-road and Strand-road lines to the north docks; or, alternatively, the construction of lines in Breeze-hill and Balliol-road to Regent-road, and offering to construct and maintain the portion of Balliol-road over the old quarry. The town clerk was instructed to reply that the proposals could not be accepted.

Tees-side.—The Stockton Town Council have accepted the offer of the Imperial Tramways Company to pay the Council £200 per annum for 25 years in respect of every route mile of tramway owned or worked by the company within the borough, the Council to withdraw the petition against the company's Bill. At a meeting of the Middlesbrough Town Council it was resolved to reject the agreement submitted by the company. The Bill will therefore be opposed in the House of Lords by the Middlesbrough Corporation.

Electric Traction Co.—The dissolution is announced of this company, the syndicate which promoted the Central London Railway. The holders of the ordinary £10 shares obtain under the winding-up an allotment of Central London debenture stock equivalent to £17. 5s. for every £10 share held in the syndicate. The holders of the £1 deferred shares get £43 per share. It is understood that there will be a further distribution of £1 on the ordinary shares and £7 on the deferred. There are 29,880 ordinary shares and 1,200 deferred.

West Riding Tramways Bill.—This Bill came before Mr. J. W. Lowther, chairman of committees, in the House of Commons last week as an unopposed measure. It has already passed the House of Lords. Its object is to authorise the Wakefield and District Light Railway Company to construct a tramroad and other works in the West Riding. The Bill authorises the company to raise an additional £165,000, and empowers them to borrow £55,000 of this sum. Formal proofs were given, and the Bill was ordered to be reported for third reading.

Dukinfield.—At the last meeting of the Town Council, it was stated, in reply to several questions, that the current for all the cars running between Stalybridge and Hyde and Dukinfield to Throstle Bank was obtained through the Dukinfield sub-station. The sub-station was really doing more work then it should do. The Joint Board desired that the motormen should gain more experience in the command of the cars before they put them upon Crescent-road. It was expected that cars would be run to Mossley and Millbrook in about a fortnight.

Birmingham.—At last week's meeting of the Corporation the scheme for extending the tramway system, of which we recently gave particulars, was adopted practically in the form prepared by the Tramways Committee, who were instructed to draft an empowering Bill. A suggestion was made that a line should be constructed from Bristol-road to Mosely-road, and the chairman of the committee promised that the matter should have consideration, but added that he scarcely regarded the proposal seriously, as it would entail the widening of the railway bridge at Camp Hill.

Yarmouth.—The following recommendation of the Tramways Committee was adopted at Tuesday's meeting of the Town Council: "That on receipt of the Royal assent to the Corporation Bill now before Parliament, the Council instruct the borough surveyor to at once submit the necessary plans to the Board of Trade for their assent, and that immediately on their approval the work of constructing the tramway in Blackfriars-road from St. Peter's-road to Queen's-road be proceeded with, so as to ensure the completion of that section of the tramway before the commencement of the fishing season, at a cost of £2,200, in addition to the rails already in stock."

Wigan.—The minutes of the Tramway Committee, confirmed at the last meeting of the Town Council, stated that the Pemberton and Platt Bridge routes would be in use again in a few days, and that

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they would be ready to run on the Pemberton section as soon as the Pemberton Council had finished their work. They had been constantly in negotiation with the Hindley District Council for running powers in regard to the short length in their district—namely, from Amberswood Common—but their demands were such that the committee could not agree to them, as they were absolutely unreasonable, and the committee had decided to run the cars in that district as far as the boundary of Ince, which would be Amberswood Hotel.

North Wales Electric Power and Traction Co.—The 10,000-h.p. hydraulic station is now well under way, and 18 miles of new railway line are in course of construction. The pipe line and dam works are in full swing, and it is expected that current will be ready by the end of the year. A considerable portion of the 10,000 h.p. to form the first installation has been already booked. The whole contract, including the supply of six 1,000-kw., 10,000-volt turbo-alternators, 10 250-h.p. locomotives, the whole of the rolling-stock for the new line, the complete erection of the hydraulic works, transformer stations, and over 100 miles of high-tension transmission lines, is being proceeded with by the sole contractors, Messrs. Bruce Peebles and Co., Limited.

Rhondda.—At the meeting of the District Council the Legal and Parliamentary Committee reported the completion of the purchase of that portion of the Pontypridd and Rhondda tramways situated within the district of the Council, and that a letter from Mr. G. E. Morewood, 23, Leadenhall-street, London, had been considered respecting the leasing of the tramways. The committee had replied that the Council would be prepared to receive offers for the grant of a lease of the Council's rights on the basis of a term of 42 years, the lease to contain a proviso that in the event of the Council repurchasing the system it should be treated as a going concern, and asking Mr. Morewood to submit alternative terms for the grant of a lease for a similar period, leaving the Council's statutory rights of purchase unaffected.

Ashton and Stalybridge Tramway Deadlock.—There are indications of a settlement of the deadlock in the through running of the Ashton and Stalybridge electric cars. At a meeting of the Stalybridge Joint Electricity Board last week it was resolved that the sub-committee meet the Ashton Tramway Sub-Committee to discuss the situation, but that they be not empowered to finally settle matters. They are to report to the Joint Board, which will give its final decision. The chairman of the Ashton Tramway Committee expressed himself as highly gratified at the turn of events. He was extremely desirous of bringing about a settlement, and should do all he could towards that end. One ticket only would be required for each through passenger, the destination being indicated by punching. Through tickets could, of course, be apportioned, each authority having equal length of track.

Bury.—At a special meeting of the Tramways Committee the town clerk read a letter from the town clerk of Salford submitting proposals for the granting to Salford of running powers on portions of the Bury and Radcliffe tramways, and various other suggestions, as the result of interviews which the chairman, the manager, and himself had had with the chairman of the Salford Tramways Committee, their town clerk, and manager, and it was resolved that the consideration of the matter be deferred. The system adopted by this committee on April 29 last in connection with the reduced fares for workpeople—whereby any passenger desiring to travel at such rates was required to fill up an application form stating place and nature of employment—has been discontinued. A suggestion that ½d. fares should be adopted was rejected, it being considered that it would be premature to introduce such an arrangement. It is expected that the Manchester-road section will be finished within two or three days.

Huddersfield.—The extension of the Longwood section was opened last week. Huddersfield, the pioneer of tramway municipalisation, is also first in the field amongst the municipalities of the country in the matter of supplying motor power for the haulage of coal. Some time ago the Tramways Committee were approached by a company at Lindley with the object of securing a light railway service to carry coal from the Hillhouse railway siding to the works of the company at Lindley, a distance of some three miles. A seven years' agreement for the Corporation to carry all the company's coal was entered into, and the work of constructing the necessary permanent way to connect the two points was commenced. That in the company's mill yard has been finished, and it is expected that the whole of the work will be completed in a few weeks. The Tramways Committee will restrict the hours of haulage to slack hours in the morning passenger traffic, and none will be carried in the afternoon. It is considered probable that other large consumers of coal will enter into arrangements with the Corporation for a similar service.

Leeds.—The Committee of the House of Commons, Mr. Heywood Johnstone presiding, gave their decision on the clauses of the Corporation's Bill relating to tramways on Tuesday. The committee gave the Corporation power to carry animals, goods, and other things on the existing tramways of the Corporation. Regarding Clause 102, which proposed that the Corporation should be in a position to make agreements with adjoining authorities to work tramways, the clause was granted to the extent of giving the Corporation power to enter into such agreements, but without purporting to give that power to other persons, companies, or local authorities. This decision, however, would not affect the Horsforth case. The York-road extension has been opened. It is hoped to have the extension along Belle Vue-road and Moorland-road to Hyde Park ready by the 25th inst. Proposals are on foot for the running of lines through Bramley to Rodley, and to the boundary on Whitehall-road, thus placing Drighlington in touch with the city. Arrangements are being made for the adoption of a system of high-tension transmission.

Wolverhampton.—The report for the year ending March 31 shows that the section operated by horse traction resulted in a loss, after allowing for interest, sinking fund, and depreciation, of £1,275. The electric traction account shows that the income in excess of working expenses amounted to £8,611. 15s. 8d. Repayment of loans, interest, and sinking fund came to £6,488. 3s., leaving a balance of £2,123. 12s. 8d. The contributions to the renewals fund for the past year, based on figures supplied by the electrical engineer and borough surveyor, amounted to £3,213. 13s. 6d., so that, after setting aside this amount, the loss on the year's account appears as £1,090. 0s. 10d. The committee anticipate that now the additional routes on the Willenhall-road and the Wednesfield-road are in operation, and the Waterloo-road and Stafford-road line approaching completion, the undertaking offers every prospect of proving a financial success. The following particulars refer to the year's working of the electrical section: miles of single track at March 31, 1904, 13·4; number of miles run, 507,527; number of passengers carried, 4,555,435; traffic receipts from passengers, £23,204. 12s. 2d.; traffic receipts from parcels, £47. 4s. 3d.; total traffic receipts per mile run, 10·9953d.; working expenses (exclusive of renewals), £14,910. 17s. 7d.; working expenses per mile run, 7·051d.; renewals, £3,213. 13s. 8d.; average number of cars running daily, 15.

New Lifeguard.—A new tramway car lifeguard was tried last week on the Oldham, Ashton, and Hyde tramways. A dummy, resembling a human being, was laid across the track, and a heavy double-decked car fitted with the Nuttall and Pearson contrivance was set running at full speed towards it. The car met the obstacle, the cradle descended, swept it up, and stopped the car without the least apparent injury, and without the driver touching a single lever. Four trials were made, each of them giving very satisfactory results. In the last trial the driver was presumed to have seen the obstacle, and by the action of one foot on a small lever the car was pulled up in a minimum of time. The patentees of the contrivance claim that it accomplishes three distinct objects with one mechanism—viz., the moment the obstacle touches the gate in front of the car, the cradle falls, at the same time applying the brakes to the wheels, and cutting off the current from the motors, bringing the car to a standstill. Moreover, if the driver sees the obstacle a short distance ahead, he can stop the car as described above, bringing all three actions into play instantly. In addition, the patentees claim that the cradle cannot ride the obstacle. The reason is that the cradle is usually placed at an angle of at least 45deg. before it loosens itself, but in the present one it flies loose instantly. The driver can also apply his ordinary brakes distinct from the lifeguard.

Newcastle.—It was decided that a meeting of the Parliamentary and By-laws and Tramways Committees be held as soon as possible to consider the proceedings on the Tyneside Tramways Bill. A sub-committee was appointed for the purpose of considering the actual expenditure on the tramways, and also with a view, if possible, of reducing the expenditure on revenue account. At a meeting of the Finance Committee the city treasurer presented a report upon the question of depreciation of the tramways. It was resolved that the report, together with the tramway estimates, be sent out to each member of the committee for consideration at next meeting. The past 13 weeks have yielded £48,915. 13s. 7½d., as against £43,126. 15s. 11½d. in the same period of last year, an increase of £5,788. 17s. 8d. It appears that a meeting between the Tramways Committee and the company has been arranged, and was fixed to take place yesterday. The Corporation, it is stated, are now desirous of coming to an amicable arrangement. Proposals have been forwarded to the company, the effect of which is that there shall be an interchange of traffic between the centre of the city and Wallsend, on similar terms to those prevailing in Liverpool. It is proposed that a number of the Tyneside Company's cars should be allowed to run to the centre of the city, and that the Corporation pay so much for the use of each car which will be under their control. In turn there is a proposition that the Corporation should be allowed to run a certain number of their cars to Wallsend.

Glasgow.—The following are particulars of the year's working o the Corporation tramways: The revenue amounted to £724,851. 5s. 8d., and the working expenses, including depreciation, to £496,266. 14s. 11d., thus leaving a gross balance of £228,584. 10s. 9d. The revenue of the previous year was £656,572. 7s. 11d., and the working expenses, including depreciation, £431,870. 2s. 11d., leaving a gross balance of £224,702. 5s. This year's gross balance thus shows an increase of £3,882. 5s. 9d. The gross balance of £228,584. 10s. 9d. has been applied in meeting interest and sinking funds, etc., on cost of Govan and Ibrox tramways, interest on capital, sinking fund, parliamentary expenses, and "annual payment to the common good," these payments amounting in all to £147,794. 0s. 6d. The net balance remaining amounts to £80,790. 10s. 3d., of which £62,000 has been applied in writing down the cost of buildings, ducts, cables, overhead equipment, and power station plant, the balance of £18,790. 10s. 3d. being added to the general reserve fund. Although the gross revenue for the past year shows an increase of £63,278. 17s. 9d. over that of the previous year, the average traffic revenue per car mile has decreased from 11·19d. to 10·58d. This decrease is chiefly due to the augmented service of cars which is now given on all routes. The average working expenditure per car mile shows a slight increase from 5·21d. to 5·26d. The total number of electric cars in stock is 682, and the Corporation have decided to build another 100.

Wednesbury, etc., Tramways.—A conference took place last week at the offices of the British Electric Traction Company, Birmingham, at which several officials of the company were present, including Mr. Emile Garcke (chairman) and Mr. J. A. Lycett, and representatives of the municipal authorities of Dudley, Tipton, Coseley, Wednesbury, etc. The interview took place at the invitation of the company, and the chief subject of discussion was the question of the reconstruction of the lines for the purpose of electric traction. On behalf of the local authorities it was pointed out that the action of the company in ceasing to run the old steam trams had caused serious inconvenience to the travelling public; that until some satisfactory arrangement had been made as to the reconstruction of the lines the company should allow the steam cars to continue running; that the company had undertaken

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by an agreement with the Tipton District Council to electrify the line in that parish by the end of April last; and that, pending the removal of all the difficulties in connection with the reconstruction of the whole of the two routes, the company should at least electrify the line from Dudley to Princes End—a 2d. stage. In regard to the stoppage of the tramway between Dudley and Wednesbury, it was explained on behalf of the company that the service had been unprofitable, and had been carried on solely for the convenience of the travelling public, and, further, that they could not incur additional loss by a continuance of steam traction. Reference was then made to the report of the company's engineer, stating that subsidences had occurred. A continuance of such subsidences would cause a deflection of the joints of the rails, with a consequent leakage of electrical current, and damage to overhead poles might also result, involving danger to the public. Quite apart, however, from the probability of further subsidences, the position of the company, as explained by their officials, was that it is quite impracticable, because of the serious loss of power, to electrify the line in sections, and that the principal obstacle was the present inability of the company to come to a satisfactory settlement with the Corporations of Wednesbury and Dudley in reference to their powers of purchase. In addition there were difficult complications in regard to the original shareholders of the South Staffordshire Tramway Company, from whom the British Electric Company leased the lines. It was intimated that the terms upon which the company had invited the Dudley and Wednesbury authorities to exercise their powers of purchase, but which were not disclosed, had not been accepted, and that, as matters now stood, there was a probability of the whole question having to be submitted to arbitration. Mr. Garcke stated that the company were anxious to electrify the line from Dudley to Wednesbury, and from Wednesbury to Darlaston, but nothing could possibly be done in this direction until a settlement had been arrived at between the company and the Corporations of Dudley and Wednesbury in regard to the purchase by those authorities of the sections of the lines within their areas, and new leases of them secured by the company. In regard to Wednesbury, he had formulated a scheme which he hoped might meet the difficulty so far as that authority was concerned.

London County Council.—An important scheme for the relief of London's congested traffic was foreshadowed at Tuesday's meeting of the London County Council, the nature of which is indicated by the two following clauses in a resolution which was carried unanimously: "That, having regard to the necessity for providing additional traffic facilities in London, and to the importance of linking up the Council's northern and southern tramway systems, it be referred to the Improvements Committee to consult the Highways and Bridges Committees, and to report at an early date: (1) whether the South-Eastern and Chatham and Dover Railway Company are contemplating the rebuilding of Charing Cross Station and the widening of Hungerford Bridge; (2) whether the Council can be advised to take the opportunity of submitting to Parliament a scheme for the acquisition by the Council of Charing Cross Station and Hungerford Bridge, providing the railway company with a site for a new terminus station on the Waterloo side of the river in place of the present terminus at Charing Cross, and erecting for general traffic a new road bridge of sufficient width and capacity to take a double line of tramway in the centre of the roadway, so that the Council's northern and southern tramways from Aldwych to Waterloo could be linked together." The transfer of the London, Deptford, and Greenwich tramways has been completed, and the lines are now being worked by the Council. The Woolwich Borough Council have decided to call the attention of the County Council to the great delay which is taking place with regard to the Well Hall tramway and to the importance of proceeding with the work of laying the tramway track during the widening of the roadway, otherwise this work, which is now in hand, must be postponed, or a large sum will be wasted through breaking up the carriageway for the purpose of laying the tramway; also to ask for a reply as to whether they are prepared to allow the Borough Council to carry out the work; and also to ask the County Council to state definitely whether they are prepared to accept the quotation of the Borough Council for the supply of electricity, as the lighting of a large portion of the borough is being held over pending such reply. The Council's receipts from tramways for the week ending the 2nd inst. amounted to £13,329, against £11,495 for the corresponding week last year; and for the period April 1 to that date to £156,931, against £130,780. The County Council have informed the Wandsworth Borough Council that they do not propose to submit the Clapham Common to East-hill and Streatham to the county boundary tramway schemes to Parliament in the 1905 session, but that they would be considered in connection with any schemes which might be placed before the County Council for the 1906 session. The Finsbury Borough Council have resolved to urge upon the County Council the need for accelerating the arrangements for reconstructing Goswell-road for electric traction, so that certain paving work decided upon by the Borough Council may not be delayed. The County Council Tramways and Improvements Bill was again before a Select Committee of the House of Lords on Monday. Further evidence was called in respect of three new lines which the London County Council propose to construct in the south-eastern district. The first line will run from the Horniman Museum to the Lewisham High-road, the second will couple up Lewisham and New Cross, and the third will run from Lewisham to Eltham-road. It was also proposed, in connection with these lines, to reconstruct the existing tramway in Rushey-green and High-street, Lewisham, for electrical purposes. The committee sanctioned the construction of these lines, and the consideration of other parts of the Bill was adjourned. The tramways will be on the conduit system, and the average cost per mile will be about £40,000. At Wednesday's meeting of the House of Lords Committee evidence was given in respect of tramway No. 4, a double line from Grove-vale along East Dulwich-road to the eastern corner of Peckham Rye Common. Short lines would connect with the systems of tramways and give access to the termini at Waterloo, Westminster, and Blackfriars Bridges. Mr. M. Fitzmaurice, C.M.G., engineer to the Council, gave particulars of the line, the estimated cost of which was £42,050; in addition street improvements would cost £1,500. Evidence was also given on behalf of the County Council in support of line No. 10, a double line 1¼ miles in length from Lordship-lane, Camberwell, to London-road, Lewisham. The cost was estimated at £51,000, and street improvements would be necessary at a cost of £21,500. A petition against this line was presented by the London, Camberwell, and Dulwich Tramways Company. The Camberwell Borough Council strongly supported both routes. As the result of a conference, the County Council had undertaken to purchase the whole undertaking of the London, Camberwell, and Dulwich Company for £6,500. The committee decided to pass tramways Nos. 4 and 10.

Leith.—The first instance of an appeal from the decision of the local Commissioners under the Private Legislation Procedure (Scotland) Act to a Joint Committee of both Houses of Parliament occurred last week in the case of the Leith Corporation Tramways Order (Confirmation) Bill. The two Houses decided to remit the Bill to a joint committee chiefly on the question whether the Edinburgh District Tramways Company should be given a *locus standi*. The Earl of Camperdown was elected chairman of the committee. Mr. Hutchinson appeared for the promoters of the Bill, who are the Leith Corporation, and Mr. Balfour Browne, K.C., and Mr. Forbes Lankester represented the Edinburgh District Tramways Company. Mr. Hutchinson explained that in 1871 the Edinburgh Street Tramways Company was incorporated and authorised to construct certain tramways in Edinburgh and Leith. Among the tramways was one communicating between Golden Acre and the Newhaven district of Leith. In 1874 this was abandoned under an Act of Parliament, and an omnibus service was required to be set up in lieu of the tramways which had been abandoned. That was the price the company had to pay for the abandonment of the tramways. In 1884 the Edinburgh Northern Tramways Company was incorporated, and it was authorised to construct a line from Princes-street to Golden Acre, but the company was required, as the price of the powers Parliament had given it, to continue the 'bus service into Leith from Golden Acre. The 'bus service became part and parcel of the tramway undertaking of the Northern Company, and existed now. In 1893, under the Tramways Act, the Edinburgh Corporation purchased the whole of the lines in Edinburgh, with the exception of the Northern route, and so stepped into the shoes of the Edinburgh Street Tramways Company. The lines in Leith still remained the property of the Street Tramways Company, and these lines the provisional order empowered the Leith Corporation to purchase. In 1897 the Corporation of Edinburgh purchased the Northern system, and so took upon themselves the obligation to work the whole of the undertaking, including the omnibuses. A proviso to that effect was inserted in the Act of 1897. The petitioners, the District Tramways Company, came on the scene, and leased from the Corporation of Edinburgh the whole of the Edinburgh tramways, including the omnibus service. The relation between the petitioners and the Edinburgh Corporation with respect to this tramway undertaking was that the petitioners were to work the whole. The question arose whether the petitioners appeared before the committee as lessees. Section 19 of the Tramways Act was incorporated in the 1897 Act. It gave authority to a local authority to lease tramways of which they might be possessed, but subject to the condition that the lease was to be approved by the Board of Trade. His contention was that unless the lease was approved by the Board of Trade it was not a lease which complied with the provisions of the Tramways Act. His second point was that, granted the District Tramways Company might establish that they had a lease, the approval of which by the Board of Trade was not necessary in order to make it valid, then the company were coming as the lessee of the Edinburgh Corporation, who were not there complaining. The District Company were seeking to extinguish that part of the undertaking of their lessors which under the lease it was under an obligation to work—namely, the omnibus section. Mr. Balfour Browne, K.C., said that if tramways had been made to Trinity instead of an omnibus service, there would have been no question that the Leith Corporation would have been bound to buy the whole of the tramways in its district. The omnibuses were only a poor substitute for tramways. As they were connected with the Edinburgh tramway system at Golden Acre, the obligation had been put upon his company to work them, although they ran in the burgh of Leith. That was an onerous obligation, as the omnibuses were run at a loss. The Corporation of Leith was going to compete with the District Company, as they proposed a new tramway along Pilrig, which would compete with the line from Trinity and Golden Acre to Princes-street. The *locus standi* had been refused by the Commissioners under a misapprehension because the Corporation of Edinburgh were opposing the order, and it was considered that the Corporation of Edinburgh covered the lessees. With regard to the contention as to the approval of the Board of Trade being requisite, as a matter of fact the District Company were the lessees, and they were working the whole of the tramways in Edinburgh. If the approval of the Board of Trade were necessary, it could be had at any instant. Under a section of another Act, however, they had perfect power to enter into a lease. That was the Act of 1897, which over-rode the general statute, because it was subsequent legislation. The tramways had been inspected by the Board of Trade, and the petitioners were paying £90,000 a year for the use of them. The committee after a brief consultation allowed a *locus standi* to the Edinburgh and District Tramways Company. Several witnesses were then called, and in the course of the proceedings Mr. Balfour Browne submitted a clause for the consideration of the committee, the effect of which would be to transfer the obligations as to running omnibuses between Golden Acre, Trinity, and Newhaven to the Corporation of Leith. The committee refused this amendment, and ordered the Bill to be reported without amendment. An application for costs was made on behalf of the promoters, but this was refused.

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LIGHTING AND GENERAL.

Watford.—It is proposed to revise the price charged for public lighting.

Dundalk.—The Urban District Council will apply for an extension of their electric lighting order.

Stockport.—On last year's trading the electricity works made a gross profit of £4,568. 11s. 7d.

Cuckfield.—The Haywards Heath Electric Supply Company intend to apply for a provisional order.

York.—About £200 is to be expended during the holidays for electric lighting at the Fishergate School.

Hastings.—An enquiry has been held into an application for sanction to borrow £3,416 for electric lighting.

Halifax.—The Tramways and Electricity Committee are about to lay electric mains at an estimated cost of £117.

Beverley.—The Electric Power and Lighting Company, Limited, London, intend to apply for powers in the district.

Nelson.—Sanction has been received by the Town Council to the borrowing of £25,000 for electric lighting purposes.

Haywards Heath.—Two companies are anxious to secure the privilege of supplying the town with electrical energy.

King's Norton.—An expert is to be called in to report upon the electric lighting offers recently made to the District Council.

Golborne.—The Lancashire Electric Power Company intend to apply for a provisional order for electric lighting in the district.

Turton.—The Lancashire Electric Lighting Company intend applying to the Board of Trade for a provisional order for this district

Andover.—The Southern District Electricity Corporation are applying for a provisional order to supply electric light in Andover.

Coseley.—A provisional agreement has been drafted with Messrs. Whittaker Bros., of Dudley, for the electric lighting of the district.

Mirfield.—The agreement between the Council and the Yorkshire Electric Power Company for the supply of electricity has been signed.

Tottington.—The Lancashire Electric Power Company intend to apply for a provisional order for the supply of electricity in the district.

Tring.—The Empire Electric Light and Power Company intend to apply for a provisional order to supply electric light in the urban district.

Darlington.—The net profit on the electric lighting works has been £568. The amount will be placed to a depreciation and renewals account.

Carnarvon.—The Town Council have sealed the agreement with the National Construction Company to which we have already referred.

Macsteg.—The Council are negotiating with Mr. G. B. Fowler, Norwich, for the transfer of the Council's provisional order to a syndicate.

Malling.—The Rural District Council have declined to grant power for electric supply purposes in their district to the Kent Electric Power Company.

Frimley.—The Bournemouth and Poole Electric Supply Company, Limited, intend to apply for a provisional order this year for lighting the district.

Kingsbridge.—The electricity company intend to apply for a provisional order for supplying electric light to the town of Kingsbridge.

Dundee.—Mr. G. Balfour is to have an interview next week with the Town Council in relation to a proposed scheme of electrical supply for power purposes.

Camberley.—The Camberley Electric Supply Company and the Mutual Electric Supply Company intend to apply for provisional orders in the district.

Westhoughton.—We understand that the Urban District Council are about to put into operation the powers of their electricity provisional order of 1902.

March.—The Model Electricity Supply Company intend to apply for a provisional order or orders to supply electricity within the Urban District Council's area.

Matlock.—Messrs. Foot and Milne, Westminster, intend to apply to the Board of Trade for a provisional order to supply electricity within the Matlock area.

Holyhead.—Application is to be made for sanction to a loan of £1,750 for electric lighting. The acceptance of a conditional tender is noted in another column.

Sherbourne.—The Mutual Electricity Supply Company and the Southern District Electricity Corporation intend to apply for provisional orders in the district.

Dalkeith.—An offer of Messrs. Crompton and Co. containing terms for street-lighting and pumping water at Bridgend is before the Water Committee of the Town Council.

Knaresborough.—Messrs. Jeckell and T. P. Pollitt, of Manchester, intend to apply for a provisional order for introducing the electric light into Knaresborough and district.

Chorley.—It is intended to transfer the undertaking authorised by he Chorley Electric Lighting Order, 1898, to Mr. O. Hansom, electrical ngineer, of Fleetwood, Lancashire.

Skipton.—Mr. G. V. Fowler, of The Chestnuts, Warwick, intends to apply in due course for a provisional order enabling him to supply the Skipton urban district with electricity.

Bournemouth.—It is reported that the canvass for subscribers to municipal telephones has been very satisfactory, sufficiently good to warrant the Council going on with the scheme.

Barnet.—The North Metropolitan Electrical Power Company intend to apply for a provisional order authorising the company to supply electrical energy within the area of this authority.

Frome.—The Western Electric Distributing Corporation, Limited, intend to apply for a provisional order to supply electricity for public and private purposes within the area of the rural district.

Boston.—The Council have sealed an agreement with the National Telephone Company, Limited. A rent of 1s. per pole is charged, and the company are to remove all poles at six months' notice.

Wandsworth.—The County of London Electric Supply, Limited, are giving customers the option of an alternative flat rate of 6d. per unit for the supply of electric current for lighting purposes.

East Molesey.—The Mutual Electricity Supply Company, 11, Union-court, Old Broad-street, intend to apply to the Board of Trade for a provisional order to supply this district with electricity.

Clewer.—The Parish Council have consented to the intended application of the Windsor Electrical Company for an order for the supply of electrical power generally in the parish of Clewer Without.

St. Andrews.—The Electric Supply Corporation, Limited, have included St. Andrews in their scheme of operations, and it is stated that the erection of the works will be proceeded with forthwith.

Thrapston.—Mr. Edwin Percy Harvey, Richmond, Surrey, intends to apply for a provisional order for the supply of electricity within the Council's area. The Council have decided to oppose the application.

Kilkenny.—The Electricity Supply Corporation of Ireland, Limited, intend to apply to the Board of Trade for a provisional order to supply electricity for public and private purposes in the township of Kilkenny.

Tenbridge.—The electrical engineer in his last report states that two further applications for light had been received during last month, bringing the total up to 104 consumers, equivalent to 3,454 8-c.p. lamps.

Egham.—The Urban Electric Supply Company, Limited, intend to apply for a provisional order for the electric lighting of Egham. The Rural District Council are about to consult the County Council in the matter.

Longton.—In the electricity department the number of units generated during the month ending June 23 was 4,992, against 4,512 for the coresponding period last year, being an increase of 480 units, or 10 per cent.

Barnsley.—The electricity mains are to be extended to enable the Corporation to supply several residences on condition that the owners guarantee to pay the Corporation at least £25 per annum for a period of five years.

Bradford.—The Electricity Committee have recommended the Corporation to purchase 30,500 incandescent lamps required for free distribution to Corporation customers during the half-year ending Dec. 31 next.

Aston.—Extensions of mains have been authorised as follows: 1,180 yards of ·3 three-core cable, £553; 600 yards of ·12 three-core cable, £132. 10s.; 350 yards of ·3 three-core cable, to be laid in two-way 3in. ducts, £235.

Rye.—The Mutual Electricity Supply Company intend to apply for a provisional order authorising them to supply electricity within the borough. The borough do not propose to let the power to supply electric light go out of their hands.

Middlesbrough.—Sanction has been received to the borrowing of £19,900 for the extension of the electric light undertaking at Middlesbrough. The estimated profit during last month was £327, exclusive of interest on loan and sinking fund.

Morley.—The output from the electricity works during the month ending May 31 was 8,015 units, against 8,008 the same month last year. Sixty lamps were connected during the month, the total number connected to date being 11,733.

Portslade.—The Mutual Electricity Supply Company and the Hove and District Electricity Supply Company intend to apply to the Board of Trade for provisional orders authorising them to supply electricity within the Urban District Council's area.

Aspull.—Two years ago the Council applied to the Board of Trade for an electric lighting order. Twelve months ago the Board of Trade granted a further extension of the order for 12 months, and an application is to be made for another renewal.

Bishop's Stortford.—The Bishop's Stortford and Stansted Electric Lighting Company, Limited, and the Mutual Electric Supply Company intend to apply in November for a provisional order authorising them to supply electric light within the Council's district.

Farnham.—Messrs. Foote and Milne, Limited, the Farnham and District Electric Supply Company, Limited, and the Farnham Gas Company, Limited, intend to apply for provisional orders for the supply of electricity within Farnham urban district.

Swindon.—The last monthly report of the electrical engineer shows that the number of consumers connected on June 15 was 200, as against 195 a month previously. The number of street lamps converted to electric light was 135, as against 132 the previous month.

East Barnet.—The Empire Electric Light and Power Company, Limited, and Mr. G. Vaughan Fowler, The Chestnuts, Warwick, intend to apply for provisional orders to supply electricity within the East Barnet Council area. The Council will oppose the applications.

Sunbury.—The question of an exchange telephone connection with the National Telephone Company has been deferred for the present. Two electric light companies intend to apply for electric light orders for the district, but Edmundson's have practically obtained an order.

Sale of Plant.—The Dundee Town Council invite tenders for the purchase of a number of continuous-current Ferranti meters, which can be seen and full particulars given on application to the City Electrical and Tramways Engineer, Dudhope-crescent-road, Dundee.

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Littlehampton.—A small committee has for some time been negotiating with the electrical engineer, Mr. Aylwin, who proposes to form a company for the electric lighting of the district. A maximum price of 5d. per unit for light and 3d. for power has been agreed upon.

Ludlow.—Notices of intention to apply to the Board of Trade for provisional orders to supply the borough with electric light have been received from Mr. William Norton, Ludlow; the Mutual Electricity Supply Company; Foote and Milne, Limited, London; and G. Vaughan, Warwick.

Harrogate.—The following resolution passed by the Council on June 13—namely, that the demand indicator tariff be reduced from 6d. and 3d. to 5½d. and 3d. per unit—has been rescinded, and the demand indicator tariff is to be altered from 5½d. and 3d. to 6d. and 2½d. per unit.

Ogwen.—The Portdinorwic electric lighting order has been approved. It embodies the use of overhead wires, on condition that the power is reserved to the Board of reveiwing the situation at the end of five years if they thought fit. The Council have decided to offer no observations upon the subject.

Tamworth.—The Rural District Council have been asked to consent to the Town Council's intended application for a provisional order authorising them to supply electricity for both public and private purposes within the parishes of Bolehall and Glascote and Wigginton in the rural district.

Edmundson's Electricity Co.—The directors have declared a final dividend on ordinary shares of 9 per cent. per annum for the half-year ended March 31, 1904, making, with the interim dividend of 5 per cent. already paid, a dividend of 7 per cent. for the year. Dividends will be paid on the 25th inst.

Limerick.—The Electric Lighting Committee have decided to allow special discounts to consumers as follows: less than 200 units per quarter, 2½ per cent.; not less than 200, 5 per cent.; not less than 400, 7½ per cent.; not less than 500, 10 per cent.; not less than 650, 20 per cent., if the accounts are paid within the quarter.

Caversham.—A letter from Mr. Warden-Stevens referring to the report as to electricity supply made by him last year, and desiring to know if the Council were disposed to consider making application for a provisional order in the coming session, is before the Highways and Lighting Committee of the Urban District Council.

Wealdstone.—The Mutual Electricity Supply Company intend to apply to the Board of Trade for a provisional order or orders to authorise them to supply electricity within the Council's area. An agreement with the Harrow Electric Light and Power Company *re* the extension of their mains to supply electricity to certain premises in the Wealdstone district has been sealed.

Promenade Concerts.—The tenth season commences at the Queen's Hall on Aug. 6, when nightly promenade concerts will be given until Oct. 21. A very complete list of artists who will work in conjunction with the Queen's Hall orchestra under the conductorship of Mr. Henry J. Wood has just been published. Mr. Robert Newman is the manager, as in former years.

National Telephone Co.—The directors, subject to final audit, recommend the following dividends for the half-year ended June 30, after payment of the dividends on the preference shares: at the rate of 6 per cent. per annum on the preferred stock; at the rate of 5 per cent. per annum on the deferred stock, less income tax in all cases, carrying £100,000 to reserve and about £9,000 forward.

Airdrie.—The Scottish House-to-House Electricity Company, Limited, intend to apply in November next for a provisional order empowering the company to transfer the order of the Airdrie Corporation of November, 1898, to some other company or person, along with their undertaking within the burgh of Airdrie. Mr. Kennedy has been asked to look after the Council's interests in the matter.

Mountain Ash.—The South Wales Electrical Distribution Company having applied for leave to carry their main through a portion of the Council's district, it has been decided to reply that the Council could not agree to the application, but that they would be prepared to receive terms from the company for lighting the district, the mains to be sufficiently low as not to be injured by the Council's traction engine, etc.

Cardiff.—In the estimate for furnishing the new town hall we note the following items: mayor's parlour—a 20-light electric pendant, £100; assembly hall—electrical fittings, £724; Council-chamber—electric pendants, etc., £480; town clerk's private office—electric fittings, £16; electrical engineer's private office, £98; chief constable's room—electric fittings, £30; assize courts (a number)—electric fittings, £187.

University College of North Wales.—In October next a systematic course of instruction in electrical measurement and practical electricity for students proposing to enter the profession of electrical engineer will be commenced. The physical laboratory is equipped with a compound steam-engine, continuous and alternating current (single and three phase) dynamos and transformers, secondary battery, and the most approved modern measuring instruments.

Wells.—The town clerk has been instructed to write to the Postmaster-General, and point out the delay occasioned in establishing telephonic communication in Wells and the district, and requesting that a canvasser be sent to get sufficient subscribers or a guarantee. It is stated that a call to Wells Fire Brigade to attend a fire at Shepton Mallet Prison, sent at 10.20 p.m., was not received at Wells, in consequence of their having no telephonic communication, till 11.20.

London County Council.—On Tuesday tenders were received for the supply, etc., of overhead cranes, electric jib cranes, and locomotives, etc., at the Greenwich generating station and wharf (London County Council tramways). These were referred to the committees concerned. It was agreed to lend the Poplar Borough Council £20,000 for electric light installation. Sanction was also given to the borrowing of £9,958 by the Shoreditch Borough Council for electric light installation and meters.

Gillingham.—The engineer's last report shows that 334 8-c.p. lamps have been connected to the mains since the June meeting, making a total of 11,064 8-c.p. lamps with 188 consumers connected, and that applications had been received for 327 8-c.p. lamps. A ·05 four-core distributor and a $^{7}/_{20}$ twin lighting cable are to be laid. The cable is in stock, and the resident engineer is to undertake all necessary cable work in future, and arrange with the borough surveyor for the necessary labour for excavations and paving.

Oulton Broad.—The Urban District Council have adopted a report by the Electric Lighting Committee stating that they are at present of opinion that arrangements can be made with the Oulton Broad Electricity Company, Limited, as to a provisional order, but before proceeding further asking the consent of the Council to obtain expert advice prior to giving any final recommendations. Incidentally it was stated that one or two experts had promised to give the Council advice for nothing when they were in the neighbourhood.

Norden and Bagalate.—The Lancashire Electric Power Company, Manchester, intend to apply for a provisional order authorising the supply of electricity in the Norden district for all public or private purposes. Messrs. Foote and Milne, Limited, of London, also intend to apply for a provisional order authorising them to supply electricity within the Council's area. It is understood that the Lancashire Electric Power Company intend to at once lay a cable through Heywood, Norden, Whitworth, and Bacup, and the District Council will endeavour to arrange a conference on the matter with other councils affected.

Torquay.—An equivalent of 125 8-c.p. lamps were connected during June, and there are two applications in hand, according to the electrical engineer's report. For extra time spent in preparation of drawings for the new electric station, the Council have granted £8. 4s. 6d. each to Messrs. C. Gilliard and H. Hooper. The borough surveyor and electrical engineer have been authorised to proceed with the preparation of the necessary plans and details for the extensions, referred to in our last issue, to enable application to be made for sanction to borrow the amount required as soon as the Royal assent has been given to the Dolter Tramways Bill.

Stock Exchange.—The Stock Exchange Committee have appointed July 20 special settling day for Metropolitan Electric Tramways, Limited, £350,000 4½ per cent. debenture stock, and July 27 for Marconi's Wireless Telegraph Company, Limited, further issue of 25,000 shares of £1 each, fully paid, Nos. 196,128 to 221,127. They have ordered Metropolitan Electric Tramways, Limited, £350,000 4½ per cent. debenture stock to be quoted in the official list. Applications have been made to the Stock Exchange Committee to grant a quotation to Madras Electric Tramway (1904), Limited, £50,000 5 per cent. debenture stock; and Urban Electric Supply Company, Limited, £200,000 first mortgage debenture stock.

Colchester.—Application will be made for a loan of £16,500 for various purposes, including mains extensions, £1,200; boiler, £750; condensing plant, £700; water-softening plant, £300; one 375-kw. 550-i.h.p. combined set, £2,200; one 550-i.h.p. high-speed engine, £1,360; house connections, meters, etc., £2,180; mains extensions under contemplation, £1,942; further main extensions, estimated up to 1906, £1,558; multitubular boiler and dynamos, £1,942; contingencies, £623. The committee have reported the following statistics: output in May, 1904, 20,258 units (1903, 17,825); consumers, 462 (358); 8-c.p. lamps connected, 25,206 (22,752).

Southport.—It is proposed to apply for sanction to borrow £20,000 in accordance with the following estimate: four miles high-tension cable and laying, £1,584; 1,000 cast-iron pipes for crossing streets at 7s., £350; 12 30-kw. transformers at £60, £720; four watertight transformer tanks at £15, £60; two sub-stations and switchgear at £360 each, £720; services and meters at £2 000 per annum, £6,000; low-tension mains at £2 000, £6,000; line booster (500 amperes 50 volts), £250; battery, £1,300; automatic reversible battery booster, £400; battery-room, £300; switchboard extensions, £50; equipment of meter-testing room, £150; six mechanical stokers, £479—£18,363; contingencies, £1,637.

Camberwell.—An application from the Blackheath and Greenwich District Electric Light Company, Limited, the successor to the Crystal Palace and District Electric Supply Company, Limited, giving notice of intention to lay a $^{37}/_{15}$ low-tension concentric lead-covered cable from the north-east corner of Westow-hill and Crystal Palace-parade, along the west side of the parade to Farquhar-road, then along the southern and western side of Farquhar-road to its junction with Jasper-road (at letter-box), where the cable will cross the road and continue along the east side to the junction of Farquhar-road and Dulwich Wood-park, has been agreed to. The Council will support any application made to Parliament for the purpose of obtaining powers to enable the councils of metropolitan boroughs to wire and fit consumers' premises for electric lighting, and to obtain loans for so doing.

London Gazette.—The Electric Extension Company, Limited, will be wound up voluntarily. Mr. C. E. Ruckley has been appointed liquidator. The capital of the British Aluminium Company, Limited and Reduced, is now £310,000, divided into 10,000 "A" cumulative preference shares of £10 each, 20,000 preference shares of £10 each, and 10,000 ordinary shares of £1 each, instead of the capital of £400,000, divided into 10,000 "A" cumulative preference shares of £10 each, 20,000 preference shares of £10 each, and 10,000 ordinary shares of £10 each. The *London Gazette* of the 8th inst. publishes a table of rates for foreign and Colonial telegrams, which came into operation from the 1st inst. Mr. Harold de Vaux Brougham, liquidator in the estate of the Electric Lamp Regenerating Company, Limited, 3, Crown-court, 62, Old Broad-street, London, has been released from July 7.

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Battersea.—Electric mains (including arc light leads) are to be extended from Northcote-road along Bramfield-road to Ashness-road, at an estimated cost of £142. 5s. 7d.; and an electric supply service laid from a point in Nightingale Park-crescent to 19, Blenkarne-road, at an estimated cost of £24. The following particulars relative to applications for the supply of electrical energy to premises within the borough, including the Council buildings, appear in the last report: Quarter ended June 14, lighting, number of applications 638, March 15, 569—increase, 69; actual consumers, 589 (534) + 55; electrical energy equivalent in 8-c.p. lamps, applied for, 47 385 (43,172) + 4,213; actually supplied 41.085 (38.361) + 2,724; motive power—applied for, 638¼ h.p. (585¼ h.p.) +53 h.p.; actually supplied, 450⅛ h.p. (418⅛ h.p.) + 32 h.p.

Edinburgh.—The electric lighting accounts for the past year are eminently satisfactory. The revenue was estimated at £108 835; the actual amount has turned out to be £116,178. The expenditure was estimated at £94 660, but it has been kept at £92,181. The estimated balance available for appropriation at the close of the year was £14,175; the actual was £23,997. The maximum to which the reserve fund might be built up on the present capital expenditure is £84,000. At the present moment it amounted to £43.000, so that the balance of £24.000 would bring the fund up to £67,000, and in the present year the Electric Light Committee estimates that, after reducing the price of the electric current, there would be a balance available for appropriation at the close of the year of £17,000, which, apart from the accumulations of interest on the reserve fund investments, would virtually bring the reserve fund up to its maximum at this time next year.

Newport (Mon.).—The report of the Electricity and Tramways Committee, which was adopted on Tuesday, deals with the proposed addition to the generating plant in order to meet the demands for current for power and lighting purposes. The scheme provides for an additional 300 kw. of high-speed plant, together with a battery at Corporation-road station, thus enabling the Highfield boosting plant to be used, giving a net increase of 500 kw. to the lighting and power portion of the plant. The estimated cost was £8,200. New high-tension feeders are to be laid in certain districts, and two new sub-stations constructed at a cost of about £1,900. In connection with the low-tension supply new feeders and cables are to be laid and switch-gear obtained for Llanarth-street and the sub-stations at Maindee, and a balancer is to be fixed at Llanarth-street. This is estimated to cost about £4 725, with an additional £3,000 for cable work that might be required in places not yet specified. The application which will be made will amount to £17,825.

Sunderland.—It will be remembered that recently the Corporation failed to enter an appearance when the petition by them against the Sunderland district electric lighting order was being heard by a committe of the House of Lords, and the Corporation were ordered to pay the costs of the proceedings, amounting to over £500. The Electricity and Lighting Committee, in the report upon the matter at Wednesday's meeting of the Council, explained that they were advised that opposition in committee would have little chance of success, and they decided to instruct their parliamentary agents not to proceed further. No appearance was therefore entered. The agents stated that the ordinary and regular practice was followed on behalf of the Corporation, and that the action of the House of Lords is not precedent, irregular, and in excess of their jurisdiction. They caused application to be made for the Corporation to be heard upon the matter with a view to the reversal of the order. That application having been refused, the committee are now arranging for proceedings in the House of Lords to the same effect.

Aldrington.—The Brighton and Hove Councils have come to the following agreement: "The Hove Corporation to take all the electricity required by them for the supply of or use in the parish of Aldrington, at the rate of 4½d. per unit for the first 365 hours' use of the maximum demand, and 1½d. per unit afterwards, such electricity to be at low tension at 440 volts. The Hove Corporation to have the option on giving six months' notice, expiring on June 30 or Dec. 31, in any year of taking future supply for the remainder of the period of the contract, at the price of 5d. per unit for first 365 hours' use, and 1d. per unit afterwards. Contracts to be for nine years—*i.e.*, to expire Dec. 8, 1913, or such other date about that time on which the Hove Corporation have power to take over the Hove Company's undertaking. The Hove Corporation to carry out the supply of electricity in accordance with the terms of the Aldrington electric lighting order and any regulations of the Board of Trade made thereunder. The Brighton Corporation to be empowered to disconnect the supply in the event of such terms and regulations not being complied with, but only during such period as the default continues."

Islington.—The Borough Council have petitioned against the Supply of Electricity Bill. At to-night's meeting it will be proposed: "(*a*) That the London County Council be informed that the Islington Borough Council are in favour of the renewal of the application for parliamentary powers to enable metropolitan borough councils to wire and fit consumers' premises for electric lighting and to obtain loans for the cost of the work, and that they will support any Bill that may be introduced into Parliament for this purpose. (*b*) That the metropolitan borough councils who are electric lighting undertakers be informed that the Council are prepared to support the application in question, and that they be asked to take similar action." The borough treasurer's report of the electric enterprise for the year ending March 31 last shows that while in March, 1903, there was a deficit of £1,496, there is now a debt owing from the Council of £1,656. The present success is said to be largely due to the use of the day load for purposes of motors in factories. Last year the supply went up to 289,894—an increase of daylight supply of 213,221 units. The revenue of the year was £48,436—an increase on the year of £4,009; whilst the expenditure shows a decrease of £304. The number of additional consumers was over 200. Making allowance for interest on loans, there is a net surplus of £1,218. That is, if the undertaking were in the hands of a company, the earnings would represent a dividend equal to 3·6 in the £.

Manchester.—A deputation from the New Mutual Telephone Syndicate waited upon the Lord Mayor on Tuesday. Mr. W. Thomson, chairman (*pro tem.*) of the Mutual Telephone Company, described the several proceedings subsequent to the first effort to produce a municipal competitive telephone system in Manchester 8½ years ago, when the Corporation of Manchester was asked to join the Glasgow Corporation in applying to the Postmaster-General for power to produce municipal telephone exchanges. The position now, he said, was somewhat altered by the recent declaration of the present Postmaster-General that he proposed to try to purchase the undertakings of the National Telephone Company this year. This declaration, it was understood, stopped for the moment the Telephone Committee from going on with their municipal telephone scheme, and it was felt that the Corporation should without further delay arrange to meet the liabilities which had been incurred by the New Mutual Telephone Syndicate, otherwise a serious injustice would be done to the members of the syndicate. The work of the syndicate in Manchester had proved of great value to the mercantile community in compelling the National Telephone Company greatly to improve its system, and it was largely due to the syndicate that the right to produce municipal telephony became possible. The Lord Mayor, in reply, promised to convey the views of the deputation to the proper quarter.

Wimbledon.—The accounts of the Urban District Council's electric lighting undertaking for the year ending March 31 last give the following particulars of the trading since the installation was first laid down by the Council: existing debt, £110,312; income, £18,640; expenditure, £16,699; loans, £1,940. In 1903 a reserve fund was started with £500, and in the year ending March last £1,000 was added to the reserve. The repayment of principal has increased from £135 in 1899 to £2,992, the payments for interest from £114 to £3,155, and the working expenses, which in 1900 were £2,322, rose last year to £9,552. The amount actually borrowed from the start totals £120,130, and sanction has been received to borrow a further £8,872. The cost of generation per unit sold was 1·201d., coal and other fuel (including carriage and other expenses) costing only ·92d. per unit. Cost of distribution works out at ·005d.; repairs and renewals of public lamps, ·134d. per unit; rents, rates, and taxes, ·148d.; management expenses, ·281d.; law and parliamentary charges, ·012d.; and special charges, ·019d.—making the total works cost 1·88d. per unit. Repayment of principal and interest on loans, payment to reserve fund, and other expenses absorbed 1·236d. per unit. The total cost of each unit sold was 3·116d. The sale of current for private lighting brought in £12,111, of which £5,641 was derived from current sold at 7d. per unit, £2,802 at 5d., £691 at 4½d., £905 at 4d., £171 at 3½d., £136 at 3d., and £1,762 at 2d. per unit. Sale of current under contracts brought in £11, and for public lighting £5,984 was received. The rent of meters amounted to £535.

Beckenham.—The Urban District Council have approved of a report in which the Electric Lighting and Tramway Committee stated: "A communication from the British Insulated and Helsby Cables, Limited, offering to pay 4 per cent. on any further free wiring expenditure as from the date of the expenditure and during the continuance of their lease was submitted. The committee recommend that funds up to maximum of £5,000 be provided for extending the free wiring, that a loan of this amount be included in the scheme for the equation of loan payments, and that the question of raising the necessary money by instalments be referred to the Finance Committee. A letter was read from the Board of Trade approving of the transfer of the Crystal Palace District Electric Lighting Company to the Blackheath and Greenwich Electric Lighting Company. A plan was also submitted of the company's intention to lay mains in the Beckenham district. One of these mains appears to be for the urban district of Penge and the other for improving the system of supply to the Crystal Palace district of Beckenham. As to the latter, the committee, in view of the Council's notice to purchase already served, very strongly object to the expenditure, and they recommend the Council to take the necessary steps to give effect to this objection. With a view to encourage the purchase of free-wiring installations by consumers, the Council is recommended to sell free-wiring installations at the contractor's charges plus 5 per cent. (instead of 10 per cent. as hitherto) for supervision, etc. An application for an increase in the price for trenchwork on extension of mains and services was submitted. The committee cannot recommend the Council to accede to the application. It was referred to the surveyor to report as to providing a bath for the use of the men working on the dust destructor."

St. Pancras.—On Wednesday the following motions were considered: (1) "That the resolutions of the late vestry on April 11, 1900, fixing the following charges for the supply of electric current, be and are hereby rescinded—viz.: (*a*) for supply to consumers not using the maximum demand indicator, 5d. per unit; (*b*) for supply to consumers for motive power, heating, etc., 2d. per unit; (*c*) for supply of electric current to public street lamps, 3d. per unit, and a special charge of £250 for keeping certain lamps in lighting throughout the night." (2) "That the resolution of the Council of May 8, 1901, fixing the charge for supply of electric current by the maximum demand indicator system after the first hour at 3d. per unit, be and is hereby rescinded." (3) "That, in place of the existing charges rescinded, the following charges for supply shall come into operation commencing with the present (September) quarter: (*a*) For lighting purposes—by the maximum demand indicator system, 6d. per unit for the first hour and 1½d. per unit after; customers not using the maximum demand system at a flat rate of 4d. per unit; supply to buildings, 3d. per unit. (*b*) For power purposes—1d. per unit. The foregoing charges to apply only to consumers who are supplied at the pressure of 220 volts or 440 volts and also to consumers who agree to change from the 110 volt pressure of supply to the higher voltage when required by the Council. They shall not apply in the case of

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Messrs. Price and Reeves, the contractors of the Charing Cross, Euston, and Hampstead Railway, until such time as they have taken the minimum of 1,000,000 units in accordance with the contract entered into with them. (c) Public street-lighting—1½d. per unit. and the general fund to take over the capital liability of £4,311. 1s. 2d. now borne by the electricity fund, and to pay, in addition to the 1½d. per unit for current, the charges for labour trimming, repairs, carbons, and maintenance.

Fulham.—On Wednesday the Electricity Committee reported as follows: "In April last the borough electrical engineer submitted a report recommending the Council to undertake an extension of its electric lighting undertaking, involving a considerable expenditure, and pointing out the necessity for taking immediate action, with a view to making provision for the coming winter season. After careful consideration we then recommended the Council to order a 750-kw. turbo-alternator, at an estimated cost of £7,000, as a first urgent instalment of the proposed extension, and instructed the borough electrical engineer to prepare for our further consideration a comprehensive scheme dealing with probable future requirements for the next five years, so that the extension recommended might form part of a well-considered scheme which would be carried out from time to time as necessity required. The borough electrical engineer has now submitted reports dated June 4 and July 1, 1904 (copies of which have been circulated amongst the members of the Council), and plans giving particulars of a scheme, which he is of opinion it will be found necessary to carry out in sections during the next five years at a total estimated cost of £129,000—viz.: first section, £42,000; second section, £32,000; third section, £25,000; mains, sub-stations, etc., £10,000; house connections, meters, etc., £20,000. The first section, which he recommends should be authorised at once, comprises the following—viz.: one 750-kw. turbo-alternator (already ordered), £7,000; one 1,000-kw. Belliss set, complete with condensers, pumps, etc. (to be ordered), £8,947; one exciter set, £500; switchboard additions, £500; four boilers with accessories, £4,340; coal bunkers, elevators, etc., £2,230; economisers, £1,075; boiler pumps, £250; wiring motors, etc., £200; condenser, steam, and other pipes, £3,000; condenser, sump, and river work, £2,000; chimney, £4,000; boiler-house buildings and alterations, £7,500; contingencies, £500; for connections, £6,000; extra buildings, £4,000—£52,042; less already sanctioned by the Council, £7,000—£45,042."

Wolverhampton.—The report of the Electric Lighting Committee shows a gross profit of £11,495. 7s., equal to 8·30 per cent. on the capital expenditure (averaged) during the year. Out of this amount the following charges have to be met, on capital expenditure (averaged) during the year: interest (less interest received), £3,839 (2·80 per cent.); sinking fund, £4,981 (3·50 per cent.)—£8,720 (6·30 per cent.); balance, being net profit for the year, £2,775 (2 per cent.)—£11,495 (8·30 per cent.). The committee express the opinion that this result of the past year's working is satisfactory in all respects, and indicates that the undertaking is in a sound financial condition, and that this result was especially gratifying in face of a very substantial reduction which was made in the price of current for lighting purposes during the period covered by these accounts, and a large reduction in respect of the charges for public street-lighting, the actual reduction in revenue from this cause being over £1,400. The committee are pleased to be able to report a continuous diminution in the cost of production, the expenditure on the generation and distribution of electricity—inclusive of all management charges, but exclusive of capital charges—being actually less for the year ending March 31, 1904, than it was for the preceding 12 months, although the output of electricity has increased by over 21 per cent. During the past year the output of electrical energy to private consumers for motive power has increased by 55 per cent., and the committee have every reason to believe that this rate of increase will be proportionately maintained. The comparison shows the continued growth of the undertaking, and, although a considerable percentage of the total increase in units sold is in respect of electrical energy supplied to the tramways company, yet it will be seen that the percentage increase in units sold to private consumers is also of a very satisfactory character. Number of consumers, 1904, 739 (1903, 655)—increase, 13·0 per cent. (20·2); number of lamps connected, 64,382 (54,578)—increase, 18 per cent. (30·5); units sold, 1,971,794 (1,624,639)—increase, 21·4 per cent. (17·0).

Hereford.—Sanction has been received to the borrowing of £1,100 for the completion of the electrical installation at the Burghill Asylum. The sanction issued by the Board on Nov. 25 last, authorising a loan of £550 for the same purpose, has been cancelled. The Electric Lighting Committee's report shows that the surplus profits for 1902-3, after paying interest, amounted to £673. 7s. 5d.; the repayment of principal was £920, leaving a balance of £246. 12s. 7d. to fall upon the rates. For 1903-4 the surplus profits were £815. 1s.; the repayment of principal was £1,000, a balance of £184. 19s. thus falling on the rates. The financial results of the undertaking for the year ended March 25, 1904, are as follows: Total units sold, 128,100, as compared with 108,815 units sold in 1902-3. Of these there were charged at 6d. per unit, 92,738 units, realising £2,318. 9s.; at 4d. per unit, 17,509 units, realising £291. 16s. 4d.; at 3d. per unit, 9,688 units, realising £121. 2s.; at 2d. per unit, 9,165 units, realising £68. 0s. 10d; sundry receipts, £3. 9s. 6d.; less discounts and irrecoverables, £271. 18s. 9d.; meter rents, £117. 17s. 2d.; sundry receipts, £23. 19s. 7d.—total, £2,672. 15s. 8d. The working expenses for the year, including wages, salaries, oil, stores, coal, repairs, taxes, etc., were £1,222. 15s. 6d.; interest, £634. 19s. 2d.—total, £1,857. 14s. 8d., leaving a profit toward repayment of capital (£1,000) of £815. 1s. The committee submit a return showing the output of current for the year ended March 25, 1903, and March 25, 1904, as follows: units sold for lighting during the year ending March 25, 1904, 110,247, against 95,213 the previous year; units sold for power 17,855, against 13,602; total units sold 128,100, against 108,815; equivalent number of 8-c.p. lamps at beginning of year 9,372, against 8,257; 8-c.p. lamps added 1,528, against 1,115; equivalent number of 8-c.p. lamps at end of year 10,900, against 9,372; number of arc lamps connected 22, against 20; number of motors connected 17, against 13; horse-power of motors connected 50¼, against 42. The committee have examined the estimate of income and expenditure on the electric light works for the current year as follows: estimated expenditure, £3,046; estimated income, £3,030; balance to be provided, £16.

Hammersmith.—Mr. G. G. Bell, the electrical engineer to the Hammersmith Borough Council, in his report upon the annual accounts of the electricity works for the year ending March 31 last, states that the accounts being made up to the last Thursday in March, this year includes 53 weeks instead of 52 weeks. Meters were, however, read as near as possible to the same date as formerly, so the cost sheets are charged one week extra without any corresponding increase in the revenue. He particularly draws attention to the fact that the cost of fuel has actually decreased £21 when compared with the previous year, in spite of the fact that 487,084 more units were sold, producing an increase of revenue amounting to £5,546. Repairs and maintenance have also decreased, owing to the fact that last year this account was debited with a certain amount of work which has this year been charged as "special charges." The increase shown in management expenses is principally due to the fact that the salary of the station superintendent has been charged under this heading instead of to wages as formerly. After deducting special charges (£2,071, not incurred in the actual production of current) the total costs amounted to £17,204, as against £16,254 for last year, but credit should be taken for the special charges and work done and goods supplied to consumers and others which had nothing to do with the cost of working the department. After deducting these items from both accounts, the cost of generating and distributing electricity was £15,793 for last year, and £16,035 for the year under review, or an increase of only £242 for 487,084 extra units sold. With regard to the special charges—£2,071—this expenditure is set out in detail. Strictly speaking, these should not be charged to revenue account, being works of a permanent nature in the generating station and elsewhere, but owing to the fact that for a portion of the expenditure they had no power to obtain loans, whilst the other portion would probably mean some difficulty in obtaining loans from the London County Council, it was considered advisable to discharge them direct out of current revenue, and not burden capital account, particularly as they did not increase the capacity of the station for supplying current. Interest had increased from £5,335 to £5,925, or £590 more, whilst the redemption of loans had increased by £1,089—from £4,514 to £5,603—being 2·8 per cent. of the capital outlay at the end of the year. This was the highest percentage of any metropolitan municipal undertaking, but was still insufficient to allow for the actual depreciation of the plant. Mr. A. G. Kean, the borough accountant, in his report says: "On capital account, the amount of capital borrowed for the purposes of the undertaking remains the same as at this time last year — viz., £196,311—as no new loans have been taken up during the year. During this period debt has been redeemed to the extent of £5,603, the unpaid capital borrowed at end of year being £176,168. The total capital redeemed to March 31 last was £20,143, being a percentage of 10·26 on the amount of loans taken up. The revenue account has much increased during the year, the gross income being £32,725. 5s. 5d., whereas at the corresponding date the income was £27,185. The greater part of this increase is accounted for by the expansion of revenue from private consumers, including the users of power, the increase of income for maintenance of public arc and incandescent lighting being £94 only. The working expenditure for the year has been £19,276, thus leaving a gross surplus of £13,449—a sum which, after allowing for irrecoverables, etc., and providing for an adequate reserve, would, in the case of a private company, be available for distribution to shareholders as dividend. The gross profit represents a percentage of 6·7 upon the amount of capital expended on the undertaking. Last year the gross profit was 5·74 per cent. upon amount of capital expended. After meeting charges of interest on indebtedness and redemption of capital, the net profit for the year was £1,855, the corresponding sum last year being £1,063. This net profit is equivalent to ·92 per cent. on the amount of capital expended, whilst the percentage last year was ·55. This net profit has been made after charging to the year the cost of certain works of a permanent nature. The total cost of these works amounts to £2,071. 18s. A reserve fund of £2,500 has been formed, but as this sum is not invested, it would not be immediately available in the case of any sudden emergency or breakdown of machinery, etc." He suggests the advisability of investing the same in Consols. Apart from this reserve, the accumulated balance now standing to the credit of the scheme was £3,169.

Croydon.—A further sum of £20,000 is to be raised for the purposes of extension of mains. Twenty-five applications were received during June, being equivalent to 963 8-c.p lamps. Eighteen consumers were connected, being equivalent to 694 8-c.p. lamps, and 925 yards of mains extensions carried out. The engineer (Mr. Alex. C. Cramb) has reported on a suggested system of charging for current for power and other purposes during the period of light load. He said it would be apparent that if a demand for electric supply could be created during the hours when the lighting load was not on the station, this demand could be supplied with the existing machinery at a very low rate. He was of opinion that a charge of 1½d. per unit during the hours of light load would well pay the department, and therefore submitted the following scheme. Taking the hour of dusk and 11 p.m. as being the hour at which the lighting demand falls off, he recommended that the charge for current should be 1½d. per unit for all times except between dusk and 11 p.m. During the time between dusk and 11 p.m. consumers should have the option

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of being charged at the rate of 5d. per unit for all current consumed during this period, or, alternately, the supply should be cut off for this time. By means of a time switch set once a month the relative hours during which the two rates were charged could be predetermined. In the case of those consumers who wish to have a supply available during the hours at which the higher rate (5d. per unit) was charged, the time switch would be arranged to pass the electric current through a second meter. In the case of those consumers who did not require a supply between dusk and 11 p.m. he suggested that the following rentals be charged for the time switches: for motors up to 5 b.h.p., £2 per annum; for motors above 5 b.h.p. up to 10 b.h.p., £2. 10s.; for motors above 10 b.h.p. up to 20 b.h.p., £3; for motors above 20 b.h.p., £4 per annum. As the demand for electric light on Wednesdays and Sundays was much less than on other nights of the week, the time switches would be arranged so that the higher rate would not be charged on these two days of the week. The revenue from current for motive purposes for last year amounted to about £524. Should all the present consumers elect to be charged on the first scheme herein set forth—viz, at 1½d. per unit—the revenue would amount to £360, or a reduction in revenue of £264. He estimated that this drop in revenue would be more than compensated for within a short time, and suggested that the fact of the Corporation being able to supply electrical power at a low figure would be of considerable assistance to many small men of business, and in conjunction with the motor hiring scheme a very considerable increase in the demand for electrical power in the borough might be anticipated. With respect to the hiring of motors, the engineer recommended that agreements be entered into with motor manufacturing firms for the hire-purchase and hiring of motors to prospective consumers in the borough. He received offers from a number of firms in the country based on specifications and certain proposed agreements issued to them, but owing to the fact that there were two systems of supply in the borough, it was found necessary to obtain prices for both direct and alternating current motors, and he found that separate agreements would have to be made with two different firms for the respective supplies. He recommended that the offer of the Lancashire Dynamo and Motor Company, Limited, for the supply of direct-current motors be accepted. Under this arrangement motors could be (1) purchased for cash, (2) taken on either three or four years' hire-purchase, or (3) simple hire for 12 per cent. per annum of value of motor. With regard to the motors for the alternating-current area, he was unable to make a definite recommendation at the present moment, but hoped to do so at the next meeting. The Corporation under this proposed scheme take no financial responsibility. The recommendations were adopted last week. The report of the seventh year of working by the borough electrical engineer contains the following: The returns show a net profit, after providing for sinking fund and interest, of £6,754, being an increase of £2,099 on that for the previous year. The capital expenditure during the year has amounted to £36,843, increasing the total capital expenditure of the undertaking to £271,258. The total receipts for the year amount to £46,596, as compared with £40,157 for the previous year, and the total expenditure amounts to £25,538, as compared with £21,889, leaving, after carrying £58 to next account, a gross profit to be carried to the net revenue account of £21,000, as against £18,200. Interest on stock, sinking fund, etc., amounts to £14,246, and the return on the average capital outlay represents 8·36 per cent. The price obtained for private supply is 4·17d. per unit, as compared with 4·34d. per unit for the previous year. The average price obtained for public lighting amounts to 2·69d. per unit. The number of consumers connected has increased during the year from 1,378 to 1,721, and the number of lamps connected from 96,479 to 115,461. The total number of units generated during the year amounted to 4,463,343, as compared with 3,889,794, being an increase of 573,549 units. The total number of units sold during the year amounts to 3,663,248, as against 3,131,841 for the previous year, being an increase of 16 per cent. The percentage of units sold to units generated amounts to 81·4 per cent. for the present year, as against 80 per cent. for last year. The number of units sold for tramways shows an increase of 12·5 per cent.; private supply, 26·1 per cent.; public lighting, 4·1 per cent. The mains laid during the year amounted to 12 miles, making the total length of cable laid in the borough 162 miles. During the year there have only been two breakdowns on the mains; each of these has been traced to external damage from picks. It is hoped that during the coming year a reduction will be made in the cost per unit generated in that part of the system which deals with the general supply.

PROVISIONAL PATENTS, 1904.

JULY 4.

14933. An improved mode of protecting life from the "live rail" danger on electric railways. Henry Curwen, 32, Sidney-grove, Newcastle-on-Tyne.

14940. An electric time switch. Arthur Joseph Parsons and Harold Mandefield, 67, Goodramgate, York.

14986. Improvements in actuating magneto-electric igniters of explosion motors for cycles and other vehicles. Ludwig Zeidler, 40, Chancery-lane, London.

JULY 5.

15011. Improvements in primary batteries. Frank Richmond, 254, Colne-road, Burnley, Lancs.

15034. Improvements in electric arc lamps. Crompton and Co., Limited, and Arthur John Hodgson, Arc Works, Chelmsford.

15035. Improvements in instruments for the measurement of electrical resistances. Kenelm Edgcumbe and Edgar Isaac Everett, 151, Great Saffron-hill, London.

15041. Improvements in means for signalling to and communicating with telephone exchanges. Gustav Ellis, 60, Queen Victoria-street, London.

15043. Improvements in electric transmitters. Henry Harris Lake, 70, Southampton-buildings, Chancery-lane, London. (Submarine Signal Company, United States.) (Complete specification.)

15046. A system for recording the number of telephone messages. Horace Stanley Williams, 7, Southampton-buildings, Chancery-lane, London.

15054. Improvements in and relating to apparatus employed in connection with electric telephones. William Walker, 18, Southampton-buildings, Chancery-lane, London.

15067. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

15068. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

15069. Improvements in fluid-pressure governors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15070. Improvements in and relating to the control of electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JULY 6.

15117. Improvements in electric cut-outs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15118. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15131. Improvements in electric railways or tramways. Walter Ffrench Gibbs, 23, Southampton-buildings, Chancery-lane, London.

15155. A new or improved automatic electrical balance. Wincenty Dworzynski, 18, Buckingham-street, Strand, London. (Complete specification.)

JULY 7.

15199. A new or improved device or apparatus for fixing electric lamps in the sockets of overhead electroliers, brackets, and the like, or for detaching them therefrom. William Veasey Bigge, 111, Hatton-garden, London.

15203. Electric burglar and fire alarm. Carlo A. Ali, 37, Chancery-lane, London. (Complete specification.)

15226. Improvements in the method of selecting electrical impulses. Daniel Watts Troy, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 11, 1903, being date of application in United States.) (Complete specification.)

15230. Improvements connected with electric arc lamps. Louisa Calvert and William Arthur Snape, 173, Fleet-street, London.

JULY 8.

15253. Improvements in dynamo-electric machines and motors. Wilfred Robert Vernet Marshall, 121, West George-street, Glasgow.

15255. Improvements in omnibuses, horse cars, electric cars, and the like. Hartley Illingworth, The Old Bank, Tadcaster, Yorks.

15258. Improvements in electromagnetic switch devices for telephone stations. Paul Arnheim, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 20, 1903, being date of application in Germany.) (Complete specification.)

15261. Improvements in dynamo-electric machines. William Arthur Ker, 65, Chancery-lane, London.

15267. Improvements in electric light fittings. John George Irving, Temple buildings, Albert-street, Nottingham.

15288. Improvements in the handles of spanners, pliers, and other tools used in electrical work. Henry Dorning Bailey and Percival Ormond Bonniwell, 65, Chancery-lane, London.

15289. Improvements in relays for direct-current automatic circuit breakers. Charles Cornfield Garrard and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

15290 Improvements in electrical measuring instruments. Charles Cornfield Garrard and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

15294. An improved process of electro-depositing antimony Anson Gardner Betts, 7, Southampton-buildings, Chancery-lane, London.

15296. Improvements in electric elevators. Robert Edward Phillips, 70, Chancery-lane, London. (Ernest Henry Vogel, United States.) (Complete specification.)

15298. An improved process of treating the metal mixtures produced as a by-product in electrolytic metal refining operations. Anson Gardner Betts, 7, Southampton-buildings, Chancery-lane, London.

15300. Improvements in electric transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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15301. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15302. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15303. Improvements in enclosed fuses. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15304. Improvements in and relating to electric controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15312. Improvements in or connected with means for the manufacture of brasses or bushes for the bearings of shafts, axles, or the like, more especially applicable to electromotors. William Hopkins Tomson and William George Hanna, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JULY 9.

15342. Improvements connected with overhead electric railways. Andrew Anderson and John Francis Dunne, 15, Water-street, Liverpool.

15344. An automatic safety device particularly applicable in connection with falling overhead trolley or other wires passing over or running parallel with same. Herbert Henry Berry and Frank Risch, 70, Upper Thames-street, London.

15360. Electrolytic circuit breaker. Alwin Kölling, 68, Alterwall, Hamburg, Germany. (Complete specification.)

15367. Improvements in couplings for electrical wires. John Griffith Thomas and David Evan Lewis, 33, Cannon-street, London. (Complete specification.)

15382. Improved sub-station connecting arrangement for telephone systems. Isidore Bernard Birnbaum and Herbert George White, 322, High Holborn, London.

15384. Improvements in or relating to memorandum and like appliances for use in connection with telephones and for other purposes. John Alexander Gamble, 6, Lord-street, Liverpool.

15386. Mechanical and electrical elevator for goods, especially goods contained in sacks. Jean Baptiste Rubando, Adolphe Estier, Henry Estier, Justin Mallet, and André Mouren, 40, Chancery-lane, London.

15391. Improvements relating to surface-contact electric railway systems. William Milton Brown, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 28, 1904.

1903.

7331. Apparatus for the transmission and reception of signals and the like through the natural media. Armstrong and Orling.

7773. Secondary batteries. Ekstromer and Lloyd.

10236. Telephone systems. Lake. (Andriano.)

14721. Holders for electric incandescent lamps. Peter Leonard and Charles Harold Jones.

14770. Electric motors or dynamos. Burnand.

14913. Electric arc lamps. Murphy and Townsend.

15199. Induction coils for the ignition apparatus for motors. Marconi's Wireless Telegraph Company, Limited, Ashley, and Hinde.

15247. Electric incandescent lamp-holders. Darrah and Hackett.

15407. Elastic fluid turbines, compressors, and the like. British Thomson-Houston Company, Limited. (Curtis.)

15514. Electrical alarm device for indicating the fall in the level of liquids contained in closed vessels or the like. Meyer.

17229. Appliance for gripping and supporting the wires of overhead wire systems of electric traction. Luby and Harris.

18731. Electrical switches. Crowe.

18960. Electrical switches. Cassella.

19015. Contacts especially suitable for induction coils. Marconi's Wireless Telegraph Company, Limited, and Priddle.

19062. Electrical locking apparatus for railway signals. Sykes.

19491. Arc lamps. Foster, Grote, and Ely.

19522. Rotary electric machines. Chitty.

19563. Flexible isolation tube or conduit for electric conductors. Deutgen.

21363. Electric accumulators. Méran.

21964. Starting switches for electric motors. Weaver.

22674. Telephone systems. Hardegen.

24581. Portable electric fan. Margowski.

26247. Electrically-operated driving mechanism for centrifugal machines. D'Olier.

1904.

455. Telautograph apparatus. Ritchie.

550. Telautograph apparatus. Ritchie.

6873. "Clusters" for incandescent electric lamps. Dale.

9633. Sanitary rotating diaphragm for telephones. Churchill-Otton.

10393. Electric bath. Schwedler.

11848. Electric igniters for explosion motors. Sander.

12344. Electric arc lamps. Heany.

12345. Electric arc lighting. Heany.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¾-6¼
—— 5 per cent. Cum. Pref., 1-100,000	5	..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	101-103
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	..	3¼-3⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	86-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅝-1
—— Non. Cum., 6 per cent. Pref.	2	..	⅝-1⅛
—— 4½ per cent. 1st Debenture Stock	100	..	96-99
—— 4½ per cent. 2nd Debenture Stock	100	..	71-76 xd
Callender's Cable, Debentures	100	..	102-106
—— Ordinary	5	..	9¼-10¼
—— 5 per cent. Pref.	5	..	5¾-6¼
Crompton and Co.	5	..	11-12¼
—— 5 per cent. Debentures	100	..	93-96 xd
Edison and Swan United, "A" Shares, 1-96,261	5	..	⅜-½
—— "A" Shares, 01-017,139	5	..	1-1⅛
—— 5 per cent. Debentures	100	..	75-79
—— 4 per cent. Deb. Stock, Red.	100	..	74-79
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2¼-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	93-98
W. T. Henley's Telegraph Works, Ordinary	5	..	11¼-12¼
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	36-39
—— 5 per cent. Bonds	100	..	99-102
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	122-127
Bournemouth and Poole, Ordinary	10	..	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9¼-10¼
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	10⅜-11¼
—— 7 per cent. Preference	5	..	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	7-7¼
—— Nos. 40,001-80,000	5	..	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-108
Charing Cross and Strand, Nos. 1-70,000	5	..	7¼-8
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	102-104
Chelsea Electricity Supply	5	..	6¼-6¾
—— 4½ per cent. Debentures	100	..	106-109
City of London, Ordinary	10	..	11-11¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	101-104
County of London Electric Supply, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5¾-6¼
—— 6 per cent. Cum. Pref.	5	..	5¾-5¾
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	1¼-1¾
—— 5 per cent. Debenture Stock, Red.	100	..	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-15,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	12-13
—— per cent. Debenture Stock Red	100	..	102-105
Kensington and Knightsbridge and Notting Hill	100	..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	5	..	1¼-1¾
—— 6 per cent. Pref.	5	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	94-97
Metropolitan Ordinary	10	..	21-22
—— 4½ per cent. First Mortgage Debenture Stock	100	..	108-112
—— 5½ per cent. Mortgage Debenture, Red.	100	..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	..	100-103
Notting Hill Electric Lighting	10	..	13-14 xd
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)	100	..	98-101
Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,310	5	..	5¼-6
—— 4 per cent. Debenture Stock	100	..	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ltd., ord., 1-12,000	5	..	3¾-3¾
—— 4 per cent. Debenture Stock	100	..	86-90
South London, Ordinary		..	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14¼-15¼
—— 7 per cent. Pref.	5	..	8-9
—— 5½ per cent. Deb.	100	..	96-99 xd
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4¼-5
Westminster, Ordinary	5	..	12¼-13¼
—— 5 per cent. Cum. Pref., 110,101-158,251	5	..	6¼-6¾

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 –	90-93
—— 4 per cent. Pref.	100 –	102-105
—— ,, deferred	100 –	79-82
—— 4 p.c. Deb. Stock (Prov. Scrips Certs., fully paid).	100 –	109-111
City and South London, Consolidated Ordinary	100 –	47-49
—— 4 per cent. Debenture Stock	100 –	106-109
—— 5 per cent. Pref. Stock '91	100 –	123-126
—— ,, ,, ,, '96	100 –	120-123
—— ,, ,, ,, '01	100 –	118-122
Liverpool Overhead, 5 per cent. Pref.	10 –	10-10¼
—— Ordinary, 1-60,000	10 –	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— –	98-101
Waterloo and City, Ordinary	100 –	89-92
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 –	5-5¼
—— Permanent 5 per cent. Debenture Stock, 1888	100 –	137-141
Blackpool and Fleetwood Tramroad	10 –	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 –	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 –	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 –	96-101
British Columbia Electric Railway Co., Ord. Def.	100 –	100-103
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 –	10¼-10⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 –	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	98-101
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10 –	9 9¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 –	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100 –	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	2¼-3¼
—— "A" 6 per cens. Cm. Pf., 1-40,000	5 –	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 –	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 –	105-108
—— Prov. Cert., all paid	100 –	101-104
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅛-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 –	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10 –	9½-10
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18-19
—— 6 per cent. Cum. Pref.	all –	14-14½
—— 4½ per cent. Deb Stock	100 –	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 –	3¼-4
—— 4 per cent. Debenture Stock	100 –	88-91
Kidderminster and District Lighting and Traction, Pref.	5 –	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10½-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	104-104
Metropolitan Electric Trams., Deferred, 1-00 001-1,314,016	1 –	1-1
—— 5 per cent. Cum. Pref., 500,001-814,016	1 –	1-1
New General Traction, Ordinary	5 –	⅝
—— 6 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,715 (Regd.).	100 –	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12½
—— 5 per cent. Cum. Pref.	10 –	9¾ 9½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 –	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	9-10
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,132 5 per cent. Preference	1 –	1
—— £528,0 4½ per cent. Debenture Stock	100 p.c. –	100 p.c.
Telephones.—		
National Telephone, Preferred	100 –	106-107
—— Deferred Stock	100 –	88-91
—— 6 per cent. Cum. First Pref.	10 –	11-13
—— 6 per cent. Cum. Second Pref.	10 –	11-1
—— 5 per cent. Non. Cum. Third Pref.	5 –	5¼-5⅝
—— 5½ per cent. Deb. Stock, Red.	100 –	97-99
—— 4 per cent. Deb. Stock, Red.	100 –	103-105
Oriental Telephone and Electric Company	1 –	5/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 9	1,6 2	1,245	+ 355	+ 1,573*h*	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	5·1
Ayr Corporation	,, 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	,, 9	37	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 10	1,111	1,101	+ 10	– 15	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 9	5,798	5,137	+ 661	+ 9,144	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 8	993	878	+ 115	+ 1,110	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 7	1,149	1,091	+ 58	+ 655	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 9	870	811	+ 59	– 184	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 10	2,151	2,014	+ 137	– 47	38	38	March 31*g*	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 6	1,052	1,058	– 6	+ 794	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 2	4,684	4,201	+ 483	+10,216	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 10	1,188	982	+ 206	+ 456*h*	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 8	5,433	5,087	+ 346	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 9	1,024	852	+ 172	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 10	387	—	—	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 9	2,186	2,601	– 414	+ 624	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 9	219	212	+ 7	+ 309	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 11	6,441	6,954	– 510	– 510*h*	6	6	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	36·6*a*
City & South London Railway	,, 10	2,336	2,473	– 137	– 81*h*	6⅝	6⅝	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 7	610	686	– 76	– 936	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	June 24	225	234	– 9	– 131	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 25	251	267	– 16	– 233	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	July 8	160	94	+ 66	+ 66*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 8	4,188	4,4 2	– 264	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 8	1,142	1,123	+ 19											
Dundee City Tramways	,, 6	836	847	+ 9	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 9	773	743	+ 30	+ 1,032	10·75	10·75	March 31*g*	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 9	13,794	13,043	+ 751	+ 1,49*h*	124	124	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	June 1	224	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 29	3,214	3,140	+ 74	+ 1,147	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	July 9	1,408	1,271	+ 137	+ 760	34	34	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 9	2,181	1,880	+ 301	+ 3,576	25	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 9	528	552	– 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 6	142	192	– 50	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 6	240	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 9	6,131	5,541	+ 590	+ 5,100	77	77	March 25*g*	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 9	1,133	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 2	11,343	11,121	+ 222	+ 5,897	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 10	1,672	1,718	– 46	– 29*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *e*
London County Council	,, 2	13,329	11,495	+1,834	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 9	285	—	—	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 9	13,216	12,209	+1,007	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 9	129	77	+ 52	+ 751	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 9	3,542	3,237	+ 305	—	38½	38½	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 9	542	494	+ 48	+ 1,676	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 2	2,220	2,183	+ 37	+ 2,207	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 7	470	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 11	4,251	4,148	+ 303	+ 4,996	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 9	287	—	—	—	7⅜	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 10	4,923	4,738	+ 184	+ 2,092	53½	53½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 7	892	1,122	– 230	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 6	435	399	+ 36	+ 357	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 8	653	371	+ 282	+ 3 580	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	June 26	1,761	1,405	– 44	+ 343	18·48	18·48	,, 31*g*	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	July 9	849	774	+ 75	+ 522	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 7	1,106	—	—	—	1⅜	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 6	730	476	+ 254	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Institution of Electrical Engineers.—The following are the names of the gentlemen who have been appointed by the Institution as delegates to attend the International Electrical Congress to be held at St. Louis: Mr. R. Kaye Gray, president; Colonel R. E. Crompton, C.B., past-president; Prof. John Perry, F.R.S., past-president; Dr. R. T. Glazebrook, F.R.S., member of council; and Mr. H. E. Harrison, B.Sc., B.A. Mr. W. Duddell will act as hon. secretary to the delegation. The two last-named gentlemen have previously served on the Council of the Institution. The congress will open on Monday, Sept. 12, and will meet daily until Friday, the 16th.

Copper Production.—The output of copper during the year 1903 amounted to 565,820 long tons, being an increase of 24,525 tons over the previous year. With two minor exceptions, all the copper-producing countries showed an increase. The great bulk was obtained in North America, the produce there amounting to 64·7 per cent. on the whole, the United States being credited with 53 per cent. In the aggregate Europe yielded 16·5 per cent., Spain and Portugal being the most prolific countries. Asia, as represented by Japan and Australasia, contributed 10 7 per cent. South America produced 7·1 per cent., the greater portion of which was obtained in Chili.

New Publications.—"An Enquiry into, and an Explanation of, Decimal Coinage and the Metric System of Weights and Measures," by E. Anthony (Anthony Bros., Limited, Hereford); "Magnetism and its Elementary Measurement," by W. Hibbert (London: Longmans, Green, and Co. 2s.). A volume entitled "The Telephone Service: Its Past, Present, and Future," by Mr. H. L. Webb, which is to be published shortly by Messrs. Whittaker and Co., will doubtless be read with interest in view of the present discussion on the telephone question. This work will be an endeavour to describe in plain language the general features of a modern telephone exchange, and it is hoped that it may be of assistance to the telephone user and others interested in the working and development of the telephone service.

The Government and Wireless Telegraphy.—The Wireless Telegraphy Bill introduced by Lord Stanley, which passed its first reading in the House of Commons on Monday, proposes to give the Post Office power to regulate wireless telegraphy, but does not confer a monopoly, as it was freely reported to do, upon the Government. Under the terms of the Bill the Post Office is to be empowered to deal with wireless telegraphy by license, in order to ensure that in time of national danger the Government will be in a position to take over, suppress, or make use of all wireless telegraphs, so as to be of assistance to themselves and to prevent their being of assistance to the enemy; and also to protect stations from being interfered with by the erection of rival stations in the neighbourhood. Special provision is made for experimental installations. The Bill is drawn in very concise terms, and must pretty well constitute a record in point of brevity.

Carbon Vaporised in Incandescent Lamps.—In a paper recently read before the French Academy of Sciences, Prof. Berthelot examines, at the lowest possible temperatures, the state of the vaporised carbon produced in the vacuum of incandescent lamps from the amorphous carbon of the filaments, comparing it with such well-known allotropic modifications of carbon as the diamond graphite amorphous carbon. The main results of this investigation, as described in the *Scientific American*, are that carbon gives off an appreciable vapour tension at a temperature not exceeding 1,500deg. C., this tension being so low as to require several hundreds of hours to produce some milligrammes of condensed carbon, even in the nearly absolute vacuum of electric lamps. On the other hand, the carbon thus vaporised at the lowest possible temperatures is, under Prof. Berthelot's experimental conditions, amorphous carbon without any addition of graphite or diamond. The temperature at which a vapour tension of carbon may be noted appears from this to be about 2,000deg. below the boiling point, which, according to Prof. Violle, is 3,600deg. This interval is very much larger than the interval of temperatures during which most of the remaining bodies exhibit an appreciable vapour tension. This tension, however, in the case of carbon does not, in Berthelot's opinion, correspond with a simple vaporisation, occurring without any intimate change in the chemical constitution of the body.

High-Potential Alternators.—At the recent National Electric Light Convention held at Boston, U.S.A., one of the papers read was by Mr. G. N. Eastman, the subject being "Grounding the Neutral on High Potential Alternators," of which a summary is given in the *American Electrician*. The author presented a mathematical demonstration to show that the advantages obtainable by insulating the [of neutral a high-tension alternating-current system from the earth, will be more than offset by the liability of developing abnormally high potentials relative to the earth. The paper was based on a consideration of the three-phase four-wire system of the Commonwealth Electric Company, of Chicago, and was illustrated by diagrams showing the voltages obtained with wholly-insulated and neutrally-grounded circuits. The author expressed the opinion that a proper method of grounding the neutral of generators is through as low a ground resistance as can possibly be obtained, thus fixing the maximum potential which can be obtained between a system and ground at the normal potential which will exist between the neutral of the generator and its phase terminals. The systems of the Chicago Edison Company and the Commonwealth Electric Company have been operated with a grounded neutral for a period of four years, during which time they have apparently been entirely free from the high-potential breakdowns that have occurred on other systems of a similar character entirely insulated from the ground.

The Positive Auxiliary Car-Lighting System.—The Lackawanna and Wyoming Valley Railroad Company has recently adopted an auxiliary car-lighting equipment of the automatic type, supplied by the Kinsman Electric and Railway Supply Company, of New York, for the purpose of providing lighting current when the propulsion current is interrupted. The Kinsman system, described by the *Street Railway Journal* of New York, consists of an equipment for providing electric current for the car from a small storage battery, which will be operative normally only when the propulsion current supplied to the car is interrupted. The passage of the propulsion current through the regular lighting system of the car is arranged to normally pass a charging current to the storage batteries for the auxiliary system, and by means of an automatic switch to keep the auxiliary lighting system cut out. Whenever the propulsion current is interrupted, however, the automatic switch releases and throws the auxiliary lighting circuit on to the storage batteries, leaving them connected in and burning until the propulsion current again flows. The system is convenient and economical, as only a very small battery is required in each car. Upon the above-mentioned railroad each car is equipped with a storage battery of six cells of five ampere-

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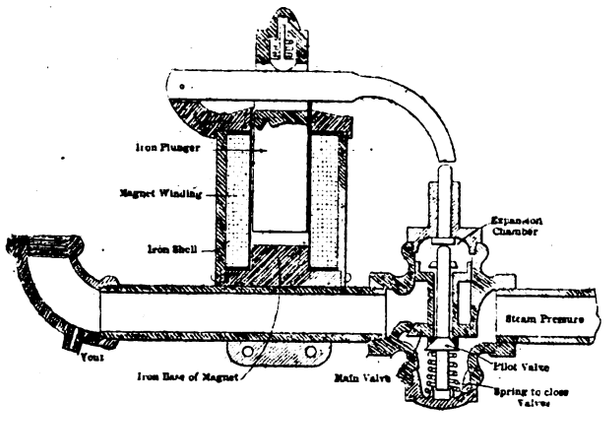
hours capacity each, the batteries being enclosed in a box for convenience, occupying very little room and weighing only 60lb. in all.

Hydro-Electric Development in Mexico.—A few weeks ago we referred to the awakening which has lately taken place in Mexico in regard to the utility of electricity. The country possesses great natural resources in this respect, water being found in great abundance near the larger centres of population. There are but very few large streams in the republic, but owing to the mountainous nature of the greater part of its area there is an abundance of small streams, which, owing to their rapid fall, offer a great amount of power. Certain obstacles, however, remarks the *Electrical World* of New York, have to be overcome in using this water power. One especial fault is that many of the streams have dry beds for about six months of the year. The problem to be solved in such cases is how to profitably utilise the power which can be derived from such streams during the rainy season, when they are full. In some cases where power from streams that are dry during part of the year is now being utilised to generate electric power for lighting, etc., coal or other fuel is used during the dry season. The exclusive use of coal or other fuel for generating steam to run the plants would render the cost of their operation prohibitive to profits, but by using the water power for some six months of the year profits can be made. Another obstacle is that of vegetable growths, such as water hyacinths, which greatly impede the use of water from streams infested with it. This obstacle has, however, been overcome to a very great extent in the United States, and there is no reason why it cannot be overcome in Mexico.

An Electrically-Operated Valve.—The accompanying diagram, reproduced from *Power*, shows a valve which is operated by the action of an electric current flowing through the solenoid mounted over the pipe shown. The action is to draw down the iron core and press down the curved lever, which opens the small pilot valve just under the main valve, admitting steam to the expansion chamber



above. The pressure on both sides of the main valve is by this means balanced, and a further motion of the lever opens the main valve, allowing steam to flow by it. A spring under the pilot valve seats it when the current is turned off the solenoid, and a spring mounted in the top of the solenoid plunger raises it above the bent lever when out of action. The device is manufactured by the Electrical Appliance Company, Cincinnati, Ohio, and recommended by them for use on a whistle valve.

Electricity in Siberia.—The Russian engineers in charge of the construction of the railroad around the southern part of Lake Baikal, have encountered great difficulties in the course of the undertaking. It has been found necessary in one part of the railroad, some 16 miles in extent, to build 13 tunnels, totalling 2½ miles in length, besides making numerous cuttings in the rocky soil. Appreciating the results obtained in Western Europe and America from the use of electrically-operated drills, the engineers decided on employing the same method. At the middle point of the section a central power station has been established, with high-tension cables extending on both sides along the track. The station contains a boiler-house and a generating set of 120 h.p. output. A three-phase generator produces alternating current under pressure of 2,200 volts. The high-tension cables carry the current to four sub-stations, each of which contains an alternating-current motor operating a dynamo. Some of the dynamos generate alternating current at 110 to 130 volts, while others produce direct current for driving pumps and ventilators, and also for illumination. The alternating current is distributed through the whole plant, where 25 to 30 electric drills are constantly in operation. From the direct-current machines current is supplied to eight arc lamps and 200 incandescent lamps. The direct current is also employed for driving six rotating pumps and six ventilators which are employed for air purification after each explosion in the tunnels. Notwithstanding the Arctic conditions, the installation was completed in less than three months.

An Indicating Fuse Alarm.—A short account is given in the *American Telephone Journal* of one of the latest telephonic inventions—the automatic indicating fuse alarm. The value of this adjunct to the fuse panel consists of its reliability. It will be seen from the accompanying

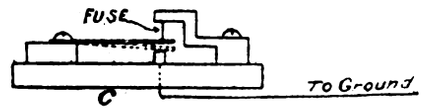


diagram that the fuse consists of a spring, which is held from a ground contact by means of a short piece of fuse wire. When, for any reason, this fuse blows, the spring makes contact with the ground and closes a circuit through a relay, which lights a lamp and also closes a second relay that causes a signal bell to ring. The relays, bell, and lamp should be placed as near as possible to the fuse panel. The fuse panel is divided off into sections, each section having a separate ground conductor connected in series with a relay, so that when any fuse for a section is opened, the relay of that particular section is closed, and the lamp is lighted and remains lighted until the fuse is replaced. A single-point switch is provided to open the bell circuit so as to prevent noise occurring while the defective fuse is being located and replaced. The number of circuits to each ground depends entirely upon circumstances, but it is preferable not to have too many, else the value of the fuse as a time-saving device is eliminated. Although the initial cost is higher than that of the ordinary fuse, the additional expense is repaid by the advantages afforded for the rapid location and removal of trouble.

The Civil Engineers' American Visit.—Provisional arrangements have been made for the tour of the Institution of Civil Engineers, who, like their brethren of the electrical profession, are to visit the States and Canada in September. The main party will leave Liverpool by the ss. "Etruria" on Sept. 3, and are expected to reach New York on Sept. 10. On the 13th of the month a formal reception of the visitors by the American Society of Civil Engineers will probably take place, the remainder of the week being spent in examining places of interest in the city and its environs. On the following Monday

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the party will proceed to Montreal, and will be engaged until the 27th in visiting various places of interest in the Dominion under the guidance of the Canadian Society of Civil Engineers. Chicago will be visited on the 28th, and on the 30th the party will arrive at St. Louis, where the exhibition will claim their attention. The programme gives a list of hotels at the different cities, and whilst members of the visiting party will communicate directly with the proprietors of the hotels, the secretary of the institution will be glad if they will inform him of the accommodation they have ordered, as he may possibly be able to facilitate arrangements, and also the names of any members of their family by whom they propose to be accompanied. Members are reminded that the arrangements made with the Cunard Steamship Company enable members to book their passages by the ss. "Etruria," with the option of return by any of the Cunard steamers from New York or Boston, or by any of the Allan Line steamers from Montreal and Quebec, at a reduction of 25 per cent. on the ordinary first-class fares. Those members who propose to take part in the tour and have not already secured outward passages are advised to do so without delay.

Mussoorie.—The Municipality have decided upon a hydro-electric plant for furnishing Mussoorie and Landour with an adequate water supply and for the provision of electrical energy for lighting and power purposes. Hitherto the only illumination in the streets has been that afforded by a few oil lamps. The *Indian and Eastern Engineer* gives some particulars of the scheme, which has been prepared by Mr. P. Billinghurst, late of the Bikanir State service, who found, as the result of comparisons between steam, oil, and electric power, that the last-named was distinctly the most economical and best adapted to the circumstances. The generating plant will be located at Kimpti Falls, 2½ miles from Mussoorie. The effective head of water is reckoned to be 776ft., after deducting the loss of head due to friction in the pipes, which is given as 45ft., the velocity of flow being taken at 5ft. per second. The quantity of water available is never less than 6½ cubic feet per second, and the power available at the generator terminals is calculated to be about 400 e.h.p. Allowing for 6 per cent. loss in the line at full load, there will be some 280 kw. available for distribution. For the water supply, springs between Kimpti Falls and Mussoorie will be utilised. The scheme provides for the lighting of 13½ miles of roads, and for the supply of electricity sufficient for the lighting of all buildings in Mussoorie and Landour. The surplus power remaining after providing for the above and pumping purposes, the latter being conducted during the hours when lights are not needed, will be available for private lighting and heating. The generator house will be fitted with four 85-kw. turbine-generator sets and two turbine-exciter sets. The load being a fluctuating one, a dam will be built after the present power is taken up, and this will increase the power for the evening load to about 800 h.p. The turbines will be of the Pelton wheel type, fitted with electric governors and designed for a speed of 600 revolutions per minute, with a direct drive to the generators. These will be of the alternating-current three-phase 60-cycle revolving-field type, giving 5,500 volts at 600 revolutions per minute. The power will be transmitted to 12 transformers situated about every 3,000ft. through the stations. The transformers vary in size from 5 kw. to 70 kw. The high-tension mains are of sufficient size for double the expected load. Energy will be distributed from the transformer houses at a pressure of 230 volts and delivered to consumers at 225 volts. The mains for the motors at the main pumping station feed two 120-kw. transformers arranged in parallel. These feed through the usual switchboard instruments two motors of 150 h.p. each. The motors are of the induction type, with starting resistances and short-circuiting switches, running at 450 revolutions per minute. The distance from the generator house is about 10,000ft., and the voltage is 220, with a frequency of 60 cycles. The scheme is estimated to cost some £47,000, and the annual expenses, including capital charges and depreciation, are put at £4,300. The present cost of lighting and water supply is given as £1,820. It is proposed to supply energy at 4d. per unit for light and 3d. for power and heating; and it is calculated, at a conservative estimate, that the sale of electricity in the first year for private lighting alone will amount to some 48,000 units. The scheme should prove a great boon to the inhabitants, and appears to justify the prediction of Mr. Billinghurst that it will show a considerable profit, at any rate after the first few years.

A Novel Gas-Engine.—A novel gas-engine is being brought out by the Maschinenbaugesellschaft München, in conjunction with the Austrian firm of Bromovsky, Schuls, and Sohr, Prague. This four-time motor, designed by Mr. Güldner, embodies a high improvement as regards the thermal utilisation and specific efficiency. The arrangement of the crank and governor shafts is extremely solid and practical, and as, moreover, the working cylinder is purely cylindrical and free from any projection, the thermic expansion will be quite uniform. Any parts in and near the cylinder cover are readily accessible. The valves and igniters may be removed and replaced in position (in case of a revision being necessary) with a few manipulations, and without removing any parts of the governor or any conducts, in addition to which the inner walls of the cylinder may be cleaned thoroughly without the cylinder cover being withdrawn, which is highly important from the point of view of safety in working. The gas valve, being governed like the inlet and outlet valves, is not liable to become obstructed by impurities. The valve cones are very strong, and guided in special slides, and the governing levers are applied between the inner and outer slides, so as to exclude any possibility of the cones being thrown to the side, and to maintain continually a perfect tightening. In order to eliminate any heat effect in the valve springs, these are located at the upper end of the cone shafts. The magneto-electric ignition is so arranged as to allow of the moment of ignition being readily adjusted by hand during operation. The igniting current is supplied from a Bosch apparatus arranged above the governing shaft and moved from the latter so as to allow of the regulation alluded to. The regulation of speed is effected by throttling the cylinder contents, the composition of the charge being influenced simultaneously with the quantity so as to maintain with any load a safely igniting mixture. The design of the combustion chamber as a regular cylinder with smooth walls greatly facilitates a thorough expulsion of the exhaust gases, while avoiding a dispersion of the fresh mixture, which is so prejudicial to a complete ignition. On the other hand, a complete combustion is secured by the efficient position of the igniter in the axis of the cylinder, which, according to thermo-dynamics, is the most suitable place possible. The inflammation is started in the centre of the condensed charge, whence it may diffuse to all sides on the shortest possible paths through the whole charge of the cylinder. To these constructive details seems to be due the extraordinarily high utilisation of heat, as borne out by tests recently made. From experiments by Prof. Schröter, made on the first Güldner motor built in Munich, it is inferred that as much

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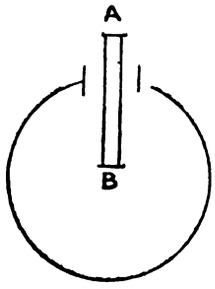
as 42·7 per cent. of the amount of heat actually supplied to the engine with the lighting gas is transformed into indicated work, while with any other lighting gas motors the figure of 30 per cent. is seldom even slightly exceeded. The same applies to suction gas operation, where a figure of nearly 29 per cent. is recorded, including any losses in producer and purifier. The extraordinary elasticity of the output of the motor, which may be increased within wide limits, should be especially mentioned. In fact, while in older types of suction gas motors, the mean piston pressure is seldom upwards of, say, 30lb. to 35lb. per square inch, the figures observed with Güldner motors—viz., more than 45lb. per square inch—are approached only in the Diesel petrol motor. In modern types of steam-engines, the average steam pressure at normal load is about one-quarter.

Electric Arcs of Large Surface.—Prof. K. Birkeland has, according to the *Elektroteknisk Tidsskrift*, Christiania (No. 16, 1904), taken out patents for a process for obtaining electric arcs of a very large surface. The invention is based on the production of a chemical compound or a decomposition of gas mixture or gases by means of a special kind of electric arc. As is well known, electric arcs will exert chemical effects on gases, this effect being essentially dependent on the magnitude of the contact surface between the arc and gas mass With a view to augmenting this contact surface, the use had been suggested of electrodes of such an arrangement and performing a movement with respect to one another such as to expand the arc in its longitudinal direction until it is closed on the mutual distance of the electrode becoming too great.



With these processes, exceedingly small currents had, however, to be used. The process suggested by Birkeland consists in having the point of contact between two conductors, one (or both) of which is susceptible of a vibrating movement, traversed by an electric current in a strong magnetic field. The inventor has found under these circumstances an electric arc formed between the contact points, even in the case of the distance between the latter being increased only to a fraction of a millimetre, to be thrown violently upwards or downwards, so as to form a large and plane permanent arc disc, susceptible of absorbing high amounts of energy and current. This process seems to be especially adapted to producing nitrogen-oxygen compounds of air, and in the description given below it is assumed that the method is to be applied to the oxidation of nitrogen. After arranging a circular electromagnet, as shown in the accompanying diagram, the air is conveyed through a prismatical tube, A B, being insulated fireproof in its interior. This tube is, by means of partition walls parallel to the magnet surfaces, divided into shallow compartments or channels. In each of these compartments there is placed a special interrupter, working both for alternating and direct currents, and consisting in its simplest form of two metal rods, one end of which is clamped fast, while the other terminal is maintained in good contact with the springs. One end is prevented by means of a stop from swinging upwards, while the free end of the other rod is prevented in a similar way from downward swinging. Now, in the case of a high-tension alternate current, or a low-tension direct current of convenient intensity, traversing all the interrupters in parallel (convenient inductive resistances being connected to each of them), there will result an alternate movement of the two rods, one swinging down and the other swinging up alternately, so as to form frequently a very slight interruption of the contact, when the remarkable phenomenon above alluded to will occur, and a violent projection of the arc be observed, resulting in the space becoming filled with expanded arcs. In the case of fairly high tensions being available, the current may be thrown partly or wholly through the interrupters in series. In the case of direct current being used, only one spring of the contact interrupters will be set vibrating. The air may be made to traverse either all the channels in parallel or partly in series, or else wholly in series so as to cause it to pass subsequently before each of the arcs, a contact thus being produced with an exceedingly high number of arc discs. In order to further augment the number of arc discs the air comes in contact with, several systems of the same kind may be connected to one another. Instead of the automatic interrupter above described, some other means are available for producing the frequent slight interruptions. Big tuning forks driven by small electromagnets may, for instance, be used for the purpose.

The American Visit.—A detailed programme of events in connection with the reception and entertainment of its visitors by the American Institute of Electrical Engineers and the holding of the International Electrical Congress at St. Louis, just received from Mr. R. W. Pope, the secretary of the American Institute, shows that practically all the arrangements have now been completed. An outline of this programme was given in our issue of April 22, and we cannot do better than reproduce our notice, supplemented by the additional features appearing in the later programme: "The itinerary will commence on Sept. 4 with a journey up the Hudson River by steamer. In the course of the week the visitors will be entertained by the New York corporations, under whose guidance they will inspect the power-houses of some of the chief New York companies; there will be a formal reception under the auspices of the institute; the party will be received and entertained at Schenectady by the General Electric Company, following which they will leave for Albany, and in the evening start on an all-night trip to Montreal; McGill University and large transmission plants in the neighbourhood will be visited; the Niagara Falls will receive attention on the Friday; and the next day will see the party exploring Chicago, leaving in the evening for St. Louis. On Monday, Sept. 12, the opening of the international electrical congress, at 10 a.m., will take place, and on the Wednesday there will be a special joint session between the American and British institutions. Sessions of the various sections of the congress will be held from the 13th to the 17th, after which the party will leave St. Louis for Pittsburg. The following week, commencing Sept. 19, will begin with a reception and entertainment by the Westinghouse Company, other events being the inauguration of the National Bureau of Standards at Washington, and visits to Philadelphia and Harvard University, the Massachusetts Institute of Technology, and other places of interest at Boston." The last-named events—the visits to Harvard, the Massachusetts Institute, and other places at Boston—appear to have been transferred to the other end of the programme, and will initiate the tour on Sept. 3. For the convenience of visitors arriving at New York on or prior to Sept. 1, and who will proceed to Boston to join the main party, an excursion has been arranged *viâ*

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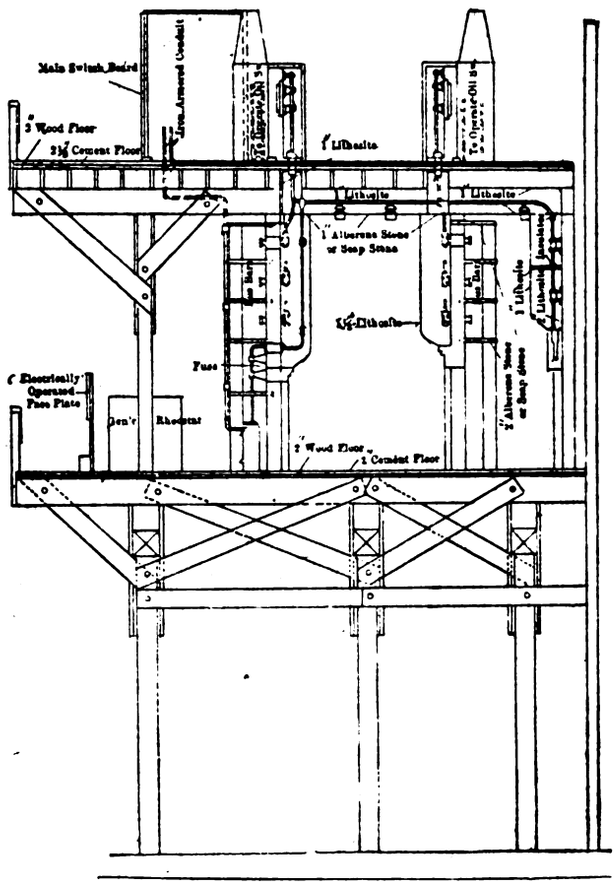
Newport, leaving New York by steamer on the evening of Thursday, Sept. 1, at 5.30 p.m. After spending a day at Newport, those who go on this excursion will proceed to Boston, arriving there at 7.13 p.m. of the same day in time to join the main party in seeing Boston on Saturday, Sept. 3. Inclusive terms of £4 have been arranged for this trip from New York to Boston, *viâ* Newport and direct return, including hotel expenses in Boston. The circular tour will be by special train composed of Pullman drawing-room and sleeping cars, and will leave the Grand Central Station of the New York Central and Hudson River Railroad at 8.45 a.m. on Tuesday, Sept. 6. This train will run along the east bank of the Hudson River as far as Albany, giving views of the Palisades and of the Highlands of the Hudson. All visitors are invited to take part in the circular tour. The visitors will be accompanied during the circular tour by representatives of the American Institute of Electrical Engineers, many of whom will be accompanied by ladies, to act as guides to the visitors. Members desiring to participate in the circular tour may obtain tickets in advance through the secretary of the British Institution, to whom intimation should be sent without delay, so that there may be no lack of time for communicating with the American authorities. It may be mentioned that the fee for membership in the St. Louis Congress is £1. 0s. 10d., entitling the subscriber to a copy of the *Proceedings* of the congress, which are to be subsequently published. The fee may be forwarded either to the secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., or to the treasurer, Mr. W. D. Weaver, 114, Liberty-street, New York City. Between Sept. 12 and 17 the office of the secretary and of the treasurer will be at the Coliseum, St. Louis, Mo.; before and after that date they will be at the addresses given above. Other information is given in the programme relating to fares and hotels, the substance of which we have given in previous issues. The completeness of the programme testifies to the care exercised in its organisation.

The Large Switchboard at the St. Louis Exhibition.—The great switchboard at the St. Louis Exhibition is designed for the control of all the 6,600-volt three-phase current used on the exhibition grounds. It is a brick masonry structure, occupying two galleries and supported upon timber work. A description of it appears in the *Electrical World* of New York, and the diagram which we reproduce shows a cross-section. The switchboard consists mainly of feeder panels, as most of the generator panels will be located near the machines they control. The four generators in the service plant have control panels on this switchboard. There are in all 17 feeder panels, four generator panels, three total load panels, three exciter panels, two incoming feeder panels from the Union Light and Power Company, and one rheostat panel for controlling the water rheostats, spoken of as being inserted in the Union Light and Power Company's feeders at the entrance to the grounds for the purpose of bringing the decorative lighting up to full voltage gradually. On the control board proper, which is on the second floor of the gallery, and which has nothing but low-tension pilot circuits upon it, there are two sets of three-phase 'bus bars. Each feeder can be connected with either of the 'bus bars through the medium of a Westinghouse solenoid-operated oil switch. On each side of the oil switch there is a hook knife switch, so that the oil switch could, if necessary, be entirely disconnected, both from the 'bus bars and from its feeders, in case it should be necessary to make repairs on the switch. These switches can be operated either by a low-tension hand switch on the controlling board or by an automatic overload relay. From the accompanying diagram, it will be seen that the two sets of 'bus bars are located in independent brick compartments about 9ft. apart, one row of compartments occupying the rear part of the lower gallery and the other row the front part. On the second gallery is located the control switchboard and the high-tension oil switches. The hook knife switches, which are placed in the circuit on both the incoming and outgoing leads from the oil switches, are located on a concrete partition just back of the oil switches. Following the right-hand leg of the feeder as it leaves the three-conductor lead-covered cable at the bottom of the board, it passes up through two series potential transformers, which are used in connection with the switchboard instruments, and then up to the right-hand hook switch. From this switch it goes through the concrete partition to the oil switch, through one leg of the oil switch and back to the hook switch adjacent to the one through which it entered; then down from the hook switch to the 'bus bars. All holes where wires pass through floors have



Thomas porcelain bushings set in slate blocks with sulphur. The solenoid-operated oil switches are provided with concrete dividing walls, which separate the three legs of the circuit. On these switches the solenoid, when energised, draws the switch shut against the tension of a powerful spring. This spring is held closed by a trigger, and this trigger is released by a small magnet when the switch is to be opened. Each 'bus bar consists of two flat copper strips. The 'bus bars are separated from each other by soapstone slabs. The insulators upon which the 'bus bars are mounted are set in soapstone plugs in the wall. All the low-tension control circuits to the switchboard proper are run in iron-armoured conduit. Lithosite has been made use of freely to protect the bare connections on the wall back of the 'bus bars, and where the high-tension cables run under the floor between the first and second galleries. Arches are constructed in the brickwork just above the first gallery for the purpose of reducing the weight of masonry on the wooden supporting structure.

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AN UP-TO-DATE DOCK INSTALLATION.

The London, Brighton, and South Coast Railway Company have shown commendable enterprise in equipping their Deptford wharf with electric plant for power and lighting purposes. At this point the company possess a fine frontage on the Thames, two open docks, and a barge dock wholly under cover. The latter has the principal interest for us, due to its splendid electrical equipment. It is 300ft. long and 70ft. wide, being served lengthwise and transversely by nine overhead electric cranes and hoists, capable of raising or lowering loads up to one ton with that remarkable expedition obtainable only with electrical control. The electrical equipment of the wharf is self-contained—that is to say, the necessary generating plant is installed on the spot. It was supplied by Messrs. Dick, Kerr, and Co., Limited, under the supervision of the railway company's consulting electrical engineer, Mr. Philip Dawson. Following is a brief description :

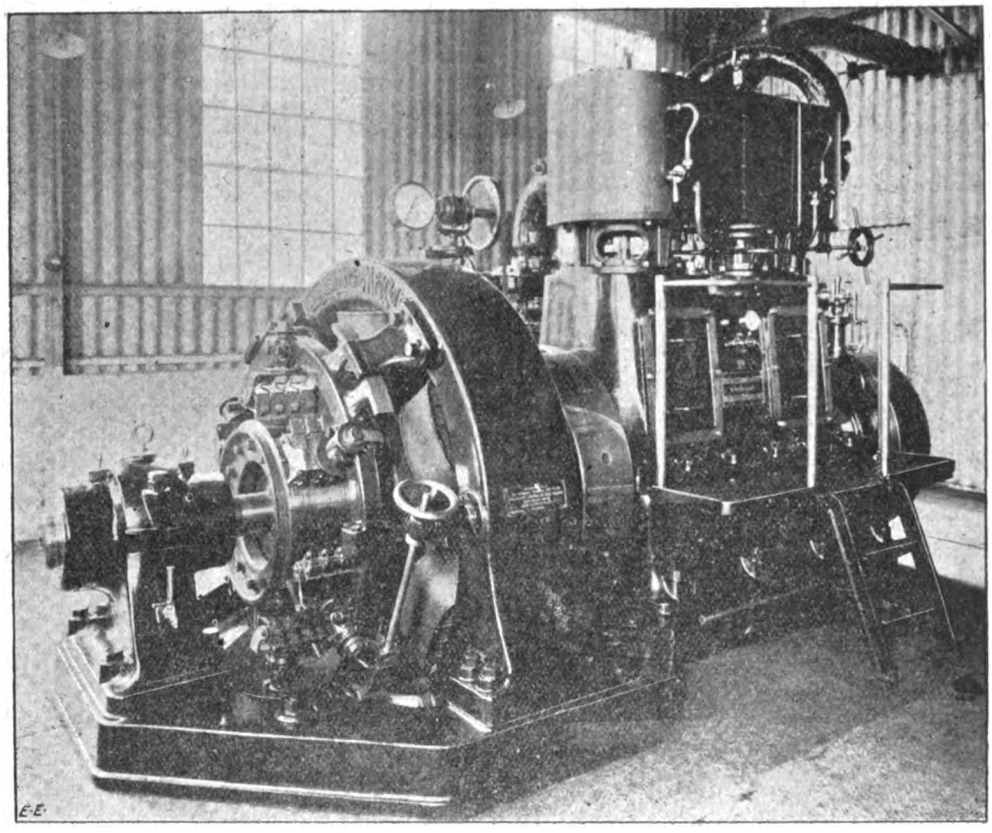
Boilers.—The boilers, which are of the horizontal water-tube type, were built by Messrs. Babcock and Wilcox. Each boiler is capable of evaporating 5,000lb. of water per hour under normal conditions, and approximately 6,500lb. per hour continuously when required, without undue forcing, the working pressure being 160lb. per square inch. The heating surface is of 1,790 square feet. Each boiler has a superheater fitted underneath the steam water drum. The superheaters will give 100deg. of superheat with ordinary stoking. Each superheater has approximately 198 square feet heating surface.

Mechanical Stokers.—Each boiler is fitted with a suitable mechanical stoker, and is so arranged that the rate of combustion may be varied over wide limits. Each stoker is capable of burning efficiently 1,000lb. of coal per hour without excessive wear or tear. The stokers are of the chain-grate type. The motive power is supplied by a horizontal shaft arranged in a culvert on the firing level at the front of the boilers. The stokers are driven by a motor connected direct to the horizontal shaft. The motor is of the Dick-Kerr standard, fully-enclosed, shunt-wound type, with a speed of about 600 revolutions per minute, and is worked at a potential of 220 volts.

Steam Feed Pumps.—One of Weir's patent direct-acting steam-driven feed pumps is supplied, delivering 1,400 gallons of water per hour at the normal rate of working, and capable of delivering at the rate of 1,700 gallons per hour continuously when required without undue wear and tear, against a boiler pressure of 160lb.

Electrical Feed Pumps.—In addition to the steam feed pump described above, an electrically-driven feed pump is also supplied. This pump is of the vertical three-throw type with variable stroke gear, the motor being connected to the crankshaft by worm gear. The pump shaft is run at a speed of 160 revolutions per minute, and the variable stroke gear is so arranged that the stroke of all plungers may be reduced to zero if required. The variations are made while the pump is running, and an indicator is fixed so that the relative discharge of the plungers may be shown in gallons per hour. The full range is from 0 to 1,600 gallons per hour. The pump is driven by a 5-b.h.p., 220-volt, 500 r.p.m. Dick-Kerr motor.

Engines.—The engines are of Messrs. Browett-Lindley's vertical high-speed enclosed self-lubricating, two-crank, compound type, capable of developing 200 i.h.p. at 155lb. pressure as normal load and 300 i.h.p. as overload, and are non-condensing.



Direct-Coupled Engine and Generator at Deptford Wharf Power House.

Generators.—There are two direct-current generators coupled direct to the engines, the output of each generator being 125 kw. with a speed of 380 revolutions per minute, and they are designed to carry an overload of 50 per cent. for one hour, the current being developed at a voltage of 230-260. They are built to work either as shunt or compound machines, and are in every respect in accordance with the standard practice of Dick, Kerr, and Co., Limited.

Switchboard.—The switchboard, which was built by Dick, Kerr, and Co., is fixed to an elevated gallery, and consists of eight polished slate panels, each supported independently on iron frames. Each panel of the switchboard is supplied in three sections. The board consists of two generator panels, two distributing panels for the power circuits, one distributing panel for the arc lamp circuit, one accumulator and booster panel, one panel for recording instruments, and one distributing panel for incandescent lamp circuits.

Storage Battery and Booster.—The storage battery consists of 112 cells, which when fully charged are able to give a discharge current of 300 amperes for one hour with a final E.M.F. of 210 volts, and momentary discharges of 750

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amperes without injury. The battery was made by the Chloride Electrical Storage Company. The Highfield reversible booster supplied with the battery is capable of giving a continuous output of 300 amperes when at its highest potential, and is able to stand 50 per cent. overload for two hours continuously, and 100 per cent. overload for short periods without heating or sparking.

Overhead Travelling Crane.—The six-ton, hand-power, overhead travelling crane was built by Jessop and Appleby, Leicester, and has a span of 27ft. 10in. All motions are worked from below.

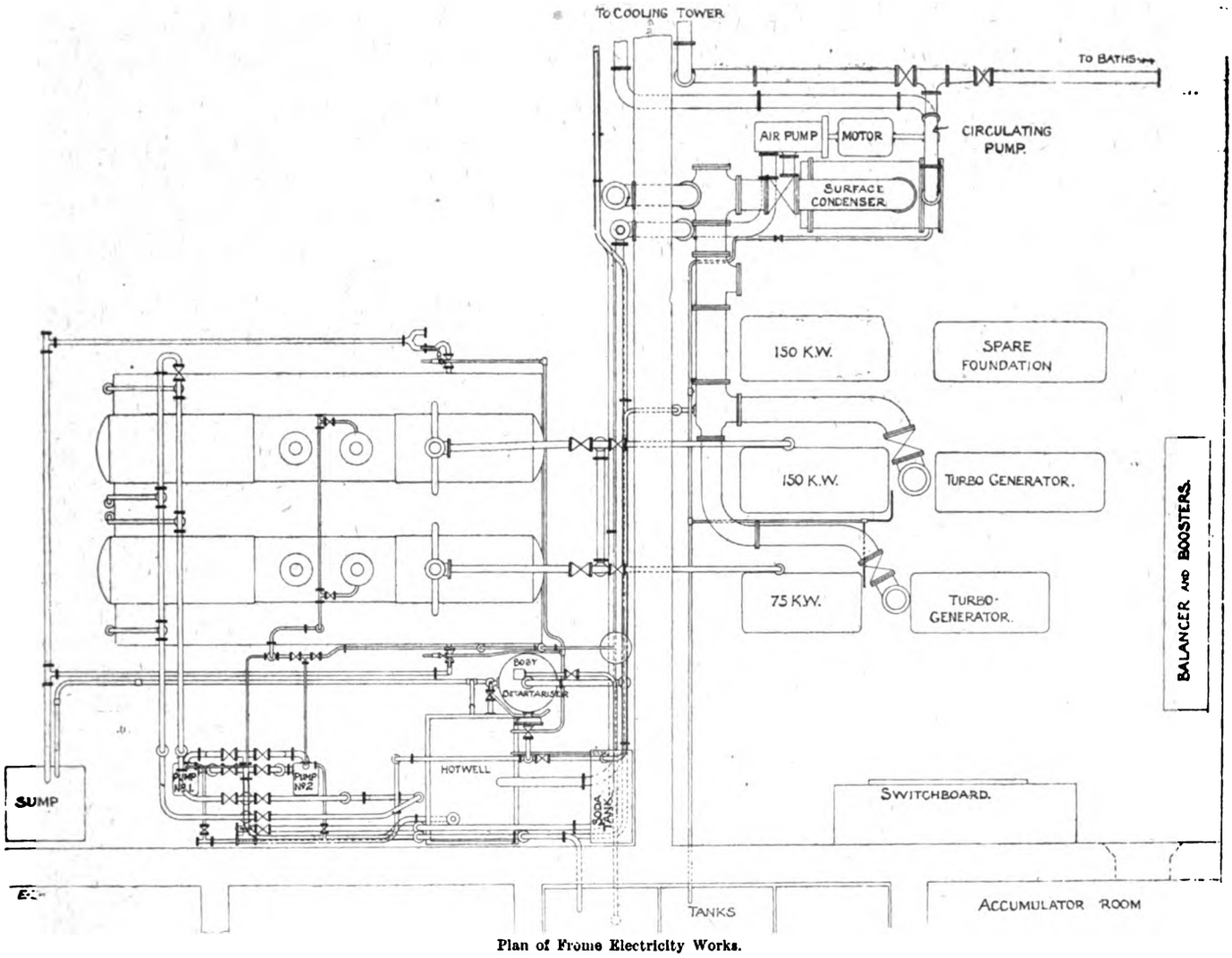
FROME ELECTRICITY SUPPLY.

BY B. PONTIFEX.

This system is of interest from the fact that small units driven by steam-turbines have been adopted, and also that the entire urban district is to be lighted by electricity to the dissatisfaction of the gas company. The provisional order was obtained in 1901 by the Urban District Council, Messrs. Medhurst and Lloyd having been appointed consulting engineers. On April 6, 1903, a contract was entered into with Messrs. Edmundson's Electricity Corporation, Limited, on condition that the Council found the capital and Edmundsons paid interest and sinking fund on same, amounting to 6 per cent. per annum; Messrs. Edmundsons to erect the station and run it for 25 years, provided that the Council do not wish to take it over before that date. If, however, they decide to do so at the end of seven years they must pay 15 per cent. on the capital outlay, at 10 years 10 per cent., and at 14 no premium.

The original amount of the contract was £20,156, but this has since been increased by £8,500 to include the cost of street-lighting and private supply in all streets where there are lamps. Current is supplied at 7d. and 3d. for lighting on the maximum demand system, or a flat rate of 6d. Power and heating are charged 4d. and 1d., or a flat rate of 2½d. per unit. Messrs. Edmundson are undertaking contract work for wiring private houses, shops, etc., on the hire-purchase system for 3, 5, 7, 10, or 14 years, charging 5 per cent. on outstanding amounts; also "free wiring" at a rate of 1s. 6d. per annum per lamp installed.

The buildings are substantially constructed of local stone, with a temporary wall of corrugated iron at the west end to allow for extensions. There are two Babcock and Wilcox boilers, each with 1,600 square feet heating surface, working at 160lb. per square inch. Superheaters are fixed direct on each boiler giving 150deg. F. superheat to the steam. The boilers are fitted with Meldrum's "Koker" stokers driven by a 2-h.p. motor. The boilers are lagged with mica boiler covering. An economiser has not yet been fixed, but space has been left for it between the boiler-house and stack. The latter will be of stone and brick, 110ft. high from ground-level and 6ft. in diameter. The feed pumps are by Messrs. J. P. Hall and Son, Limited, of Peterborough, and are each capable of delivering 200 gallons of boiling water per hour against a boiler pressure of 160lb. per square inch, with a piston speed not exceeding 40ft. per minute. The suction pipes are arranged to take water either from the hot-well, from the cooling tanks, or from the feed storage tanks. All steam-pipes are of lap-welded steel with mild-steel flanges screwed and brazed on. The exhaust pipes are of cast iron.



Plan of Frome Electricity Works.

The turbines are of Messrs. Parsons's make, direct coupled to bipolar generators. The governors are to regulate speed from full load to no load within 2 per cent. The following tests were made at the manufacturers' works:

Generator.	R.P.M.	Load.	Vacuum.	Lbs. coal per kw.-hour.
75 kw.	4,000	Full.	24in.	27·6
		Half.	24in.	38·7
150 kw.	3,500	Full.	25in.	24·3
		Half.	25in.	31·0

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The generators are capable of carrying a 10 per cent. overload for two hours, the smaller one has a grooved commutator, and there is an insulated steel band shrunk on the centre of the commutator of the larger machine. Wire brushes are used, and are held on to the commutator surface by counterbalance weights.

The condensing plant consists of a surface condenser, by Messrs. Cole, Marchant, and Morley, with 700 square feet of cooling surface, capable of giving a vacuum of 26in. when dealing with 6,000lb. of steam per hour, the temperature of the circulating water being not less than 80deg. F. The condensing water is to be taken from the public baths twice a week to the tanks under the cooling tower, which is being supplied by the Klein Engineering Company. Any make-up water drawn from the feed tanks will be passed through a Boby heater-detartariser, where it will be heated by the exhaust from the feed pumps, and the hardness reduced from 25deg. to 2deg. The balancers and boosters have their armatures all connected together on one shaft. The balancers are capable of dealing with an out of balance of 60 amperes running at 1,300 revolutions per minute; the boosters each give 54 amperes at 85 volts.

The switchboard is Edmundson's standard type, with Kelvin and White's instruments. There are two generator panels, three battery panels, middle-wire panel, balancer panel, and four feeder panels. Copper rod is used for the connections behind the board. The battery is composed of 260 cells of the D.P. Company's new standard type, of 400 ampere-hour capacity when discharged in 10 hours.

The mains were laid by Messrs. Edmundson, and are as follows: Feeders are Callender's triple-concentric, lead-sheathed, steel-taped, laid direct in the ground. Distributors in the compulsory area (about two miles) are the same firm's three-core pattern, sheathed and armoured as above, and in the outside area an additional 11½ miles has been laid with four-core cables, the fourth core being used for street-lighting.

Supply is three-wire continuous-current, 480 volts between the outers Street-lighting is to commence on Aug. 1 next. The contract covers 260 half-ampereNernst lamps (80 c.p.), of which 46 will be burnt all night and the remainder from dusk to 11.30 p.m. There are 10 Reason twin-carbon arc lamps with two 25-c.p. incandescent lamps on the same pillar, which will be switched on at 11.30 in their place. Current to the Council is supplied for all purposes at 2½d. per unit.

The above work has all been carried out for Messrs. Edmundsons under the personal supervision of Mr. H. M. Nicholl, to whose courtesy I am indebted for the foregoing particulars.

DESCRIPTIVE ACCOUNT OF THE NEWCASTLE CORPORATION TRAMWAYS SYSTEM.*

BY A. E. LE ROSSIGNOL, M.I.C.E., M.I.E.E., GENERAL MANAGER AND ENGINEER, NEWCASTLE CORPORATION TRAMWAYS.

In the following paper the author has endeavoured to give some account of the principal features of the Newcastle Corporation tramways system, which he thinks might interest the members of the Municipal and County Engineers.

The configuration of any tramway system is largely determined by the situation of the town and the character of its existing traffic; and the situation of Newcastle is peculiar, inasmuch as the greater part of the town is situated on a hill forming the north side of the valley of the Tyne. This valley being narrow at the east end of the town and wide at the west end, it follows that the tramway lines have not been able to approach the river closely at the east end of the town, but run along the top of the hill forming the valley; whilst at the west end of the town, where the valley is much wider, one line parallels the river almost at the same level. The existence of this wider valley, at the west end of the town, too, has brought into existence large works along the river bank, the principal one being that of Messrs. Armstrong, Whitworth, and Co.; and the workers in those factories are unable to find accommodation in that part of the town alone, but are obliged to live at the eastern and northern parts of the city, and the heavy tramway communication between east and west has become a necessity.

The population of Newcastle is rendered dense in certain parts, owing to the existence of a large space of open ground in the north—the Town Moor—which has compressed the town into a sort of butterfly shape, the central portion between the two wings being occupied entirely with shops and business premises. The consequence of this configuration of Newcastle is, that all the main lines of tramway communication between east and west and the north and centre (where the only railway station of any importance is situated) have to pass through the restricted central portion, which gets very congested at certain times.

View from the West of Power Station and Offices complete. Newcastle Tramways.

The history of the tramways in Newcastle commenced in 1878. After the Corporation had constructed about eight route miles of track, they leased the working of it to a company for 21 years, horses being the motive power. On the expiry of that lease the Corporation set about the reconstruction of the whole of the lines, which were then in a very bad state, and the introduction of electric traction; and, in the planning out of the system, a site which was owned by the Corporation approximately near the centre was chosen for the position of the power station, so as to enable direct current at 500 volts to be the system of supply. The site had several disadvantages to counterbalance the advantage of being near the centre, inasmuch as it was some distance, over a quarter of a mile, from the river, and 90ft. above the water-level; and, further, it was all filled-in ground, being on the site of an old dene or deep valley, which had been filled up level some time before. This situation rendered a special system of foundations necessary. The whole of the site for each building was excavated to a distance of 8ft. below the basement level, all hard ground at either end being taken out, and a block of concrete formed the full distance and width of each building, 8ft. thick, interlaced with steel girder rails, all bolted and fishplated together, and thus each building practically floats on the soft ground below it. The foundations of the chimney, however, situated at one side of the old valley as it was, were differently arranged, piles being driven down into the hard ground below, and a heavy

* Paper read before a district meeting of the Incorporated Association of Municipal and County Engineers at Newcastle.

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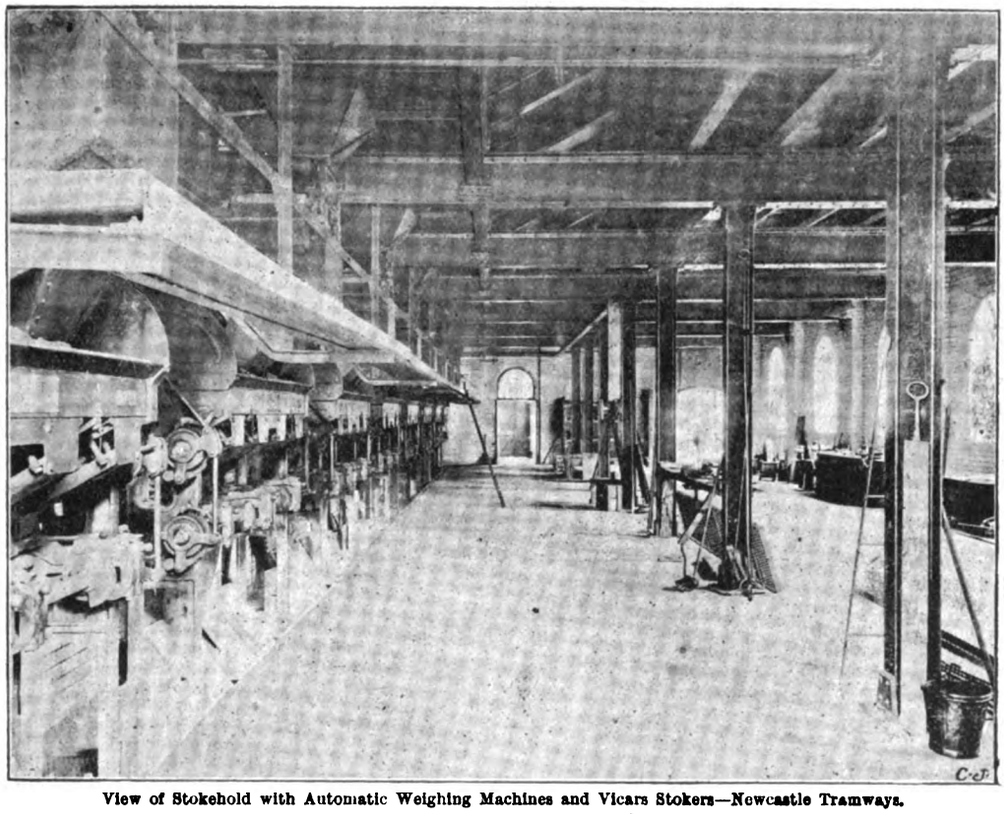
block of concrete, 30ft. square, formed on top of the piles. On this an octagonal brick chimney, 180ft. high from the level of the concrete, was built up, with a clear internal diameter of 9ft. The whole of the power station buildings

View from the West of Power Station under Construction, showing Steel Framework—Newcastle Tramways.

are steel-framed, filled in afterwards with brick walls, with steel roof principals carrying wood roofs. Coal comes direct from the railway into the top of the boiler house, being tipped direct into the bunkers; from there falling by

All the four big engines are of the vertical marine type, with Corliss valves; two being compound, of 1,000 h.p. each; one triple-expansion, of 2,000 h.p.; and one triple-expansion, of 3,000 h.p., made to the author's specification, is now being installed. These engines are all direct-coupled to the dynamos and generate current at 550 volts, which is distributed to the various feeders through a large switchboard. This, contrary to the general practice of



View of Stokehold with Automatic Weighing Machines and Vicars Stokers—Newcastle Tramways.

gravity through automatic weighing machines into the hoppers of automatic stokers.

There are 12 large size Lancashire boilers installed, which supply steam to four slow-speed engines for traction purposes, and one high-speed engine for electric lighting.

putting the switchboard on a gallery, is mounted on the engine-room floor on a glass floor so as to avoid possibility of shock. In the basement below the cables pass along a subway to the ends of the various lines of conduits.

In one respect the station is peculiar, in that the whole

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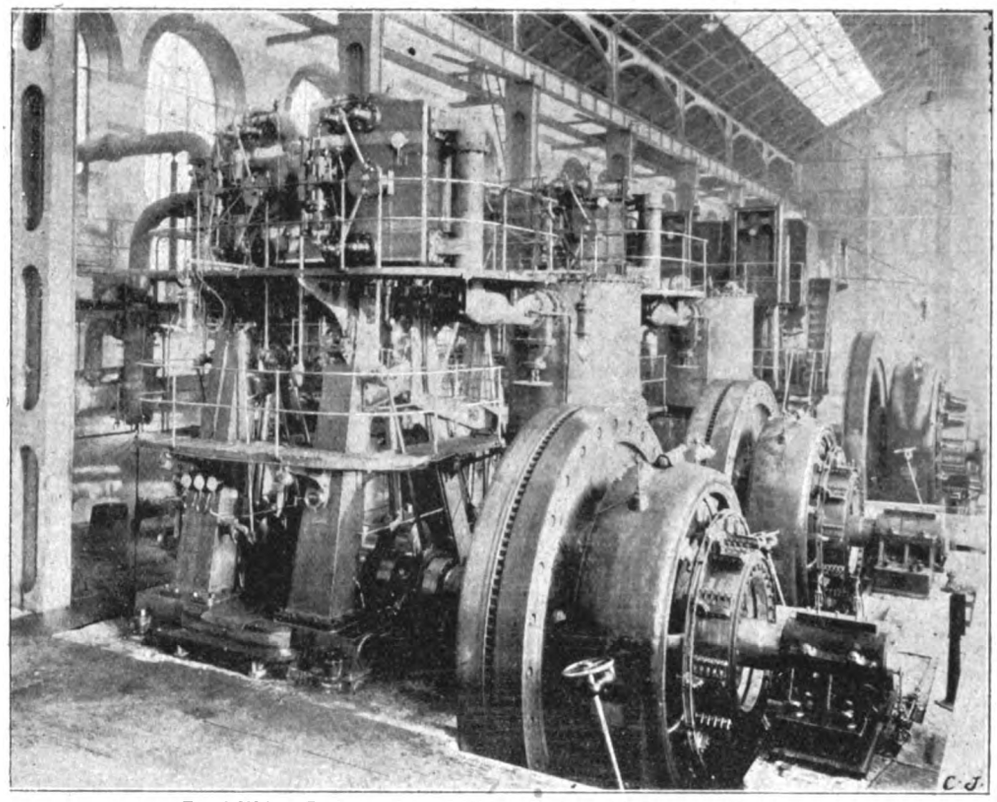
of the circulating water for the surface condensers of the engines has to be pumped up a quarter of a mile and 90ft. high from the river. As this would involve a big loss in the ordinary way, the water after passing through the surface condensers is carried back in another pipe to the pumping station, where the centrifugal pumps are situated, driven by electric motors, and passes through turbines on the same shaft as the motors, thus helping to drive the pumps, and returning about 50 per cent. of the power to the motor. By this means the cost of power for pumping purposes is reduced by about half from what it would otherwise be. A special high-lift centrifugal pump is used, the largest set being capable of delivering 3,000 gallons per minute to a height of 100ft.



Two 1,000-h.p. Engines and one 2,000-h.p. Engine, with Dynamos—Newcastle.

The construction of the track in Newcastle was at the time it was commenced fairly typical of all track construction being carried out at that time. The gauge is the standard 4ft. 8½in., and the rails were laid on a concrete foundation, 7in. thick, extending over the whole track. The rails weigh 101lb. to the yard, and the double tracks were laid 3ft. 6in. apart in the narrow streets and 5ft. 8in. apart where centre poles were intended to be used.

View of Monument Junction under Construction—Newcastle Tramways.

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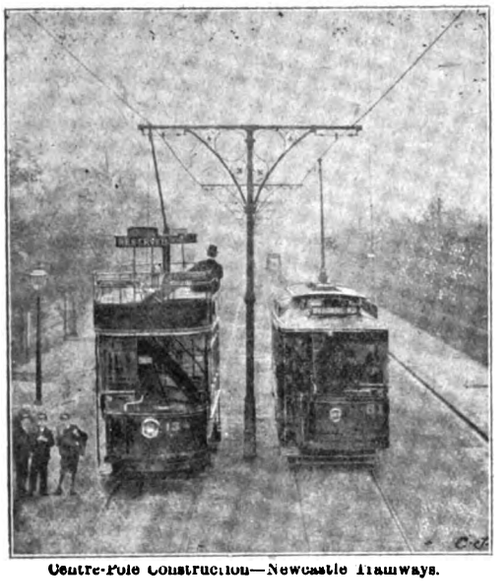
Between the centres of the track the conduits, consisting of special fireclay ducts, were laid solid in concrete; and as the Corporation wished to avoid continually pulling up the streets as extensions were required, a larger number of ducts than were actually necessary at the time were laid in nearly all the streets. A great many difficulties were encountered in laying the ducts, owing to the presence of large masses of pipes under the surface of the streets, but care was taken that the ducts always drained towards a manhole so as to avoid the formation of a pocket in which water would lie. From the power station three main lines of ducts were laid, one of 30 ducts to the west, one of 30 to the north, and one of 12 to the east; and the manholes vary in size from 8ft. square for the large numbers of ducts to 4ft. square for any number of ducts up to nine. All manhole covers are provided with drip-pans, and ventilated so as to avoid accumulation of gas, and trap-drain connections are run into all manholes which are not below the level of the adjacent sewers. All sharp curves on the track are laid with increasing curvature, commencing with a long radius, and finishing with the required radius at the centre of the curve, and all have been laid to standard gauge, whilst the whole of the special work, points, and crossings has renewable hard-steel centres, which are fixed in with white metal, and can be taken out when worn and new ones put down.



Centre-Pole Construction—Newcastle Tramways.

Two systems of paving are in operation—namely, granite blocks and hardwood paving, the latter having been adopted for the whole of the central portion of the city. Experience has shown since the track was constructed that the heavy bogie cars, which are run on some of the routes, cause a great deal of loosening of the paving, which originates from the hog-backing of the rails, due to the rolling out of the top fibres of the metal; and this hog-backing of the rail leaves a cavity underneath the base into which water find its way, and acts as a hydraulic pump, each time a car passes over, to raise the adjacent paving. This shows up very much on the roads on which the heavy bogie cars run, and can only be cured by the insertion of anchors into the concrete below the rail, which hold the rail firmly down to the concrete and prevent this action, and all the new work is being carried out with the anchors. The first rails used were 45ft. in length, but the length has now been increased to 60ft., and all joints are laid butted up together, a clip fishplate being used, which holds the bottom flanges in line and prevents jumping at the joints.

The overhead work is of heavy construction, 0·4in. diameter trolley wire being used, suspended over the centre of each track by centre-pole brackets where the streets are wide enough, or by span wires and side poles where the streets are narrow, and automatic lever frogs control the trolley at junctions. Combined with the overhead work is the electric lighting by arc lamps, of the whole centre portion of the town, 200 lamps being fixed at the top of the poles in the main streets. These lamps are supplied with current by separate cables from the power station, are 40 yards apart, and are on alternate cables, so that should one series fail the street will still be supplied with half the usual amount of light, and in summer an economy can be effected by half of the lamps never being lit, whilst half are always turned out every night after 12 o'clock. The overhead work itself is divided up into the usual half-mile sections, which are fed by separate feeders in such a way that the breakdown of any outlying section does not affect the centre portion of the city.

There are several types of cars in use; single-deck cars having to be adopted at first because of the existence of several bridges, which prevented double-deck cars being used. The height under these bridges has now been increased to admit double-deck cars by lowering the road, but the single-deck bogie cars, of which 60 were originally ordered, are in very great favour with the travelling public, who find them convenient to get into and easy in riding. These all have an open portion at each end, in which smoking is permitted, the only drawback being, from the smokers' point of view, that ladies frequently occupy these seats in the summer time to the exclusion of the smokers. These bogie cars are 40ft. in length, with 15ft. bogie centres, each bogie having equal sized wheels of 31in. diameter, and there are in addition 22 bogie cars of the same length, which have been built by the department, with double decks, and carry 102 passengers, these cars being principally used for meeting heavy rush traffic at any time. The single-deck bogie cars have two motors of 30 h.p. each, and the double-deck bogie cars four motors of smaller size. The remainder of the rolling-stock consists of four-wheel cars, a few of these being single-deck, and over 80 being double deck of the standard type, driven by two motors. The department is now building its own cars at the car works at Byker. The cars are housed in four car-sheds of various sizes, two of these being old tramway stables, the roofs of which were raised to give increased height, and two being new buildings of steel frames filled in with concrete walls. All are equipped with pits for the inspection of the mechanism of the car, and have the usual offices and messrooms for the staffs. In the car works at Byker a complete set of wood-working machines are installed, each driven by a separate motor, and there is a large machine shop provided with metal-working tools and a smiths' shop. To provide sand for the cars a special furnace with rotary scraper is provided, which evaporates the moisture out of the sand, it being then lifted by mechanical means into a riddle, where all the stones are taken out, and the sand is filed from hoppers into bags for supplying to the cars.

RHYMES FROM THE OFFICE.

BY PABLO.

No. 2.—The Slide-Rule.

He won me as a prize, and called me "fine";
Yet in his hands I'd many artful tricks,
And calculations weird were often mine—
Eighteen by three divided—answer, nine;
Or fourteen five times over—sixty-six.

In constant practice full perfection lies,
And now his slide no longer causes slips—
His rule's unruly spirit has grown wise.
No problem he by mental effort tries;
In ready reckoner he never dips.

As use is second nature, so he needs
My service for the simplest rule of three.
Unconsciously he takes me up and reads
My face when asked (nor vulgar laughter heeds)
If it will rain, or what he'd like for tea!

And when, sometimes, too soon five-thirty comes,
And he at home would fain sit working late,
Perchance I help—'tis one of nature's sums—
His youngest find the product of it's gums,
While he can only frown, and watch, and wait.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Ninth Annual Convention.

(Continued from page 89.)

Following the reading of Mr. H. Faraday Proctor's paper on "Some Notes on the Bristol Electricity Works Fire," given in our last issue,

Mr. M. H. KILGOUR, of Cheltenham, complimented the author on his paper, and on his courtesy in inviting other engineers to see the results of the fire. He considered that the fire was caused by the improper action of a fuse due to the spring becoming stiff. It would then fail to draw the fuse wire under the oil. As regards the covers of these fuses, he had found it best to prop up these to prevent the explosive action when a fuse went. He considered the Ferranti board most excellent with the sole exception of the fuses, which should be replaced by automatic oil-break switches.

Mr. G. H. COTTAM, of Hampstead, raised the question as to whether the oil-pot was full of oil.

Mr. L. ANDREWS did not think the fire had started from static discharges over the surface of the slates. He was inclined to believe that a trunk main was the seat of the first fault, and that this caused the heavy current on the Temple Back generators. The fuse then started the fire. He referred to the variability of fuses, and said all their action were dependent on the point in the wave at which the current was broken.

Mr. C. H. WORDINGHAM, of the Admiralty, drew attention to the importance of having both the switchboard and the station fireproof. The switchboard gallery should be of expanded metal in concrete. Rubber mats were dangerous. He would like to know if sulphur compounds were used in and around the fitting of the fuse pots, as this was inflammable, and also it softened under heat, and thus tended to distort the fitting. Could the author tell them what fraction of the total loss had been paid by the insurance companies? As regards the cable insulation, he had tried copper-covered paper cables for special work.

Mr. J. H. CLOTHIER traversed the whole field of possibilities, and said that the coil used would not burn by itself He did not think the switchboard insulation had failed, as there was at least 2½in. of porcelain in the leakage path.

Mr. S. Z. DE FERRANTI first referred to the honourable way Mr. Proctor had dealt with the matter. His conclusion was that the fuse had failed, and this was the simple explanation. They had made several patterns of fuse pots, and it was hard to make improvements. The one at Bristol was the worst pattern of fuse ever made. Without doubt the spring had failed and left the ends of the fuse sticking up over the oil. He considered that the cellular pattern of switchboard had even then justified itself, as the fire would have been confined to three or four panels but for the surroundings of combustible material. Indiarubber mats were very bad, and he thought that a glass and iron construction for the switchboard gallery floor would be best. The lids, as one speaker had said, were a fatal adjunct to the fuse pots. The firm had advised the users of this, but some engineers used them to keep the dust out. It was the Grosvenor Gallery switchboard fires which led to adoption, 14 years ago, of the cellular type of board. He considered that fuses, while good for small currents, had been used much beyond their sphere of service, and should now give place to oil-break circuit breakers.

Mr. PROCTOR, in reply, was sure that the fuse pot was full of oil, and that a new fuse had been recently inserted. He did not fancy glass for a switch gallery, as it was liable to be slippery.

The two following papers were also submitted:

Boiler-House Economies.

BY REGINALD S. DOWNE, M.I.E.E., BOROUGH ELECTRICAL ENGINEER, SOUTHPORT.

The problem is to deliver a unit of electricity at the station 'bus bars with the minimum number of pounds of coal, and this question is the most difficult one the engineer has to face in the power-house, but the one most likely to give the best money return for the time expended on it. Numerous papers bearing on the economical use of coal have been read before the I.M.E.A. and the various institutions with which its members are connected. It is, therefore, a matter of some difficulty to add any information to what has already been written. To all engaged in central-station management the question is of such daily importance that all will agree the council has acted wisely in putting the matter forward at conventions from time to time, so that it may be fully discussed to the mutual benefit of all concerned. Coal in some cases accounts for 50 per cent. of the total costs. None of the items which make up the total costs of production, with the exception of coal, are capable of being materially reduced, as the economical limit has been reached. Any further reduction can only be brought about by increased output. One of the papers previously referred to was read by Mr. A. S. Giles, in January, 1904, before the Manchester Section of the Institution of Electrical Engineers. From data supplied by the chief engineers of a large number of central stations, Mr. Giles compiled a table giving particulars of coal consumption, load factor, etc., which has been with his kind permission attached to this paper (Table A). The stations here tabulated represent fairly well the best practice now prevailing in this country, yet the particulars given are so widely divergent that it is difficult to account for them. For instance, non-condensing stations with moderate load factor and low-priced slack consume 6·5lb. per unit generated, whereas there are condensing stations with similar priced slack and higher load factor consuming 10lb. and upwards.

Broadly speaking, the only conclusion one can arrive at after carefully studying the table is that the stations with the largest output and highest load factor appear to give the best results, and that the other contradictory figures must be due to local or special conditions unknown to engineers. A central station is run on a money basis, and all the conditions are carefully studied when the lay-out of plant is decided upon; one can therefore only work in the most economical manner, and introduce such improvements and modifications as will give a reasonable return on the capital outlay. Each separate station has to be dealt with on its merits, and the measure of success is the net saving in the coal bill at the end of the year. The great majority of stations burn bituminous slack, costing from 6s. to 12s. per ton delivered in the bunkers. Where the railway rate is high and smoke conditions stringent, Welsh coal is used; in a few cases where it is available, smudge or low-grade fuels are burned. This point is entirely settled by local conditions. Assuming bituminous slack is used, how many pounds ought to be considered the maximum necessary to generate a unit of electricity? In a well-designed condensing station, with economisers and superheaters, and having a load factor of not less than 15 per cent., in the author's opinion, with the experience at present available, it ought not to exceed 5lb. This quantity of coal should cover all the losses between the furnace and the engine. Several private industrial plants are now generating a unit of electricity with 3lb. of cheap slack. No comparison, however, can be made between the coal consumption of private plants and public supply stations, the nature of supply being totally dissimilar. The results obtained are excellent, but under the same favourable conditions one could do better.

Before this problem can be dealt with, it is necessary to know where the losses are taking place; are they due to low boiler efficiency, steam range losses, excessive steam consumption of engines, or all three? To enable this to be ascertained it is necessary to have a rigid weekly analysis of units generated, together with coal and water used. In most works completed quite recently provision has been made for these measurements, and it is possible to have a daily analysis which enables a close check to be obtained, and any discrepancies to be immediately looked into. A number of stations of earlier date are not so well provided in this respect. It is, however, possible for all to obtain the weekly consumption of coal, and thereby calculate the pounds of coal per unit generated. The measurement of water, unfortunately, is not such a simple matter; in many cases where the supply is not obtained from the town's mains it is not possible. Several stations have recently had water-meters fixed, in some cases to each boiler, and in others to the main feed ranges. The author has tried several types of meters fitted on the suction and on the delivery sides of the feed pumps, but found after a few weeks of constant running that water was passing without being recorded. It would be instructive to have the experience of those members who have water-meters at work as to their accuracy. In a large number of evaporation tests recently carried out by the author, meters have been discarded and two measuring tanks used instead. Where a duplicate feed range is available, tests of this character are quite simple. If it is not possible to isolate an economiser for the purpose of a test, hot water from the economiser delivery can be run into one tank whilst the other is being emptied, and pumped into the boiler at 190deg. to 200deg. F. The various directions and means through which one may still hope to effect a further reduction in our coal consumption are included in the

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TABLE A.—Coal Consumption in Electricity Supply Central Stations. Year 1902-1903.

Name of Town.	Quality and Calorific Value.	How Fired, Mechanical or Hand.	Steam or Electric Auxiliary Machinery, Number of Units used.	Condensing or Non-Condensing.	Percentage of Output Non-Condensing.	Superheat in degrees Fahrenheit.	Price per Ton.	Lbs. per Unit Generated.	Cost per Unit Generated.	Load Factor on Feeders.
Aberdeen	South Hetton, Wearmouth, Wilson & Clyde, &c.	hand and mechanical	both	both	13·4 N.C.	none	11/6 11/10 11/9 12/6	—	d. ·47	17·49
Blackburn	Wigan slack 11,900	mechanical	both	both	—	none	7/3	10	·38	17·45
Blackpool	Lancs. slack and nuts	both	steam	N.C.	—	very little	10/- aver.	15·4	·826	14·32
Bootle	Lancs. slack	mechanical	both	condensing	—	none	7/6	9·02	·357	28·44
Bradford	11,700 to 13,000 B.T.U.	mechanical	both	both	20·0 N.C.	partially	9/9 about	4·1	·214	20·93
Bristol	Rhymnly washed peas 13,500 to 14,000 Hanham slack 12,500 to 13,000	mechanical	mostly steam	condensing	—	partly 500°—560°	11/10—7/6	8·6	·54	13·75
Burnley	Small lump 13,290	both	electric	condensing	—	none	10/3	5·2	·28	15·59
Croydon	Best Welsh	hand	nearly all 372,140	condensing	—	partly up to 500	24/6	5·03	·66	16·81
Derby	Small peas 14,103	both	both	condensing	—	50	7/8	13·2	·543	13·36
Devonport	Welsh	hand	steam	condensing	—	35	14/2	9·6	·72	19·02
Dundee	Fife small about 11,000	both	225,000 almost all	condensing	8% N.C.	very little	9/6—7/-	7·7	·35	13·63
East Ham	Hucknell steam and slack	hand	—	condensing	—	60° above	19/9—12/6	6·2	·6	12·95
Edinburgh	Washed nuts 12,500	almost entirely mechanical	both	non-condensing	—	slightly	6/11—7/6	6·35	·247	14·91
Glasgow	Washed nuts 11,000	mechanical	all purposes 745,801	condensing	—	500	7/-	6·05	·227	14·01
Halifax	Nuts and slack	mechanical	both 409,015	condensing	—	430 to 450	7/6	9·6	·39	16·98
Huddersfield	Slack	both	both	condensing	—	none	5/5	11·02	·296	10·47
Hull	Yorkshire steam 14,700	hand	steam	condensing	—	none	12/4	7·05	·465	9·96
Leeds	Smudge 10,000—11,000	mechanical	steam	condensing	—	Portion to 460	[5/-	8·4	·224	12·31
Nottingham	Partly large and partly Pea nuts 9,000—10,000	both	steam chiefly	N.C.	—	none	9/—9/6	6·5	·37	16·31
Salford	Slack	mechanical	elec. 554,381	condensing	—	50 to 100	8/4	4·3	·244	21·84
Sheffield	Engine slack 12,000	mechanical	—	condensing	—	none	7/9	7·8	·32	11·92
Southport	Slack	hand	both 95,377	condensing	—	60 to 100	8/6	6·5	·295	15·31
South Shields	Small	hand	steam	condensing	—	none	9/6	6·3	·32	15·82
St. Helens	Lancs. slack	hand	both	condensing	—	460	6/9	5	·18	19·78
Sunderland	Durham Bean and small 13,480	mechanical	both	both	40% N.C.	none	9/10	10	·535	17·87
West Ham	Best Welsh Derby Pea nuts	both	steam	condensing	—	slightly	20/6 13/8	—	·75	12.82
		hand	both	—	10% N.C.	none	7/3 9/1	7·9	·43	18·38
South Country Station	Tredegar Best Welsh 13,500	hand	both 180,177	both	—	none	22/4½	5·2	·637	17·38
Bolton	Engine slack	mechanical	both 127,351	both	16% N.C.	100	7/8	7	·281	16·87
Manchester	Washed slack 13,900	mechanical	both 1,368,794	both	22% N.C.	90° 30% of plant	9/11	5·22	·27	18·61

Tramway Generating Stations.

Glasgow	Washed singles 10,000	mechanical	elec. 988,000	condensing	—	390—400	6/8	3·64	·13	47·7
Sheffield	Treeton washed and screened nuts 13,700	principally hand	partly	condensing	—	none	8/8	4·3	·2	37·15
Hull	Hickleton Main washed slack	mechanical	partly 93,861	condensing	—	none	12/4	8·9	·58	29·5

following list: (1) the influence of output and load factor; (2) bonus system for firemen; (3) superheating; (4) mechanical stoking and forced draught; (5) fuel analysis; (6) analysis of flue gases; (7) auxiliary plant; (8) feed water purification and heating; (9) prevention of radiation.

The Effect of Output and Load Factor.

The stations having the largest outputs and the highest load factors show the best coal results. The coal bill of a station in its early stages, before the output has reached a reasonable figure, is often abnormal, owing to its being ready to supply before there is much demand. The conditions are not favourable to economical running, as the fuel required for banking, keeping steam on ranges, etc., is out of proportion to the output. The effect of a bad load factor is more pronounced in the boiler-house than in the engine-room. Diagram 1 attached shows Southport curves of load factor, output, and pounds of coal per unit generated for the year 1903-4. With graduated sizes of units it is possible to run the generating plant in a fairly economical manner. A standing engine does not waste coal. According to Stromeyer: "Under ordinary working conditions the radiation from a boiler amounts to from 5 to 10 per cent. If we work a boiler only at half of its power the amount of radiation will still be the same, for the steam temperature is not altered, but the ratio of loss by radiation to heat put into the boiler is doubled. On the other hand, if a boiler is overworked, resulting, of course, in inefficiency of the heating surface, the relative loss by radiation is very much reduced." From this it appears conclusive that the number of boilers under steam should be kept to the minimum possible, and some method of assisted draught fitted to help us over the peak of the load. The author thinks it will be admitted that with the class of slack usually burnt, under natural draught, the boiler duty is much lower than the maximum; in many cases the number of boilers under steam could be reduced 25 per cent. The station with which the author is connected has Lancashire boilers, and the coal required for lighting and banking fires has been found in the winter months to amount to between 5 per cent. and 7 per cent. of the coal consumed. There was a difference of 2 per cent. in economy between banking fires on the 8ft. 6in. boilers,

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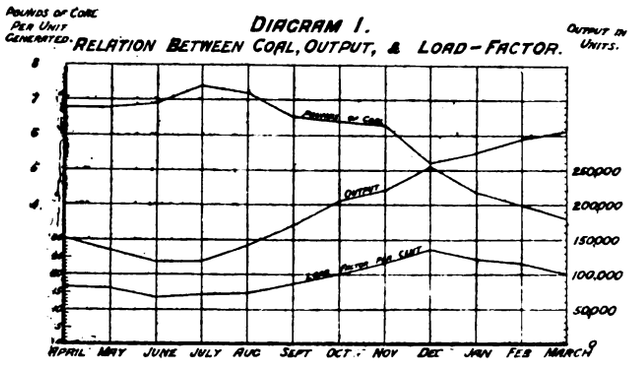
and allowing fires to die out on the 7ft. boilers, and *vice versâ*. A considerable amount of coal may be saved by finding out what banking conditions are most suited to the boilers at different periods of the year.

Bonus System for Firemen.

The personal factor in the form of the fireman has the greatest influence on the reduction of coal costs, after output and load factor. In a test quoted by Mr. Bryan Donkin, four good stokers were put to fire the same boiler—a two-flued 30ft. Lancashire—under the same conditions. There was a difference between the most and least expert of 23 per cent. in capacity and 18 per cent. in economy, a saving of £7 to £8 per week, with coal at 10s. per ton. All raw material from which there is no valuable by-product passes through the hands of the fireman. As a rule he does his best—*i.e.*, with a fluctuating load he draws a fairly straight line on a recording steam-pressure chart. He knows that the less coal he throws on, the less manual labour he is called upon to perform; he may also have a conscientious idea that by economising coal he is husbanding the national resources. Generally speaking, beyond that he has no incentive to economy, and provided he keeps a steady head of steam, is not interfered with. The man who actually burns the coal is the one who can effect the economies. When the managing engineer has convinced himself that there are no leakages through the brickwork, when the dampers are easily accessible, draught gauges have been fitted to the chimney and each boiler, and a CO_2 recorder has been fixed, he has done all that can possibly be foreseen, and the rest must naturally be left to the leading firemen.

A pecuniary incentive is a great help towards reducing the coal bill. If a central station has not reached what it considers its minimum coal consumption, it is worth while paying at least 2s. to save 20s. worth of coal, which it could not otherwise do. It would be interesting to know what results have been obtained by this means. At Southport a coal bonus has been recently introduced, and the following particulars have been added, as



they may be of interest to the members: the present contract price of coal is 7s. per ton delivered in the bunkers; the approximate number of units generated per annum = 2,327,600; the average number of units generated per week = 44,800; a saving of one-tenth of a pound of coal per unit generated on the averaged weekly output = 4,480lb. = two tons worth 14s.; per month of four weeks = £2. 16s.; the bonus is divided amongst the four leading firemen, and is distributed monthly; it has been fixed at 1s. per week per fireman for each tenth of a pound of coal saved—*i.e.*, for every 56s. worth of coal saved, 16s., or 28·5 per cent., is given as bonus. The pounds of coal below which a bonus is given has been fixed for the next financial year at 6·5lb. for the summer months and 5·5lb. for the winter months. If we have to pay more for our coal, the saving per ton is proportionately greater. Diagram 2 shows the bonus line at present fixed, and the pounds of coal consumed for each month during the past three financial years, the load factors being 14·22, 15·31, and 14·49 respectively.

Superheating.

No practical difficulties are experienced by using a moderate superheat up to 500deg. F. The saving in coal and steam may amount to between 10 and 20 per cent., and is greater where the engines are working under uneconomical conditions, and where a steam ring is in use, or the steam ranges are inordinately long. A superheater attached to a boiler may abstract 10 per cent. of the heat in the flue gases, and reduce the efficiency of the boiler by this amount; as this 10 per cent. extra heat in the steam may reduce the engine losses by 20 per cent. the net gain is very great, and alone would warrant adoption. The saving in steam is greater than the saving in coal, due to fuel being required to obtain the superheat. Tables in text-books show the great saving to be obtained in coal and steam consumption by even a moderate superheat. Many stations are now working with superheaters in side flues, which only increase the temperature some 50deg. F.; the gain in economy, though great, could be increased a further 5 per cent. by raising the superheat an additional 50deg. F. at the engine.

The author has superheaters fitted in the downtakes of all his Lancashire boilers, and has been able, by adding firebrick combustion chambers, to raise the temperature of the steam, leaving the superheaters from 80deg. to 150deg. F. Superheaters fitted in this way give a fairly constant degree of superheat, and require practically no attention. A consideration of the various types of superheaters is outside the scope of this paper, but the author is of opinion that where a high superheat of constant temperature is required (as in pure turbine stations) separately fired superheaters would be preferable. The following figures were obtained at Southport on two eight-hour tests carried out on a 250-i.h.p. horizontal Musgrave-Corliss condensing engine, supplied with steam from a 7ft. by 28ft. hand-fired Lancashire boiler with and without a Musgrave superheater:

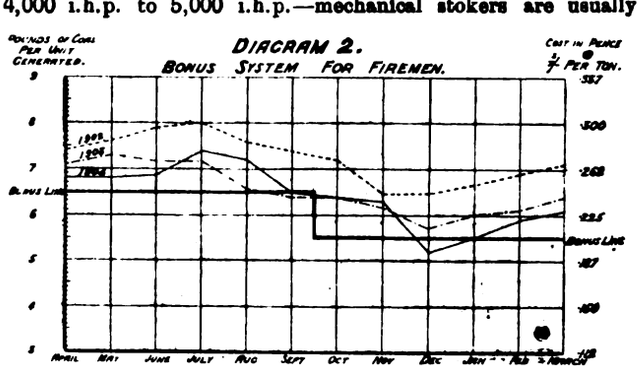
	Without superheater.	With superheater.	Saving per cent. in favour of superheater.
Water per I.H.P. per hour—lb.	16·30	13·58	17
Water per unit.....—lb.	29·27	24·24	
Coal per I.H.P. per hour—lb.	1·89	1·60	16
Coal per unit .....—lb.	3·40	2·86	

Average superheat at engine, 85deg. F.

At the time of this test a ring steam range was in use, which has since been discarded. A similar test if taken to-day would not show quite the same saving.

Mechanical Stoking and Forced Draught.

To what extent does mechanical stoking influence the coal consumption in central stations? Makers' tests do not help much, as they are not carried out under everyday conditions. Table A does not show that stations mechanically fired are more economical than those hand fired. In a large power-house having modern coal-handling plant mechanical stokers undoubtedly save labour, and where the load factor is high give economical results. In the class of station under consideration—viz, that having a total plant capacity not exceeding from 4,000 i.h.p. to 5,000 i.h.p.—mechanical stokers are usually



employed to enable bituminous coal to be burned with a minimum of smoke. Where the coal has to be thrown into the hoppers by hand there is no saving in labour, and it is doubtful whether any economy can be shown over hand firing when the interest, repairs, and cost of running are taken into account, while, on the other hand, there may be obvious disadvantages. The author does not wish to enter into a dissertation on the various types of coking or sprinkling, over-feed or under-feed stokers, but would be glad to elicit information from those engineers who have charge of hand and mechanically fired boilers, as to the economy or otherwise of the latter method of firing. As the furnace conditions are constant and uniform, there should be a saving, but from figures supplied to the author from various stations employing mechanical stokers, it does not appear to him that this is attained in practice. Many types of stokers require steam for cooling the bars, and in one station where this was tested it amounted to as much as 11·5 per cent., but this was afterwards reduced to 3 per cent. At sea, where the conditions do not lend themselves to mechanical stoking, good results are unquestionably obtained by hand firing. With but few exceptions, natural draught is depended upon for the combustion of fuel. Is it possible by adding induced or forced draught so to increase the evaporation and economy that after paying all charges there would be a saving that would be worth obtaining? A chimney is a rough-and-ready way of inducing the air to flow into the furnaces with sufficient velocity to cause the fuel to burn; it has the merit of being absolutely reliable, and the upkeep is nil. Energy must be expended in bringing the air to the coal, but as a chimney may require 20 per cent. of the heat units in the coal, this work may be carried out much more efficiently by other means.

The apparent advantages of forced draught are: (1) the steaming power may be increased 30 to 40 per cent. without injury; (2) higher temperature of combustion, giving a higher evaporative effect for the fuel; (3) air supply under control. Stromeyer in his memorandum (1902) states: "Perfect combustion is of far more importance, both as regards the efficiency of a boiler and the power to be got out of it, than is within

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limits either the amount of heating surface or its arrangement." The furnaces usually fitted by boilermakers are only suitable for burning anthracite coal or coke. As the majority of boilers burn bituminous coal, the efficiencies are extremely low, but could be raised if the furnaces were designed to suit the class of fuel burned. In a coal containing over 10 per cent. of volatile hydrocarbon, a high temperature in the combustion chamber (approx. 1,100deg. F.) is absolutely necessary for combustion. In most furnaces, when the gases have distilled they immediately come in contact with water-cooled plates, and are reduced in temperature before combustion takes place. Until the temperature of combustion is raised sufficiently high, the thermal efficiencies of boilers burning this class of fuel will remain in the neighbourhood of 50 per cent.

Fuel Analysis.

It is essential that the quality of the coal used should not be frequently changed, otherwise firemen cannot obtain the best results. How can one ascertain that the quality of coal contracted for is being delivered? Some engineers argue that by buying the cheapest slack obtainable in the district, any deviation from the contract must be in their favour, but this method of procedure cannot always be recommended. Calorimeter tests of small quantities of coal, although fairly comparative, are not of much commercial value, because the thermal value of bituminous fuel is augmented by the hydro-carbons, a large proportion of which escape up the chimney without parting with their heat. The calorific value of some soft bituminous coal is equal to that of hard South Wales coal, but in practice the evaporation is much lower. If we obtain the percentage of moisture under similar weather conditions by drying a known weight of slack, and also ascertain the percentage of ash, it is possible to keep a reasonable check on the deliveries. In the author's opinion, evaporation tests made under similar conditions give the best practical results. Where a contract is placed with a colliery, fewer deviations in quality are to be expected than where supplies are obtained from a coal merchant or colliery agent; where the colliery works only one seam of coal the conditions are even more favourable. Southport has placed a contract with the nearest colliery under the latter conditions, and the following two tests carried out by Mr. J. B. C. Kershaw, F.I.C., on samples delivered over six weeks show the qualities to be practically identical.

Tests made on Sample after Drying.

Description of sample.	Per cent. moisture.	Per cent. ash.	Per cent. coke.	Per cent. volatile matter.	Per cent. fixed carbon.	Calorific value in Fahrenheit units.
Bickerstaffe slack "A"	8·48	11·00	68·60	31·40	57·60	13 879
" " "B"	7·73	10·85	67·35	32·65	56·50	13,848

Analysis of Flue Gases.

For a complete analysis of the exit gases from a boiler it is necessary to know their chemical constituents, temperature, and draught. This information enables the engineer to reduce the loss up the chimey to a minimum; apparatus for carrying out these tests is now available. To obtain the greatest boiler efficiency the excess of air must be kept as low as possible, and this can only be ascertained by individual tests, and depends upon the quallty of coal and the draught available. Every pound of air which passes through the boiler in excess of the theoretical quantity represents a dead loss, as this air has to be heated up from the temperature of the atmosphere to the temperature of the exit gases. To obtain perfect combustion of the fuel, as much oxygen as possible should combine with the carbon to produce carbonic acid. For practical purposes, the amount of carbonic acid produced is an index to the state of combustion. Under theoretical conditions without excess air, 19 per cent. CO_2 would be produced, but in everyday work one might with reasonable attention obtain 12 per cent. CO_2 with an exit temperature of 600deg. F. The difference between 8 per cent. and 12 per cent. CO_2 represents a loss of 8·5 per cent. of the fuel burned. Many works have recently fitted up recording apparatus to ascertain this percentage, and in most cases the results have been eminently satisfactory, and have well justified the outlay, This arrangement for analysing the gases is more convenient than the "snap" method, and the readings are for all practical purposes correct, but can be checked by direct analysis. It is possible to connect the apparatus to each boiler in turn, and by reducing the air leakages, altering the thickness of fires, etc., to raise the average percentage of CO_2 considerably. Without some apparatus of this character it is not possible to keep a close watch on air leakages. Most boilers are surrounded by a quantity of brickwork, which is notoriously porous, and as this brickwork is subjected to great changes of temperature, the air leakage becomes excessive unless it is receiving constant attention. Air leakages being inwards are of an insidious character, as they do not show themselves but have to be searched for.

When boilers are shut down under natural draught, there is always considerable air leakage into the main flue even when the dampers are closed. Sliding dampers require to be an easy fit in their frames, but in most cases this is overdone; an improvement on the usual type of damper might be easily fitted. The brickwork round damper-frames is difficult to inspect; generally on being opened up it is found to pass cold air at every joint. This air has a considerable cooling effect on the gases; it decreases the draught and lowers the economiser efficiency. To what extent this cooling is possible, is shown by the following figures taken by the author from a range of six Lancashire boilers, No. 6 being nearest to the economisers.

Boilers Nos. 5 and 6 under steam.
Temperature of exit gases taken in side flues at a point 12in. on boiler side of dampers.

Average temperature of exit gases	729deg. F.
" " in centre of main flue opposite No. 6 boiler	314deg. F.
Average temperature of gases entering economisers	496deg. F.
" " leaving economisers	291deg. F.

The stream of cold air leaking past the four standing boilers passing up the centre of the main flue and mixing with the hot gases from Nos. 5 and 6 boilers, reduced their temperature 233deg. in 10ft. of flue. The fall in temperature through the economisers was only 205deg. If it is not possible to prevent these air leakages at the dampers on shutting a boiler down for any length of time, it is advisable to brick up the furnaces. The author has had one form of CO_2 recording apparatus fitted in his boiler-house for the past eight months, and has found it extremely useful. When first installed it was impossible to get more than from 2 to 3 per cent. CO_2 from certain boilers; on tests he has since obtained 15 to 16 per cent. as a maximum, but the average daily running works out about 10 per cent. Two boilers, even after the brickwork had been thoroughly overhauled, would not give more than 3 per cent. CO_2. On further investigation being made it was found that there was an opening at the back dead plates, just behind the bridges, measuring 30in. by 3in.; this was a drastic remedy of the boilermakers for smokeless combustion. On bricking up these openings the CO_2 was equal to that given by the other boilers, and they naturally gave a better duty.

Auxiliary Plant.

Mechanical stokers, economiser scrapers, coal elevators, and ash conveyors are now generally electrically driven. Most stations, however, still have steam feed pumps which are notoriously inefficient, and may require from 2½ to 3½ per cent. of the steam generated. With a careful subdivision of electrically-driven feed pumps, this may be reduced to 1½ per cent. The first cost of the pumps is greater, but after meeting all charges there is a distinct saving, and they are as reliable as any other type of feed pump. It is, however, advisable to have a steam pump as stand-by in the event of any local or other failure of the supply.

Feed Water Purification and Heating.

An exhaustive paper, entitled "An Enquiry into the Working of Various Water-Softeners," by Mr. C. Stromeyer and Mr. W. C. Baron, was recently read before the Institution of Mechanical Engineers, dealing with the different impurities to be found in feed water and their effects on boilers, and the various types of softening and purifying apparatus at present to be found in the market. It is therein stated that "Scale does not materially reduce the efficiency of a boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced; its also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is highly desirable to remove every trace of grease from the feed water. This cannot be done by filters, the only efficient method is to add mineral matter in solution to the condensed water, and then to cause precipitation by chemical means." In every case where water is treated it should be done externally before entering the boiler. For economical steaming a boiler should be clean inside and out, because the transmission of heat is rendered easier and the evaporation is increased. It is a generally accepted fact that no economy can be obtained by raising the temperature of feed water except by heat which would be otherwise wasted. Is it possible, by having separately fired feed heaters in series with economisers, to put the water into the boilers at the same temperature as the steam, and so obtain more duty per boiler, and reduce the number under steam, thus effecting a saving in coal? The true function of a boiler would then be steam raising and not feed heating in addition. Under existing methods the limit to which heating can at present be carried is to have an exhaust heater in the path of the steam, on its way from the cylinder to the condenser, and in series with it a heater which will utilise the exhaust steam from the auxiliary engines, the water afterwards passing through a third heater in the form of an economiser. The temperature to which the feed water can be raised has a decided bearing on the subject, as the economy resulting

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from raising feed water from 150deg. to 250deg. F. is 10 per cent.

PREVENTION OF RADIATION.

When the boilers and piping have been covered with the most suitable material, it is necessary to have it periodically examined and repaired, as it is usually of a perishable nature. Where it is enclosed in a metallic envelope much waste may be caused if there is contact between the piping and the shield, which may be at nearly the temperature of the steam. Condensation may be reduced one half if the valve bodies and flanges are covered. The joint itself may be left exposed, but with superheated steam there is little trouble from leaky joints if the ranges are well drained.

CONCLUSIONS.

Perfect combustion of fuel cannot be obtained in any form of boiler, but it ought to be possible to considerably raise the low thermal efficiencies at which most of them are working at the present time. The two essentials are: the highest possible initial temperature in the combustion process, as the heat transmission between the water and the hot gases is directly proportional to their difference of temperature; and a high temperature in the combustion chamber, so that the volatile gases are not cooled down before combustion takes place. To obtain full value from bituminous coal is an exceedingly difficult matter, and the numerous papers which have dealt with this problem do not assist us much. The subject is usually dismissed as follows: "In a properly constructed furnace these valuable hydrogen units can be utilised to their full value, but time does not permit of going further into this matter." What engineers are seeking is the properly constructed furnace, suitable for the particular class of slack to be burnt. The author has carried out a large number of evaporation tests at different rates of combustion, and with different forms of combustion chambers, on hand-fired 7ft. by 28ft. Lancashire boilers. The evaporation per pound of coal from and at 212deg. F. varied from 6·62lb. to 7·17lb. Coal burnt per square foot from 33lb. to 17lb. Evaporation from 5,250lb. of water per hour to 3,900lb., and the superheat from 151deg. to 80deg. F. One boiler is fitted with steam blowers. On test 5,400lb. of water per hour was evaporated. After deducting the steam taken by the blowers, the evaporation per pound of coal was only 6·21lb. On a special test it was found that the steam jets when giving a draught equal to $\frac{8}{10}$in. in the ashpits required 340lb. of steam per hour, equal to 6 per cent. of the steam generated. The fine ash made by the ordinary furnaces, amounting to 3 per cent. of the coal burned, approximately 200 tons per annum, is dealt with by this boiler; it was found to have an evaporation value equal to one-half that of the slack. Under the conditions stated, in Southport they obtained an average evaporation of 7lb. of water per pound of coal, having a calorific value of 13,800 British thermal units. Their average combined boiler superheater efficiency, therefore, is only 52 per cent. Electrical engineers have made great progress in this special branch of steam engineering, due in great measure to the fact that they are the largest purveyors of energy in a form which is readily and accurately measured. Before the advent of electricity supply these investigations were entirely in the hands of marine and water engineers, who were restricted to measuring their energy in indicated horse-power hours, which is neither a convenient nor particularly accurate method. As this question is now being intelligently dealt with by electrical engineers all over the country, we may confidently look forward to great improvements in the immediate future.

The Financial Position of Municipal Electrical Undertakings.

BY COUNCILLOR H. J. BLAKEWAY, CHAIRMAN ELECTRICITY COMMITTEE, BOROUGH OF SOUTHAMPTON.

The rise and steady growth of municipal undertakings for the production and supply of electricity is a subject which occupies the thoughts of many of one's fellow members of public bodies. It is a subject that appears to have two sides—the technical, from the point of view of the consulting and resident engineer; and the financial, as it affects, or may affect, the pockets of the general body of ratepayers (apart from those who are customers of the undertaking) who are immediately concerned in both the present and future prospects, and whose interests have to be safeguarded. It may be urged that at the outset one is wrong in this statement, and that the interests of the engineers and that of the ratepayers who find the capital are identical. The author is open to conviction on this point, and while admitting that there is unity to a certain point, it does not appear to be continuous, or if the engineers generally are in such sympathy with the ratepayers, the returns which are presently alluded to rather show that they are not the first consideration. The author states at once that he has the utmost confidence in the energetic body of men, most of them members of the association, who have largely in their hands the destinies of municipal electrical undertakings, and gladly takes this opportunity from personal knowledge of bearing testimony to their skill, their shrewdness, and, what is also of paramount importance, their honesty. His criticisms must therefore not be considered as reflections on them or their abilities.

To excuse the object of this paper, the author has been a very active member of his Electricity Committee since 1899, and has seen their undertaking under all possible conditions and vicissitudes, and it is a deep interest in this and similar undertakings that has caused him to take up the subject. That the members may the more readily follow the argument, it may be pointed out that it is based on the table of costs as published in the *Electrical Times* No. 645, published Feb. 25, 1904. It will be seen that therein are the returns of 155 municipal undertakings, and the period covered by their work is from one to twenty years. In a subsequent issue of this journal completed returns were given, but while a few new installations were added, for some unexplained reason several were dropped out, and as the figures following were not really affected, the number specified is adhered to. The total capital expended by these 155 concerns amounts to £21,983,000, and, in passing, the author would ask, how much of this is at the present date productive? The gross profit or earnings of these 155 undertakings—mostly for the year under review—amounts to £1,333,000, or on an average on the capital employed of 6 per cent. It will be generally known that from this amount of gross profit, provision has to be made for capital charges in the shape of interest and sinking fund, which as a general rule will amount to 5½ per cent. The rate of interest may, and probably does, vary, but there is not doubt that it is properly paid. The sinking fund from the figures given seems open to some doubt, as it averages only 2·62 per cent. Those of us who know the term of years for which capital for municipal electrical undertakings is borrowed, and the life of much of the plant and mains, know how desirable it is that the operation of the sinking fund should be a first principle.

We now come to the net financial result of the year's trading, and to better appreciate the position the figures are given in detail for the different periods:

Year of working.	No. of towns.	Deficit.	No. of towns.	Surplus.
First	16	£18 398	7	£8,218
Second	18	20,715	8	5,771
Third	11	8,754	10	12,759
Fourth	4	2,921	8	6,594
Fifth	2	2,080	2	2,011
Sixth	—	—	9	14,789
Seventh	6	8,659	3	2,000
Eighth	1	399	20	69,103
Ninth	2	2,195	12	45,642
Tenth	2	6,040	1	2,648
Eleventh	—	—	4	47,055
Twelfth	—	—	3	1,385
Thirteenth	—	—	3	14,744
Fourteenth	—	—	—	—
Fifteenth	—	—	—	—
Sixteenth	—	—	—	—
Seventeenth	—	—	—	—
Eighteenth	—	—	—	—
Nineteenth	—	—	1	33,415
Twentieth	1	1,080	1	2,814
	63	£71,241	92	£268,948

Thus we see that 63 towns have a deficit and 92 a surplus, and to get a really correct idea of the net result of the working of municipal undertakings approximately to date, the author deducts the deficit from the surplus. This will show a net profit on the year's working of £197,707, or 0·9 per cent. on the capital outlay. If it be urged that this is an unfair conclusion to draw, he is quite prepared to admit that in the first and second years it is rather unreasonable to expect a profit, although the returns show that even this difficulty can be overcome. But what can be said for the other losses up to the tenth, and even the twentieth year. In connection with the surplus, it must be remembered that coal, the principal item, was at a fairly low price; it is not pleasant to think what the results would have been had it reached the figures of two or three years ago. On a capital, therefore of nearly twenty-two millions, some of which is practically dead, we thus have a sum of under 1 per cent. which can be devoted to a depreciation or renewals fund. How many of us have such a fund, and is the necessity of having one generally realised? As, however, the object of this paper is not to deal with a depreciation fund, this may be passed over. The author points out that he omits from his calculations a grant in aid of the local rates, as, in his opinion, before any of the surplus is used in this direction two conditions must be observed—viz.: (1) current for lighting must be sold at the lowest possible rate; (2) the renewals fund must stand at a proportionately substantial figure—and it is easier to provide for both these conditions in the "years of plenty."

The main object of this paper is to emphasise the fact that those running municipal undertakings are under an obligation

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to safeguard the interests of the larger body of ratepayers, whose credit is pledged to find the capital, but who cannot, or do not, all equally enjoy the benefits of the concern, although in the event of losses they would be called upon to provide the deficiency. To further elucidate his contention, the author invites a careful study of the individual returns, and thinks, in many cases, the causes of the unsatisfactory financial results will be found in the charge made for traction and power purposes. It must be admitted that the main object of our undertakings is the supply of current for lighting purposes, and this at as low a rate as possible, for undoubtedly the lower the price the greater the demand, and a correspondingly greater financial success. There has, however, grown up a natural desire for a day load, a load that will employ plant and mains during an otherwise unproductive period. Current for tramway and power purposes has been the outcome of this desire, and the author expresses his opinion here that where electrical works are municipal and tramways likewise it is a matter for regret that separate works have been established, and the lighting works deprived of the benefits of the combination, an arrangement certainly not in the interests of the general body of ratepayers. Dealing first with traction: extra plant has usually to be installed, generally the stations have needed enlargement, and it must be apparent that as the traction load does not go off, but probably increases as the lighting load comes on, duplicate plant is unavoidable, and it is manifestly unfair that the tramway committees should not bear a proper share of the charges on the extra capital expended.

In the returns under notice, in too many instances, the rate charged is too low, and the combination really results in a loss. It must be remembered that equally with the tramways committees we must do the best we can for our undertakings, and this can only be done if every unit sent out from the station bears its proper share of the expenses of production. Stations with a traction load gladly avail themselves of the added units to reduce their costs, but they are not so keen on insisting that all such costs are covered. Quoting from one's own town, for the year under notice the total costs were 1·6d., and on the face of it current for traction purposes could be supplied, without profit, at this figure to a corporation department. The electric lighting department has, however, provided all feeder cables from station to section boxes, and had other considerable capital outlay for suitable plant, so that, allowing for capital charges on this work, it was bound to charge 2·25d. per unit, which provides a small margin. For the current year the price has dropped to 2·125d. This method of computation is a safe guiding rule, and the author suggests it is worthy of general adoption. To the ascertained or estimated total costs, add such capital charges as can be fairly allocated, and to the resulting figure, add a fair contribution for depreciation and renewals, but no profit. The price charged will rise or fall with the costs, the respective committees estimating accordingly, and thus treating each other fairly. If this were adopted, many of the financial results would show very different figures.

Coming now to the second part of the day load—viz., power generally—it is evident that the number of opinions relating to this are only to be measured by the number of installations. Despite the probability of causing many to differ from him, the author is bound to state his opinion, that in the majority of returns current for power purposes is being sold below cost, and without benefiting the station financially, or, indeed, doing anything beyond reducing, by the added units, the total costs. This is manifestly wrong, and almost immoral, and to prove that it cannot be done without loss one need only point out that many stations are actually selling current to the public for power at a lower rate than is charged to the tramways. This will take some explanation, as one or the other rate must be wrong, even making allowance for the fact that the lighting mains from which the motive power is taken are there in any event, while extra mains are put in for traction purposes. As in most stations it is customary to run one or more generators during the day for intermittent lighting, it is quite possible that up to a given point a few units could be sold at any price that will cover the coal consumption; but who is to decide when this point is passed and the load has grown to a greater extent, and not only grown, but continued in the winter months during the period of the peak load in lighting. By what process of reasoning, therefore, are these units to be exempted from bearing their proper share of the station expenses and capital charges? The author urges that they are not properly exempted, and a similar rule should be adopted as in the case of traction supply, only if in this instance it is not a corporation supply, there should be a margin of profit, and no current for any purpose whatever should be sold at less than the total cost of sending it out. Somebody has to pay; and if the power consumers are exempted, the customers of the concern for light, who are the mainstay and deserving of every reduction and consideration, have ultimately to suffer. Or if there is a loss, as there is in 63 installations out of the 155, the general body of ratepayers already referred to may be actually called upon to contribute to the working expenses of the industries of the district—a state of affairs which few of them realise, and which they should not tolerate. Such a position may result in a new order of "passive resisters."

A word on public lighting may not be considered amiss in this connection. Referring again to the returns, we find a load that is as profitable and productive as any that can be had. But why do so many stations handicap themselves by actually charging a higher rate than for power, and thus prevent further public lighting being added to their supply? This is another proof that the power rate is insufficient. The same rules should apply in this case, and the same methods of computation. Let us light our streets as well as we can and as cheaply as possible, but where the local body has an electrical supply it should have the greater part of the lighting, especially of the main streets, and the charge should be at a price similar to that made for traction and power purposes—certainly not more. This question has been dealt with from the point of view of a ratepayer, who is also chairman of an undertaking which, like all others, must be run for the general benefit. Unless we are all careful and prudent, we shall find our capital expenditure grow beyond a remunerative point; we shall also, in the more or less near future, have to face, within the periods of our borrowing powers, heavy renewals, and the points raised in this paper are crystallised in the question, *Will our present and prospective revenues on their present basis meet the demand?*

OLDHAM ELECTRICITY ACCOUNTS.

The accounts of the Oldham Corporation electricity department for the year ended March 25, 1904, show a total expenditure on capital account of £242,974. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended.

Dr.	Revenue Account.	£	s	d.
Generation of electricity		9,717	15	11
Distribution of electricity		669	9	2
Rents, rates, and taxes		1,625	19	4
Management expenses		1,050	8	6
Law expenses, commission, etc.		162	4	8
Insurance and bad debts		95	14	9
Balance carried to net revenue account		13,002	15	4
		£26,324	7	8
Cr.		£	s.	d.
Sale of current per meter		11,641	18	3
Ditto public lighting		180	17	3
Ditto traction purposes		13,608	3	8
Rental of meters and indicators		386	10	0
Sale and repairs of lamps and apparatus		140	12	4
Rental of land and fine		16	6	5
Income tax deducted from chief rents paid		18	2	0
Ditto from interest on loans		331	18	0
		£26,324	7	8

Dr.	Balance-Sheet.	£	s.	d.
Capital account—amount received		236,269	8	11
Sundry creditors		6,896	15	6
Balance at credit of net revenue account		389	15	10
Balance at credit of sinking fund		6,297	9	9
Balance at credit of reserve fund		9,180	4	5
Deposits		92	10	0
Balance due to treasurer on general account		12,746	9	0
		£271,872	13	5
Cr.		£	s.	d.
Capital account—amount expended for works		242,974	1	10
Stores on hand		4,792	19	6
Sundry debtors		8,627	17	11
Balance in treasurer's hand		15,477	14	2
		£271,872	13	5

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			3,330,291
Quantity sold	Public lamps	17,362	
	Private consumers by meter	848,095	3,042,766
	Traction purposes	2,177,309	
Quantity expended in distribution			55,512
Quantity used on works			197,000
Total quantity accounted for			3,295,278
Quantity not accounted for			35,013
Number of public lamps			20
Total maximum supply demanded (kilowatts)			1,765

Outing.—On July 13 the staff and employés of the Urban Electric Supply Co., Dartmouth, about 30 in number, had their second annual outing, and drove to Newton Abbot, Chudleigh, Egbrook Park, Little Haldon, and Black Forest to Stareross. At a dinner there, Mr. H. C. Babb, on behalf of the whole of the employés, presented Mr. G. E. Smith, the manager, with a very handsome smoker's cabinet as a token of their high esteem and respect. Afterwards, Dawlish and Teignmouth were visited.

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TO CORRESPONDENTS.

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CORPORATIONS v. TRAM COMPANIES.

An important judgment has been delivered by Mr. Justice Phillimore in the case of the Norwich Corporation *v.* the Norwich Electric Tramways Company, which will have a far-reaching effect. The crux of the case is simple—relating as to which party should maintain the road immediately adjacent to the granite setts of the tramway in repair. Everybody knows that the granite setts of the tramway wear at a very different rate to any macadam surface adjacent to those setts, and frequently in a very short time a rut, deeper or shallower, according to the nature of the traffic, is formed at the junction of the two road materials. All manner of dodges have been tried to minimise this trouble, but it remains, and must remain as long as two different road surfaces with different wearing qualities are used next to each other. Even by using one material for the whole road surface the trouble is merely reduced, not avoided. To keep a road surface efficient which contains lengths of steel rails, granite setts or wood setts, and macadam is a problem as yet unsolved. According to present knowledge, it cannot be done. In a short time, whatever the materials used, ruts are formed near to rails, but these are usually neither so deep nor dangerous as those formed at the junction of setts and macadam. Directly a depression is formed the skew action of wheels leaving the setts to get on to the macadam rapidly increases the depression, and this has to be taken into account, as well as the difference of ordinary wear and tear. The Norwich Corporation is blessed with a very able and experienced city engineer, who is responsible for the due maintenance of the roads and streets of the city. Whether due to his foresight—as we may reasonably assume it was—or to some other cause a clause was inserted in the Norwich Tramways Act intended to define which party—Corporation or tramway company—should pay for the work and materials required to keep these ruts from becoming dangerous. The clause is—Section 57, Sub-Section 5—as follows: Section 57: "If the company fail to maintain," etc. Sub-Section 5: "The junction of the paving laid and maintained by the company, with the surface laid and maintained by the Corporation," etc. The vital point in the dispute was the interpretation of the word "junction." The Corporation held, and successfully held, that it meant the company should maintain the material area close to the setts free from dangerous ruts. In order to get a legal decision upon the point, the Corporation did some work and sued the company for the amount, and asked for a ruling to define clearly the principle involved. Declarations were prepared by each party, and with a slight modification that of the Corporation was accepted by the learned judge. It will perhaps elucidate the principle involved if we quote the judgment on this point. The learned judge said: "With regard to the proposed declaration, he had asked each party to suggest in writing the form it should take. These forms had since been sent to him. That proposed on behalf of the Corporation was as follows: they asked for a declaration 'That the obligation of the company under Section 57, Sub-Section 5, of the Norwich Electrical Tramways Act, 1897, to maintain and keep in good condition the junctions therein mentioned, extends to cases where, by reason of the presence of the tramways in a road, the traffic in such road has caused the surface laid and maintained by the Corporation to become worn down below the level of the paving laid and maintained by the company, and involves the maintenance by the company of a uniform level of such surface immediately adjoining such paving or the lowering of the paving itself.' On the other hand, the defendants asked for a declaration 'That the

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true meaning of the word "junction" as set forth in Section 57, Sub-Section 5 of the Norwich Electric Tramways Act, 1897, is the line of contact formed—viz, the abutment of a vertical plane—that is to say, over the surface of the paving laid and maintained by the company upon a horizontal plane—that is to say, the surface laid and maintained by the Corporation—and the right of the plaintiffs to do and charge for the work under the said sub-section does not arise until and unless the level of the paving laid and maintained by the company at its point of junction with the surface laid and maintained by the Corporation varies from the level at which such paving was originally laid.' This last paragraph aptly expressed the contention of the company, and which he had rejected. As to the form proposed by the Corporation, he observed that it somewhat narrowed their claim. It proposed that the duty should only arise when, by reason of the presence of the tramways, the traffic had caused the surface of the roadway to become worn down below the level of the tramway structure. In other words, the duty would not arise as soon as a step was formed, but only when the guiding ridge was made a trough. To such a declaration as this the plaintiffs were fully entitled in his opinion, but he did not agree that the obligation of the company involved the maintenance by the company of a uniform level. It would mean the whole lowering of the tramway structure, or the raising of the whole macadam at once. What was meant was an unbroken contour, or levelling off for, perhaps, three inches, so that there should be no sharp descent. On the whole, he thought 'an unbroken contour' should be substituted for the words 'uniform level,' and with this alteration he accepted the form proposed by the Corporation; and he declared accordingly, plaintiffs to have the cost of the action."

This decision seems to agree with business principles. It is certain that the determining factor in breaking the contour over this particular area is the putting down of setts, and this is for the benefit of the tramway. The benefit of one should not in such a case be at the detriment of another, hence the cost of keeping an unbroken contour should be borne by the beneficiary. Fortunately for many companies—unfortunately for the ratepayers—a similar clause is not found in most Tramway Acts, but for the future it is certain to be included.

GLASGOW TELEPHONES.

We have now received the printed report of the Glasgow telephone service, but we prefer to deal with it fully in our next issue rather than to treat it casually now. It is far too important a document to be considered lightly; and, so far as we can see, the figures carry out to the full the contentions which have been made and are being made on behalf of the Glasgow authorities.

FORTHCOMING EVENTS.

FRIDAY, JULY 22.

Junior Institution of Engineers.—At 3.15 p.m., visit to Messrs. Bryant and May's factory, Fairfield Works, Bow.

Institution of Mechanical Engineers.—At 11 a.m., general meeting. "Design and Test of a Modern Steam Power Plant," by Mr. E. G. Hillier.

WEDNESDAY, JULY 27.

Society of Engineers.—Visit to Messrs. Yarrow and Co.'s shipbuilding and engineering works at Poplar; 1.52 p.m. from Fenchurch-street.

British Association.—At Cambridge, week commencing Aug. 17.

ARTIFICIAL LOADS FOR THE DISSIPATION OF ELECTRIC POWER.

BY F. H. DAVIES.

Of all central-station auxiliary apparatus that is not generally included in the main contract, the artificial load is, perhaps, the most important. In the days of small sets and more or less haphazard methods it was not given much thought. Some electricity works boasted sets of large and expensive resistance frames, which, constructed of steel tape or large slabs of some resistance material, were capable of dealing with 50 kw. or so, and the rest had recourse to the homely tub fitted with two lead plates and filled with a saline solution of some sort. The resistance frame for dynamo testing has had its day, but the tub in series-parallel arrangements still exists in a surprisingly large number of electricity works. With the comparatively large sets in use at the present day an artificial load is an obvious necessity, and it is safe to say that due regard to reliability and freedom from risk necessitates the trial running of a set at something approaching full load for at least a few minutes after a repair of anything but a trifling nature has been performed on it. More especially is this the case in alternating works, owing to synchronising difficulties. In direct-current stations it is often customary, say, after a bearing has been remetalled, to put the machine on load, at the same time watching carefully for any signs of heating, and being ready to change over sharply if necessary. Here this practice is fairly safe, as changing-over operations, even with large sets, may be accomplished in a very short time, but in alternating work this is not always the case, and the precious moments spent in synchronising have to be taken into account.

The attitude of the larger electricity supply concerns may be taken as indicating that the necessity of a preliminary full-power run is appreciated, for practically all arrange for a test upon artificial load after any repair of a serious nature, but the obsolete manner in which this is often carried out is surprising, and hardly creditable to those concerned. Quite recently one of the largest London high-tension electricity works afforded an exhibition to the passer-by of an alternator of some 500 kw. being run on a weird and wonderful arrangement of tubs placed in the station yard. High-tension cables strung about anyhow, no one to guard the apparatus, and no precautions for safety taken beyond a few half obliterated notices reading "Danger, 2,000 volts." This is not economical, it is not convenient, and it is certainly not safe. It is, perhaps, an extreme case, but very similar ones must be known to many.

Tubs as an artificial load even for the smallest sets are not convenient, and for large powers, in a short time of regular use, absorb enough money in the shape of wages for the men that dance attendance upon them to fit up a proper and permanent arrangement, and this in addition to the extreme inconvenience experienced in their use for dissipating considerable amounts of power. In all alternating and in every direct current works of any size, it will be found to pay to instal a properly designed and permanent water load, and the apparatus being simple in the extreme, this may generally be done at very little expense.

Before starting out to design a suitable arrangement, there are one or two points that must be considered and appreciated. Primarily, the passage of either alternating or direct current through water produces heat, and this lowers its resistance very considerably as boiling point is approached. It therefore follows that for convenient working the water must be continually renewed in order to maintain its temperature and conductivity at some fixed and suitable point. Then the nature of the water must be taken into consideration, for although the specific resistance of supply companies' water may be much the same all the world over, that of rivers and canals may be very different, the same stream even varying considerably according to the period of the year and the amount of impurities or refuse contained in it. This is especially the case with sluggish canal water; in the winter, when it is comparatively pure, its resistance is fairly high, but the advent of hot weather and putrescent matter lowers it greatly, some-

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times to an almost incredible amount. The writer may cite a case in his own experience where the matter of one of the London canals varied so largely in conductivity at different periods of the year that while in winter a 2,000-volt alternator would be tested with the electrodes about three or four yards apart, in summer it was necessary to increase this distance fourfold to obtain an equal dissipation of power with similar electrodes.

The accompanying curve (Fig. 1) shows the results of a test made to determine the nature of the above-mentioned use of conductivity with heat. The water was taken from the mains of the New River Company, and the test, lasting 2½ hours, with no fresh water added to keep down the temperature, was with direct current at 500 volts. It will be seen that up to a certain temperature the rise in current and heat is proportionate; after this, however, the former gains rapidly on the latter. The results, as far as the actual figures go, are, of course, of no definite value, as these will vary considerably according to the volume of water in the tank, and, to a certain extent, with the size of the electrodes employed. They, however, demonstrate the fact that the rises do not take place in equal proportion for any length of time, and the ratio will very probably be similar for every class of water within reasonable limits. If desired, an increase in conductivity may be obtained by the addition of chemicals such as sulphuric acid, salt, and common soda. Of these, the two latter are preferable, being cheaper and having less corroding action on the

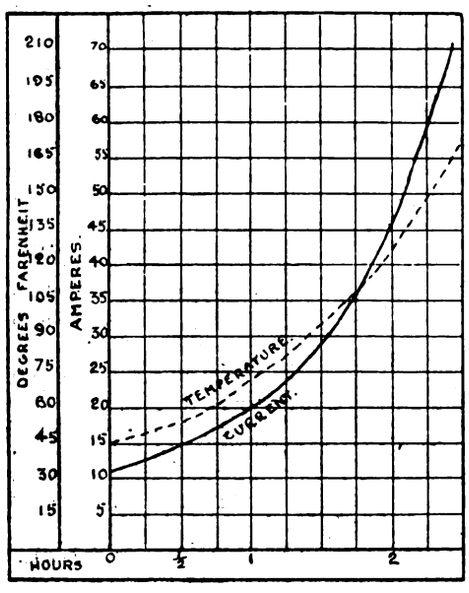

FIG. 1.

electrodes; but it is desirable, if possible, to do without them, as unless the addition is made very carefully after the water has attained its maximum heat, there is a likelihood of its being overdone, and the arrangement rendered temporarily useless by the resistance having become too low.

The design of a permanent water resistance, as far as dimensions go, must, of course, be dependent upon the size of plant to be tested; but in any case it is better to err on the large side, as the greater the volume of liquid the more satisfactory will be the results. If a water rheostat is overloaded, the resultant violent boiling gives rise to vapour troubles, and an unsteady current owing to the level of the water immediately surrounding the electrodes being constantly varied by the ebullition. A very simple arrangement suitable for dealing with up to 1,000 kw. at 500 volts direct current is shown in Fig 2. Both tanks are of iron, and the inner one, which is suspended from some suitable bracket by wires, is bottomless. The immersion of this latter is regulated by aid of a small winch—preferably one of the ratchet type—and by this means the amount of current can be regulated to a nicety. It is fitted with two bars of wood, on to which the suspending wires are fixed, being broken in their length by a series of insulators. These beams have an additional function—viz., that of preventing a short-circuit should the wires break. In working with tubs or other rough apparatus, it is common practice to suspend the electrodes by the cables themselves, the idea being partly that if the wire breaks, thus causing the two opposite poles to come into contact, the current will be automatically cut off; but such a system practically debars the use of winches, unless of special and elaborate design. It is on the whole better practice to use a strong steel rope, making sure that it is always fit for its work.

To return to Fig. 2: the positive pole of the machine is connected to the inner tank by a flexible cable, and the negative to the outer, which is earthed, the apparatus thereby being made to all intents and purposes safe. An efficient supply of cooling water is arranged for by the two pipes at the ends of the outer tank; the outlet should be at the top to allow the hottest water to flow off and the inlet at the bottom, thus causing the cold water to intermingle with the entire contents of the tank. If the supply is drawn, say, through the station circulating water mains from some adjacent stream, the hot overflow is probably of no value, and may be allowed to run to waste; but if, on the other hand, it is taken from the supply mains or other comparatively pure source, and not treated with chemicals in the tank, it may with advantage be passed

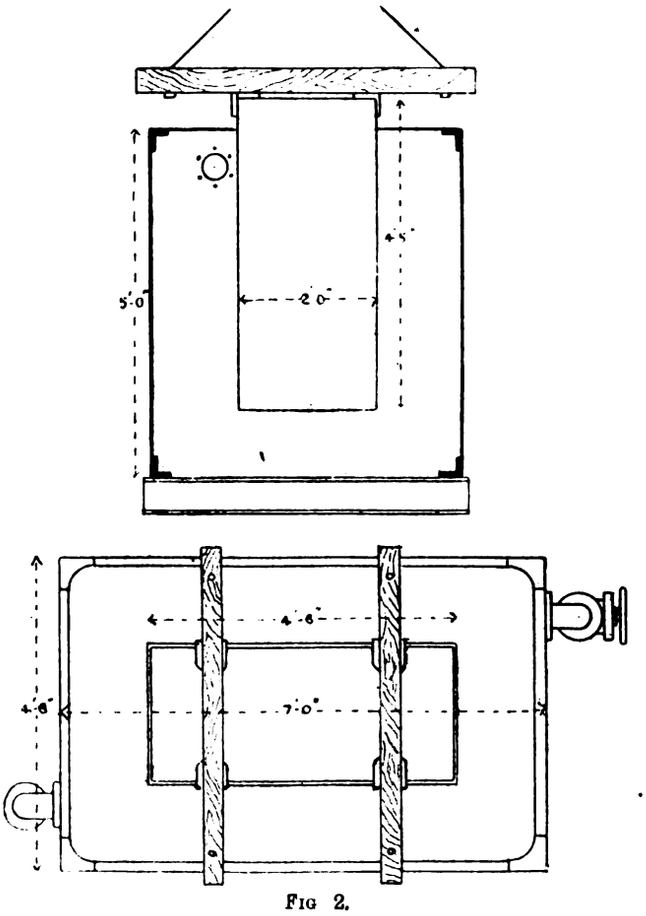

FIG 2.

into the hot-well, and an appreciable economy thus effected.

For testing high-voltage alternating-current machinery of the same output, the arrangement shown in Fig. 2 would be too large, but it may be adapted by substituting rod electrodes, the outer tank being earthed and simply used as a container and not as one of the poles. Single-phase work will necessitate two ¾in. or 1in. iron rods placed about 3ft. apart for 2,000 volts; and three-phase, of course, calls for three placed equidistantly at an angle of 120deg. Two-phase testing requires two separate tanks with two poles in each, the phases being treated separately as two independent single-phase circuits. One large tank such as the above may be used with only two inner electrodes and the tank as a common third, but in this case if accurate readings are required, say, for the purpose of an efficiency test, it must be divided between the two rods by a metallic plate electrically connected to the tank all round, as otherwise considerable current that obviously cannot be metered will pass between the two inners, falsifying the results to a large degree. When using rods as electrodes, it will be found

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advantageous, in the interests of circulation of the water, to place earthenware drain pipes around them, with their upper ends slightly below the surface of the water. The violent boiling that takes place within the pipes owing to the restricted volume of water, causes a very rapid circulation upwards and over their tops, and this, of course, tends to the desired effect of keeping the whole of the contents of tank at approximately even temperature.

There can be no doubt that for the testing of machinery and for general station work, the water load is the best and handiest medium. Other types are, however, found in use, some of which may be recommended for purposes apart from machine testing. The carbon rheostat as a power absorber is an old friend—indeed, one of the first, and although it is not much used at the present time, it has done yeoman service in the past. The best form is the well-known one that is made up of a series of carbon plates placed in a frame fitted with a screw for tightening up or slacking back, the contact between the plates being thus increased or diminished, and the resistance of the whole varied in proportion. In this apparatus the resistance is due, not so much to that of the carbon itself, as to the more or less bad contact between the plates; and as these cannot be fitted or screwed up so as to touch equally all over their surface, the current is often forced to take a diagonal path through the plates from one point of contact to another, and by this means the resistance of the whole is considerably increased over the theoretical amount that might be calculated for the particular length and diameter of the rheostat. Cooling is the chief difficulty presented by such apparatus, and for this reason it is only suitable for very small powers.

A very cheap and handy form of artificial load may be made up of galvanised iron netting wound into a spiral by the aid of non-inflammable insulating distance pieces, or folded backwards and forwards over an iron frame built up on insulators. The resistance of this netting is approximately ·0036 of an ohm per yard of No. 18 gauge, 1in. mesh, one yard wide, and the safe current capacity of such a piece would be about 100 amperes. Different makes of netting would doubtless vary in these figures, and before building up such a rheostat careful resistance measurements of a sample would be necessary.

For testing small machines, such as exciters, a very handy artificial load may be made in this way. As a dissipator of heat, iron netting is naturally very effective, especially the kind composed of a right-angled mesh, in which case only one set of wires will carry current, while the others at right angles will serve to carry off much of the heat generated. Expanded metal also makes a very effective resistance, and in many ways is preferable to netting, being, for instance, stronger and requiring less support. It is, of course, dearer than the former, but to a certain extent makes up for this by requiring less in the way of holding up and clamping together. If intended for a permanency, its use is to be recommended over netting, but as a temporary expedient the latter is preferable owing to its extremely low cost.

THE WORKING OUT OF INDICATOR DIAGRAMS.

BY H. E. HODGSON.

The most important information sought from an indicator diagram is the indicated horse-power of the engine from which it is taken. The indicated horse-power of an engine, or the rate at which it receives energy from the driving agent, is measured by the amount of mechanical energy given to the machine in foot-pounds per minute, divided by 33,000. If we let

P = M.E.P. (mean effective pressure on the piston in pounds per square inch);
L = length of the stroke of the engine in feet;
A = area of piston in square inches;
N = number of useful strokes per minute;

then the work done during one stroke = P A × L, and the work per minute = P A × L × N; then the

$$\text{I.H.P.} = \frac{\text{PLAN}}{33{,}000}.$$

The length of the stroke is best measured by making a mark on one of the cross-head guides at each end of the stroke, and measuring the distance between the two marks. The piston area is obtained by removing one of the cylinder covers and measuring the diameter of the cylinder by means of a special form of micrometer calliper. The piston area being equal to ·7854 × the square of the cylinder diameter, of course the effective area on the crank side will be less than that on the head side by an amount equal to the sectional area of the piston rod. It is due to this difference in piston area that the indicated horse-power for the two sides of the piston have to be worked out separately.

The number of useful strokes per minute for one side of the piston in a steam-engine is equal to the number of revolutions that the engine is making per minute, and may be measured by means of some form of tachometer or speed counter. In a gas or oil engine the quantity N will represent the number of explosions per minute. To find the mean effective pressure, the diagram must be "averaged," or, in other words, the mean height must be found. There are numerous methods of doing this, some of which are briefly described below. The quickest and most accurate are those which involve the use of some form of planimeter. Unfortunately, this necessitates the use of a costly instrument which may only be occasionally used, and hence a more laborious method has often to be resorted to, known as the ordinate method.

Methods of Finding the Mean Effective Pressure.

1. *The Coffin Averaging Planimeter.*—The Coffin averaging planimeter (Fig. 1) consists essentially of a rod, T, having

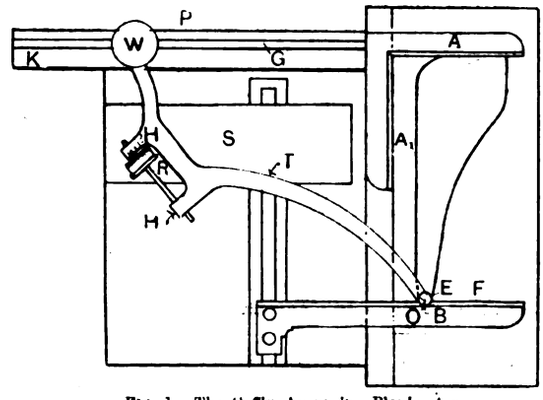

Fig. 1.—The Coffin Averaging Planimeter.

at one end a pin, P, constrained to move in a straight groove, G, in the metal plate, K, and at the other a tracing point, O. A small weight, W, is placed immediately above the pin, P, to prevent it jumping out of the groove. The rod is provided with two projecting horns, H H, which carry the bearings of the spindle carrying the flanged recording wheel, R, which runs on a specially prepared surface, S. The wheel, which is graduated, is provided with a vernier fixed to one of the horns for more accurate reading. To obtain the mean height of an indicator diagram, slide the card under the two clips, A B. Arrange it so that the back pressure line is parallel to the edge A_1 of the clip, A, and the left-hand end of the diagram touches the other limb of the same clip. Now push the clip B towards the clip A until it touches the right-hand end of the diagram, as shown in the figure. Place the planimeter in the position shown in Fig 1, with the tracing point at the point E where the clip B touches the diagram, and press the handle of the tracing point so as to mark the card at E. Then raise the wheel off the paper, by placing the finger under one of the horns, and set it to zero, care being taken not to touch the flange, which is liable to be rusted by the moisture of the hand, which would wreck the instrument. Some people prefer to take the reading at starting rather than setting the instrument to zero. The outline of the diagram is then carefully traced in a *clockwise* direction until the tracing point reaches E again. Now slide the tracing point outwards along the edge of the clip B until the wheel indicates zero or the initial reading; the tracing point will then be at some point such as F. Then E F is the mean height of the diagram. To find the mean effective pressure, measure the distance,

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E F, with a scale corresponding to the number of the spring used in the indicator.

2. *The Amsler Planimeter.*—The Amsler planimeter consists of a rod, R, carrying a tracing point, T, this rod being joined to a radius bar, S, having a pivot, P, at one end, by

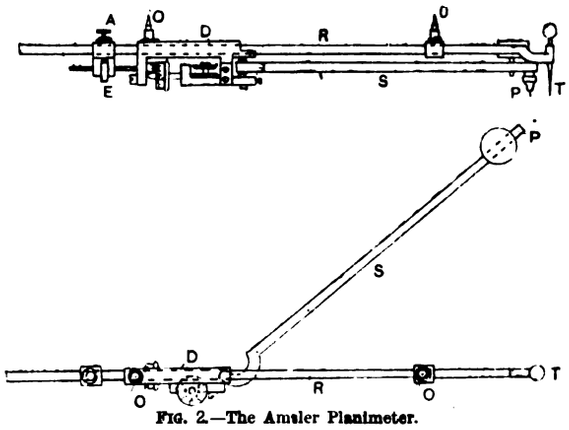

FIG. 2.—The Amsler Planimeter.

means of the saddle, D. The saddle, which is secured to the tracing arm by means of the clamping screw, A, carries the recording gear. It is preferable to use the instrument on a drawing board covered with a sheet of smooth, hard drawing paper.

Method of Use.—Unloosen the clamping screw, A, and run the saddle along the arm, R, until the distance between

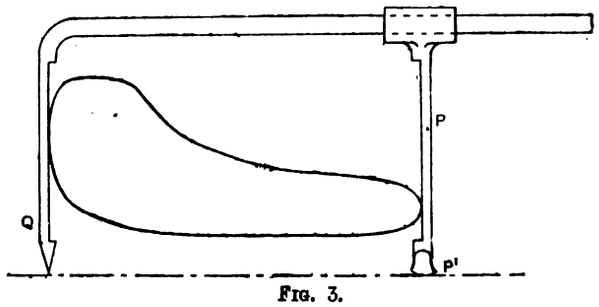

FIG. 3.

the two points, O O, equals the length of the diagram, the fine adjustment being accomplished by means of the milled head, E, after the clamping screw, A, has been tightened. Place the pivot point, P, of the radius arm at some convenient point on the paper and make some sort of mark on the outline of the diagram. It is advisable to commence

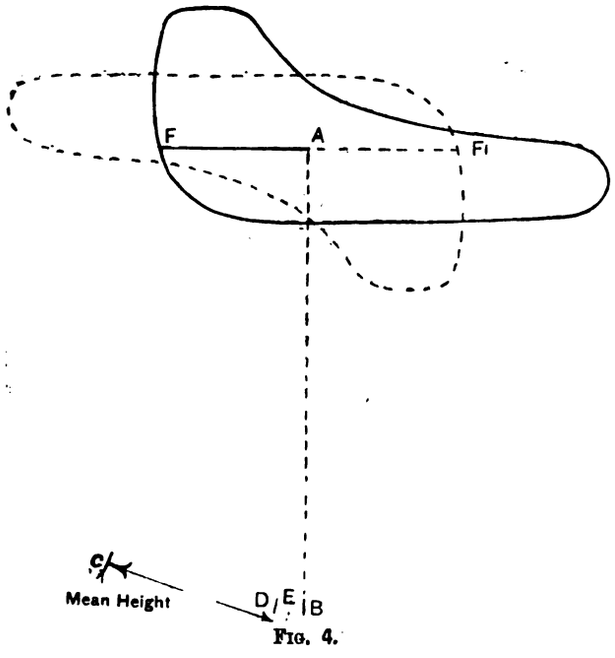

FIG. 4.

tracing a little distance to one side of this mark to obviate any slight error due to backlash in the recording gear. Take the reading of instrument when the tracing point, T, reaches the mark, trace right round the diagram, and take the reading again. The difference between these two readings divided by the constant of the instrument (40) multiplied by the scale of the spring will give the mean effective pressure.

3. *The Goodman Averager.*—Another form of instrument for obtaining the mean height of a diagram is Prof. Goodman's modification of the "hatchet" planimeter. This instrument is curious in its simplicity, consisting of a bent bar, Q, and an adjustable limb, P, held in place by a spring. The extremity of the movable arm is flattened out to form a knife-edge, P' (Fig. 3), the plane of which passes through the tracing point, Q. This intrument is totally different from the previous two, inasmuch as there is no wheel or recording gear at all, an ordinary scale being used for the ultimate reading.

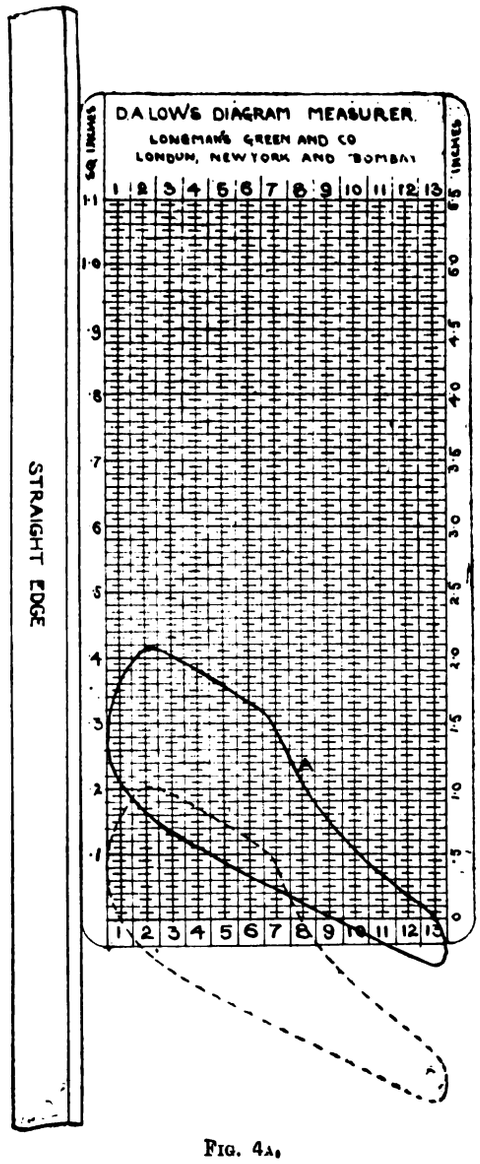

FIG. 4A.

Method of Use.—Run the movable leg along the bar until the distance between the legs is equal to the length of the diagram as shown in Fig. 4. Mark, as near as can be estimated by the eye, the centre of gravity (A, Fig. 4) of the figure, and from it draw a line, A F, parallel to the atmospheric line, to the boundary of the figure. Place the instrument along a line approximately at right angles to this line, with the tracing point at A and the hatchet at B, as in Fig. 5. Make an indent at B, trace right round the figure back to A, and make another indent at C. Then, keeping the instrument still, turn the card through 180deg. and retrace the diagram in the *opposite* direction, and make another indent at D. The points B and D should coincide, but due to the fact that the centre of gravity, A, was estimated in the first instance, and other small errors, they in general do not, so a point, E, is selected midway between them. Then the distance C E, measured with a scale corresponding to the spring used, will give the mean effective pressure. It is absolutely necessary when using this instru-

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ment to keep it in a vertical plane, and allow the hatchet to run on a sheet of smooth drawing paper.

4. *Low's Diagram Measurer.*—Excluding planimeters, the easiest method of averaging a diagram is by means of Low's diagram measurer. This handly little instrument, designed by Prof. D. A. Low, of the East London Technical College, has lately been placed on the market by Messrs. Longmans, Green, and Co., the cost being the modest sum of 1s It is undoubtedly a useful instrument to possess, for by its aid the mean effective pressure of fairly open, clear diagrams can be determined almost as quickly as with an expensive planimeter. Although perhaps not quite so accurately as with a planimeter, yet the accuracy attainable with a modicum of practice and care is more than sufficient for all practical purposes. The instrument consists of a piece of transparent celluloid about 6½in. long and 3in. wide, upon which is printed two series of equidistant parallel lines intersecting each other at right angles, as shown in Fig. 4A.

Method of Use —Place it on top of the diagram to be measured, so that the two boundary lines touch the diagram, as shown at A in Fig. 4A. If the diagram is not large enough to stretch across the whole width, a portion may be used, or if too large, it may be divided into two parts, and the area of each found separately. Then, holding a straight-edge in the position shown, slide the instrument upward till the lower end of ordinate No. 1 is on the lower boundary of the diagram, as shown dotted in Fig. 4A. It will be observed in the example illustrated the first ordinate cuts the boundary again at ·16; the area of the first strip is, therefore, ·16 square inches. Next place a needle point at ·16 on ordinate No. 2, slide the instrument downwards till the needle point comes over the lower boundary; the reading where the second ordinate cuts the boundary will give the combined area of the two strips. These operations should be repeated for the other remaining strips. However, the number of strips that can be treated in this way is limited by the length of the instrument. If the sum of the first five strips falls just within and the sum of the first six falls without the limit of the instrument, then make a note of the area up to the fifth strip, and still keeping the straight-edge in the same position, slide the instrument upwards until the lower end of ordinate No. 6 is immediately over the lower boundary, and process as before. Proceeding in this way the total area of the diagram can be found; dividing this by the length of the diagram (measured on the scale provided on the right-hand side of the instrument), the mean height of the diagram is obtained, which, multiplied by the scale of the spring, will give the mean effective pressure.

(To be continued.)

TRADE NOTICES AND NOVELTIES.

Single-Phase Motors.

From the Langdon-Davies Motor Company, Limited, 101, Southwark-street, London, S.E,, we have two sheets giving particulars and prices of their single-phase motors with a spur gear speed reduction attached, or with a friction clutch attached. The spur gear gives a cheap and compact method of speed reduction, while the company's pattern of friction clutch enables the load to be thrown on and off the motor as gradually as may be desired. This is often of great importance when the motor is driving heavy machines, since the sudden throwing-on of the load, such as occurs with automatic friction clutches, is apt to pull up the motor, or, at all events, to seriously overload it.

Superheated Steam as Applied to the Willans Engine.

Some useful information concerning the use of superheated steam with the Willans engine is contained in a pamphlet recently issued by Messrs. Willans and Robinson, Limited, Victoria Works, Rugby. Several diagrams are included, showing respectively the saving effected in steam consumption on Willans triple-expansion, compound, and simple engines with varying degrees of superheat.

Measuring Instruments, etc.

We have received from Messrs. Nalder Bros. and Thompson, Limited, 34, Queen-street, Cheapside, E.C., a copy of Section I. of their catalogue, dealing with soft-iron ammeters, voltmeters, etc. A description is included on p. 16 of an automatic accumulator switch, Crawley's patent. This switch is entirely electromagnetic, and it is, therefore, impossible for it to become reversed. It is differential in its action, and switches the cells into the charging circuit as soon as the voltage of the latter has risen sufficiently above the cell voltage, whatever it may be at the time. Moreover, it cuts out the cells directly the charging current falls to zero, there being, consequently, no sparking at the mercury-cups. This device is compact in form.

Galvanometers, etc.

Mr. W. Clark Fisher, Gordon Works, Gordon-road, West Ealing, London, W., has favoured us with advance copies of some pamphlets which he is now issuing descriptive of some of his specialities, these including highest grade improved d'Arsonval galvanometers for scale, zero, or ballistic use, and a "compensating" potentiometer of compact form. The vertical galvanometer bracket, which we illustrate herewith (Fig. 1), was primarily designed for use on board ship to economise space and to prevent any angular motion of the vessel out of the vertical being transmitted to the galvanometer. As shown, it consists of a metal framework slung off a gimbal bearing, and by its own weight thus retaining a vertical position. The framework carries two brackets, to one of which is fitted lamp, reflector, and transparent scale, and to the other a prism and reflector. The galvanometer is supported on a turntable at the back of this second bracket, the prism on which throws the vertical beam from the lantern on to the galvanometer mirror, which, when reflected outwards, is caught on a reflecting strip and by it thrown again in reverse vertical direction on to the reflecting strip on the other bracket, and thence to transparent scale. The design admits of the relative positions of top and bottom bracket with galvanometer being reversed, so that instead of the latter being below test-bench level, and approximately 18in. above floor, it may be placed above the scale—an arrangement which is to be preferred in the majority of cases. The apparatus for land use is rigidly bolted top and bottom to wall brackets, which allow of the same interchangeability of the relative positions of scale and galvanometer, etc. The design also admits of any length scale or scale distance being employed. Full adjustments are fitted throughout, and notwithstanding apparent complication they are easily manipulated, and the proper arrangement effected in a few seconds. The floor space occupied is less than one-ninth the usual 1m. triangle, and for the rest the convenience of a clear test-bench for the placing of any apparatus without regard to obscuration of beam will be readily appreciated by "spot watchers. Fig. 2 illustrates a

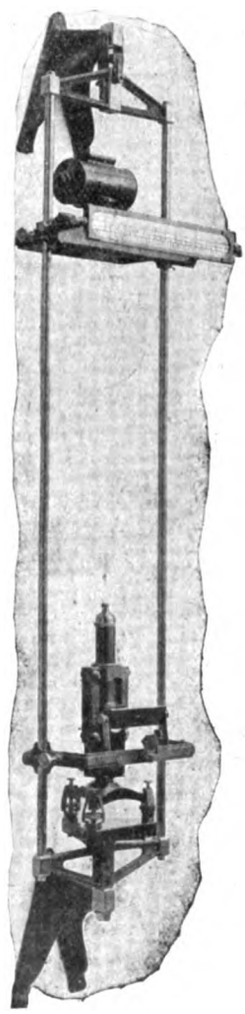

FIG. 1.—Vertical Galvanometer Bracket.

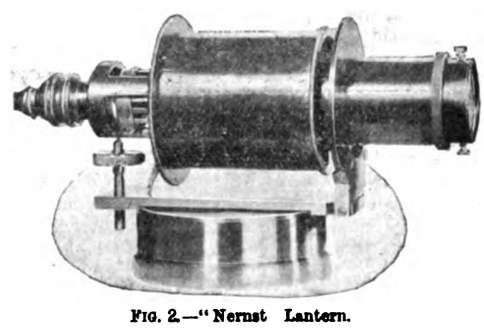

FIG. 2.—"Nernst Lantern.

Clark Fisher "Nernst" lantern for use with galvanometers, etc. This lantern gives a very bright spot with a sharp definition of the dividing line, obtained by a new device, while a variable aperture gives any size spot suitable for bench or lecture work. It has angular, rotation, and vertical movements, being, moreover, cool in use.

Reducing Valves.

From Messrs. W. H. Bailey and Co., Limited, Albion Works, Salford, Manchester, we have a voluminous catalogue of their "Foster's" patent pressure-reducing valves, pump governors, etc. The detailed descriptions and sections given of the various

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apparatus listed will be found exceedingly useful for reference. An object lesson on erosion, showing the effect of the wire-drawing of steam on valves, is included on p. 17.

Ediswan Accessories.

Catalogue Section 3, just published by the Edison and Swan Company, is claimed to be the most complete list of its kind ever brought before the trade. The contents are set forth in 68 clear and concise pages, everything being standardised, scaled, and, where necessary, accompanied by dimensions. The first part of the list is devoted to electric lighting accessories. Commencing with lampholders, we are taken in succession right back to the main switchboard, it evidently being the company's idea that small things are wanted more frequently than large ones. Amongst novelties we notice the Ediswan improved double-pole switch-holder, for which excellent results are claimed; new designs in high candle-power lampholders; a neat watertight holder; and a dust and damp proof adaptor for lampholders. Cast-iron watertight cases are also listed for ceiling roses and cut-outs. There is an excellent range of wall and floor sockets for all purposes, including some well-designed stage plugs. The "Wedge" tumbler switch naturally comes in for a large share of attention, some six pages being devoted to it. This switch has met with great success owing to its simplicity and efficiency. It is being specified by consulting engineers and architects, and we understand that the makers can hardly turn the switches out fast enough to meet the demand. Amongst new patterns we notice the D.P. tandem type, and several new designs for flush purposes, a watertight pattern, and also a watertight box for the ordinary patterns. The "Safety" tumbler switch comes in for some display; it is specially recommended for use on 500-volt circuits. Amongst the new Ediswan pear switches a two-way pattern is now listed. New designs of chopper and knife switches are standardised in a very large number of switches, finishes, and modifications. A workmanlike series of new regulating switches are shown, and next we come to cut-outs. These are listed in many types, from the circular and oblong china patterns to large new terminal and knife patterns up to 500 amperes. Then come several varieties of automatic cut-outs, and after this the well-known "Edinburgh" and "Economic" fuseboards. The former is now standardised in a size at 50 amperes per way, and both patterns are to be had in many varieties of cases, etc. Distribution boards occupy another six pages, and three distinct types are listed—namely, combinations of "Edinburgh" fuse with "Wedge" or chopper switches, and "Economic" fuses with "Wedge" switches. The last should prove a good selling line, the list price being as low as 5s. per way. Some fine examples of Ediswan main switchboards are illustrated, which show the important and large range of work undertaken by the company. The rest of the catalogue comprises casing, conduit, jointing materials, etc.—*i.e.*, all the ordinary sundries used by wiring contractors.

Polyphase Induction Motors.

Westinghouse polyphase induction motors, types "C" and "C B," for constant speed are fully described in circular B 1,070, just issued by the British Westinghouse Electric and Manufacturing Company, Limited. Illustrations are included of different applications of these motors.

Two-Way Knife Switches.

Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, London, N.W., have sent us some sheets dealing with their single-pole, two-way knife switches of standard dimensions. Each switch is fitted with a rapid quick-break action from either position, the main conducting blade carrying a spring-controlled subsidiary blade on each of its edges. Prices are included for switches of from 50 amperes to 1,000 amperes capacity.

United States Metallic Packing.

The United States Metallic Packing Company, Limited, are issuing a revised list of the users of their packings. This list is an exceedingly lengthy one, including, as it does, the names of firms in all branches of industry throughout the United Kingdom, British and foreign vessels, various railway companies, and electric lighting and power stations. Illustrated particulars of the packings are attached.

Catalogue.

The latest sheets of the Electrical Company, Limited, Charing Cross-road, W.C., illustrate and give prices of quick break single-way knife switches, up to 400 amperes 500 volts (E.C. 86); and of carbons for flame lamps, with perpendicular or converging carbons, both cored (E.C. 87).

THE SUPPLY OF ELECTRICITY BILL.

On the resumption of the discussion on the Bill of the Board of Trade for amending the Electric Lighting Acts, Lord Wolverton's Committee of the Lords dealt with Sub-Section 2 of Clause 4 relating to the right of local authorities to purchase electrical undertakings from companies. Under this section of the Bill, as originally framed, a generating station or other works of a company used solely for supplying electricity within the district of a local authority, when situated outside the district, was to be considered as being within the district for the purposes of purchase by the local authorities. Bulk companies were exempted from the clause.

The **Chairman** said the committee were willing to insert the following words in the clause to meet the objections of the companies: "Provided always that any company coming under the operation of this clause may give six months' notice by resolution of the company to the Board of Trade that they will take none of the benefits and incur none of the liabilities."

Mr. Pelham said that the Board of Trade could not agree to those words, and suggested that the following words would meet the views of their lordships and the companies: "Provided that this sub-section shall not, without the consent of the company to which they belong, apply to any generating station, mains, or other works authorised by a special Act before the passing of this Act."

Counsel for the companies urged their lordships to adhere to their own words, but after deliberating in private, the **Chairman** announced that the committee were prepared to accept the wording of the Board of Trade.

Lord R. Cecil, on behalf of the London boroughs, objected to a sub-section in Clause 4 which authorises local authorities to transfer their rights to purchase a private company's undertaking to any other local authority subject to the consent of, and on such terms and conditions as may be approved by, the Board of Trade and with the consent of the company. He submitted that a company had no right whatever to interfere in a matter of that sort.

Mr. Balfour Browne, on behalf of the companies, contended that the suggested amendment would have the effect of putting on to a company a number of different authorities to whom it had never agreed to sell, and that it would involve an alteration in the general law.

Mr. Pelham, assistant secretary to the Board of Trade, also objected to the alteration, and the clause was passed as it stood.

On Clause 5, which permits the exercise of electric lighting powers by local authorities acting jointly with the concurrence of the Local Government Board by means of provisional order, **Mr. Moon**, on behalf of the Metropolitan Electric Company, asked for the insertion of an amendment to the effect that in any area in which a company was authorised to supply for power or lighting purposes the consent of that company be obtained before an order was issued.

Mr. Fitzgerald, representing the Municipal Corporations Association, denied that the principle that local authorities should not combine had ever been laid down.

The committee rejected the amendment.

A proposal by the Municipal Corporations Association to omit Clause 6, which empowers the Board of Trade to grant a provisional order or not at its discretion, was rejected.

An amendment by the Board of Trade was agreed to, directing that the principal provision of the clause shall not apply to any provisional order authorising a company or person to supply electricity so far as the order relates to a district in which the local authority is authorised to supply electricity; and, further, that a provisional order authorising the breaking up of roads outside the area of supply shall not be granted, except with the consent of the local authority, unless the Board of Trade is of opinion that such consent should be dispensed with.

Clause 10 relates to the supply of electricity to premises having a separate supply, and requires the person having such separate supply and who demands a supply from the authorised undertakers to agree to pay such a minimum annual sum as will give a reasonable return on the capital expenditure, and will cover other standing charges incurred to meet possible maximum demands of those premises.

Mr. Coward, on behalf of the London County Council, opposed this clause on the ground that it imposed a new burden on consumers, but it was supported by **Mr. Fitzgerald** and **Mr. Balfour Browne**, and agreed to.

An amendment suggested by **Mr. Fitzgerald** applying the clause to existing contractors was also agreed to, but a new clause giving increased powers to auditors, with an appeal to arbitration, where necessary, proposed by the London County Council, was rejected.

The Bill was ordered to be reported to the House.

APPOINTMENTS VACANT.

Storekeeper, Carlisle Electricity Works. Wages, 25s. per week. Applications by July 25.

Assistant for Meter Department. Salary, 30s. per week. Apply, M E 4, *Electrical Engineer* Office. See advertisement.

Tramways Manager and Engineer, Huddersfield Corporation. Salary, £350 per annum. Applications by noon on Aug. 8. See advertisement.

Clerk of Works, Cheltenham Corporation, to superintend the construction of electric tramways. Salary, £4. 4s. per week. Applications by July 25.

Electrician, Bracebridge, Lincs., to take charge of the boilers, engines, dynamos, and electrical plant at the asylum. Salary, £100 per annum, with house (or equivalent allowance for rent), coal, and light, free of taxes. Application by July 30.

Electrical Engineer, Acton Urban District Council; resident electrical engineer to organise and superintend their electricity undertakings under the direction of the consulting engineer. Salary, £200 per annum, with residence, coal, and light. Applications by July 25.

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LEGAL INTELLIGENCE.

NORWICH CORPORATION v. NORWICH ELECTRIC TRAMWAYS COMPANY.

Mr. Justice Phillimore delivered his reserved judgment in this action, which was reported in our issue of the 1st inst.

The Corporation claimed £53. 13s. 10d., the cost incurred in repairing and maintaining certain parts of the road adjoining the company's tramways. By Section 57 of the Norwich Electric Tramways Act, 1897, if the company failed to maintain and keep good the junction of the granite setts alongside the lines with the surface of the road, the Corporation, after giving seven days' notice, might do the work and charge the company with the cost, and 5 per cent. interest. This had been done in several parts of the borough. The company denied liability, and submitted that they could not be called upon to repair the setts until the Corporation had made up the road surface to the original level that Parliament contemplated.

The learned Judge held that the defendants were liable, and gave judgment for the Corporation for the amount claimed, plus 5 per cent. interest, and costs.

ELECTRIC TRAMWAYS CONSTRUCTION.

On the application of Mr. Martelli, on Monday, Mr. Justice Kekewich postponed the hearing of the case of the Electric Tramways Construction Company *v.* Pain until after the Long Vacation, in consequence of certain criminal proceedings now pending.

A petition to wind up the company has, as reported in our last issue, been directed by Mr. Justice Buckley to stand over until after the Long Vacation.

ARE ELECTRIC FITTINGS MACHINERY?

An action was heard at the Manchester Assizes last week before Mr. Justice Relf and a jury, in which Thos. Kay, an iron turner, employed by the British Westinghouse Electric and Manufacturing Company, Limited, claimed damages from the company for personal injuries which he received on Feb. 22 last, whilst in their employ.

Mr. Acton, instructed by Messrs. Rowley and Co., appeared for the plaintiff; and Mr. Taylor, K.C., and Mr. Wingate Saul, instructed by Messrs. Norton and Howe, for the defendants.

Mr. Acton said the accident that happened to the plaintiff was due to the neglect of the defendants to fence off certain dangerous parts of machinery. The learned counsel stated that in the usual hurry to go to the "clocking-off" board at the close of work on Feb. 22, the plaintiff was pushed against two copper switch plates, through which a high-voltage current of electricity was running. His face came against the plates, with the result that he was fearfully burned—his right eye, the flesh round it, and the face being burned away. The plates at the time were only 5ft. from the ground and unfenced. The plaintiff had earned 35s. a week, and would be unable to follow his occupation again, as his left eye was in a very bad state through sympathetic disease. The learned counsel asked the jury to say that the existence of the two unprotected plates with the high voltage of current running through them was dangerous. It appeared, said Mr. Acton, that the plates were examined the next day on behalf of the firm, and they were moved from 5ft. above the ground to 7ft. above the ground, they were enclosed in a metal box, and a notice put up warning the men. The defence was contributory negligence, and, secondly, that the defendants were a limited company, and the negligence, if there was any, was that of their manager, who was in the position of a fellow-workman of the plaintiff.

Medical evidence was given as to the extent of the injuries, the doctor stating that the whole of the right side of the plaintiff's face would be so loathsome to look at that he would have to wear a shield or he would not be able to go amongst people. He would suffer a good deal of pain and discomfort throughout his life.

The **Plaintiff** gave corroborative evidence in support of his counsel's statement. In cross-examination, a fellow-workmen, who saw the accident, said the men always rushed the nearest way to join the line for "clocking off." In reply to the jury, another workman said there was no notice put up to direct the men which way to go or not to go. Evidence was also given as to the subsequent alterations to the switch and the notice put up.

Mr. F. Cortez Leigh, electrical engineer, Manchester, said he considered the switchboard to be part of the machinery of the works. He described it as such, because it was absolutely necessary for their works when lighting was required. In reply to Mr. Taylor, witness decidedly maintained that the switch should have been fenced.

Mr. Taylor, K.C., submitted there was no evidence of any breach of duty on the part of the defendants in not fencing a dangerous part of the machinery of the factory. His point was that the actual thing in connection with which the accident happened could not, within the meaning of the consolidated Factory Acts, be described as part of the machinery in a factory. He further maintained that if there had been an omission of duty, it was an omission by a servant of the company.

Mr. Acton submitted that Mr. Taylor's contention was too narrow. He urged that the question whether the switch was part of the machinery was one of fact. He submitted that it was just as much part of the machinery as the gas-engine that drove the dynamo.

His Lordship said he had very great doubt, indeed, whether it could be said to be part of the machinery within the meaning of the Act. The plaintiff had still his common law action for neglect. The question was, was there neglect which involved a want of reasonable care on the part of the directors?

Colonel Montague Craddock, one of the directors, was called for the defence, in order to prove that they had no knowledge of the danger.

Mr. H. S. Loud, general manager, admitted receiving a letter from Mr. Scott Ramen, electrical inspector to the Board of Trade, on June 4, 1903, pointing out that there were a number of power switches, from 3ft. to 5ft. from the ground, entirely unprotected, and saying that it was important that all such switches should be protected by suitable covers. The letter also said that the lighting switches should be treated the same way. He gave instructions that the work should be done without consulting the directors. In October, 1903, there was another letter about the switches from the Board of Trade.

His Lordship pointed out that from June to October witness allowed that dangerous switch to remain in that condition, and asked Mr. Loud what was the good of giving orders if he did not see them carried out. Attention was again called in October, and it was still unprotected in February.

Mr. Taylor, K.C., urged that the whole question was whether or not it was the responsibility of the directors or of a fellow-servant. His case was that a fellow-servant was responsible, and therefore the directors were not liable for any damage. Further, plaintiff knew the switch was dangerous, and behaved negligently.

Mr. Acton said his Lordship had held that the question whether the switch was part of the machinery within the meaning of the consolidated Factory Acts was a question of law. It was evident from the letters produced by the defence that the factory inspectors considered it their duty to inspect these appliances. Apart from that he saw no merit in the defence. He quoted the dictum of Lord Herschell that the employers' duty was to provide proper appliances, to maintain them in proper condition, and to so carry on their operations as not to subject their employés to unnecessary risk.

His Lordship having reviewed all the circumstances at length, the jury returned a verdict in favour of the plaintiff, awarding damages to the amount of £850.

COMPANIES' MEETINGS AND REPORTS

ELECTRIC CONSTRUCTION.

The eleventh annual meeting of shareholders in this Company was held on the 14th inst. at Winchester House, Mr. James William Barclay presiding. The report was published in our issue of the 8th inst.

In the course of his remarks, the **Chairman** observed that the orders on hand included, amongst others, important contracts with the London County Council and with the Great Western Railway Company for their new electrical installation at Park Royal. Within the last few years new factories had been established both in England and in Scotland, and the Chairman stated that, although he looked for a development in the use of electric power, the Company must expect, and be prepared for, keen competition for some time. The Company were well equipped for the struggle. The works were up to date, and no expense had been spared in adopting labour-saving machinery, and the directors had full confidence in the skill of the Company's engineers and in the zeal and ability of the employés.

The report was adopted *nem. con.*

METROPOLITAN ELECTRIC SUPPLY.

An extraordinary meeting of the Metropolitan Electric Supply Company, Limited, was held on Tuesday at Winchester House, Mr. W. H. Cripps presiding.

The **Chairman**, in moving the adoption of a resolution to divide the profit on the sale of the St. Marylebone portion of the undertaking by a £6 per share bonus on the ordinary shares, stated that there was a sum of £1,212,000 to be dealt with as a result of the sale to the Borough Council, of which £700 000 was regarded as profit. The bonus would absorb £600 000, and a part of the remaining £100,000 would go to reserve, so that at the end of the year that fund would stand at £230,000, all in gilt-edged securities. They took £500,000 to represent capital, and the suggestion was to reduce capital from £1,000,000 to £750,000 by giving every holder of two £10 shares three £5 shares and £5 in cash. That, however, was a scheme for subsequent consideration, and would have to be carried through by Act of Parliament. Having referred to the fine site received as part of the Sardinia-street station award, he said the Board were advised by eminent counsel that they could treat the £600,000 already mentioned as profit, but the debenture holders declared it ought to be treated as capital and not as dividend. They had as security for their £250,000 the whole of the concern and the £500,000 now lying in the bank; but they were not satisfied, and were going to the Court of Chancery for an injunction to prevent the distribution of the £6 a share bonus. He thought that was the best thing they could do, and the matter would come on for consideration in about 10 days. If, however, the shareholders now passed the resolution, he promised that as soon as the Court gave authority the same day cheques should be sent out. As to the current year's business, it promised to be very good, but the Board thought it would be wise not to pay more than 9 per cent.; next year, with the reduced capital, they would again pay 9 per cent., and in the two following years the same, aided by the margins carried over, and after that they believed the ordinary growth of business would enable them to distribute dividends on an ascending scale.

Sir Eyre Shaw seconded the motion, which was agreed to unanimously.

CITY OF BUENOS AYRES TRAMWAY.

An extraordinary general meeting of the City of Buenos Ayres Tramway Company, Limited, was held at Winchester House on Monday

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for the purpose of considering resolutions dealing with the proposed sale of the undertaking, assets, and property of the Company to the Anglo-Argentine Tramways Company, Limited.

Mr. J. Heaton presided, and explained that the Anglo-Argentine Tramways Company had made a definite offer (of which we gave particulars in our issue of the 8th inst.) to take over and work the line. That company had further agreed to secure to this Company a sum of £68,960 per annum as a preferential revenue charge upon the united undertakings for a period of 80 years, an annual sum for necessary administration, and a further sum for compensation for those deprived of office. The £68,960 was equal to a dividend of 8 per cent. per annum on the present share capital, together with interest at 6 per cent. per annum upon the debenture stock. There would be surplus lands which the Anglo-Argentine Company would not require, and which would be handed back. The value of these lands was estimated at a considerable sum, which, when realised, would be available for distribution.

The resolutions were unanimously adopted.

ANGLO-ARGENTINE TRAMWAYS.

At an extraordinary general meeting of the Company at Winchester House on Monday, the shareholders ratified the agreement for the purchase of the business of the City of Buenos Ayres Tramways Company, and authorised the directors to increase the capital of the Company in due course by the sum of £600,000, by the creation of 120,000 new ordinary shares of £5 each, "and to issue such shares, or any of them, subject to such conditions as to postponement of rights to dividend and otherwise as they may think fit."

A resolution was also passed altering the articles of association.

GENERAL ELECTRIC.

The report of the directors to be submitted at the ordinary general meeting of the shareholders to be held on Wednesday, July 27, states that the net trading profits and income from investments, etc., for the past year amounted to £83,864. 14s. 1d., and that after deducting depreciation and debenture interest amounting to £25,607. 14s. 11d., there remained a balance of £58,256. 19s. 2d., out of which a dividend on the preference shares at the rate of 5 per cent. for the year ended March 31, 1904 had been paid, absorbing £12,500, leaving an available balance of £45,756. 19s. 2d., which the directors recommend should be appropriated as follows: to payment of managing directors' and employés' bonus, £4,575. 14s.; to payment of dividend on ordinary shares at the rate of 7 per cent. for the year ended March 31, 1904, £21,126; to reserve account, £20,055. 5s. 2d. The reserve account stands in the accounts at £60,210. 2s., being the amount of undivided profits as at March 31, 1903. The proposed appropriation of the undivided profit of the year ended March 31, 1904, amounts to £20,055. 5s. 2d., giving a total of reserve account of £80,265. 7s. 2d. The directors remark that the trading profit must be deemed satisfactory considering the general depression of trade. The Witton engineering works and foundry are now in full working order. The favourable anticipations expressed in last year's report have been realised, and the number as well as the nature of the contracts in hand are very encouraging for the future. The position of the carbon works is much improved. The Manchester and Birmingham factories continue to show good results.

DIRECT UNITED STATES CABLE.

The report for the six months ended June 30 states that the net revenue amounted to £43,121, as compared with £48 886 for the corresponding period of 1903. The working and other expenses, including income tax, amounted to £21,185, leaving a balance of £21,936 as the net profit, making, with £2,479 brought forward and £1,966 compensation for surrender of leases of premises at New York, a total of £26,381. For the corresponding period of 1903 the working expenses and other payments amounted to £21,724. Three quarterly interim dividends of 3s. each per share, amounting to £27,319, have been declared and paid during the year, and a final dividend of 3s. per share is now proposed, making, with the three interim dividends, 3 per cent. for the year, being a total distribution of £36,426. After transferring £6,000 to the reserve fund account, the balance of £2,168 is carried forward. The reserve fund account has been debited with £11,725 for cost of cable repairs, and, after being credited with interest on the investments and amount transferred from revenue, the balance now amounts to £463,952, taking the investments at cost price.

EASTERN TELEGRAPH.

The report for the half-year to March 31 last shows a total income of £635,885, as against £626 800 for the corresponding period. Expenditure, however, has likewise advanced, and the increase in net revenue is only £2,000, the total being £419,965, which, with the carry forward from the preceding half-year of £32,867, brings the available balance up to £452,833. After making provision for income tax, interest on loan from a sister company, and debenture and preference interest, there remains £359,233. A sum of £178,000 is placed to the reserve funds—£7,000 less than last year—while the dividend on the ordinary stock with bonus is maintained at the same rate, 7 per cent. per annum.

CITY AND SOUTH LONDON RAILWAY.

The report states that the receipts for the past half-year amount to £80,203, and the cost of working has been £36,569, leaving a profit of £43,634. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £44,403. After making provision for the debenture stock interest and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £31,684 Out of this sum the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, and that a dividend at the rate of 2¼ per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £701 to be carried forward to the next account. This represents a slight decrease in the dividend as compared with last year, the competition from the electric trams having increased owing to the progress of the reconstruction operations. Negotiations with the railway companies and other public bodies with whom agreements have to be made in respect of the extensions to King's Cross, St. Pancras, and Euston have made considerable progress, but are not yet sufficiently advanced to allow a contract to be entered into for the construction of the line. It is, however, hoped that these negotiations will be brought to a conclusion at an early date, and authority will therefore be asked for the creation and issue, when required, of the capital necessary to carry out the extension, the interest on which will not be a charge on the revenue of the Company until the line is open for traffic. The works of the Baker-street and Waterloo Railway are making rapid progress, and the plans of the low-level subway at the Elephant and Castle, connecting the platforms of the two stations, have been agreed. The Great Northern and City Railway was opened in February last, and the interchange traffic with that railway is steadily progressing.

NEW COMPANIES REGISTERED.

Paddington Electric Supply Company, Limited.—Capital £1,000. Objects: to carry on the business of electrical, mechanical, and chemical engineers, electricians, etc. Registered office: 19, Carnaby-street, Golden-square, W.

Murdock Gas Fittings Company, Limited.—Capital, £5,000. Objects: to acquire and carry on the business of C. Lucas at Bridge-street West, Birmingham, as the Murdock Gas Fittings Company, formerly a branch of the business of Chris. Lucas, Limited, as lamp manufacturers and dealers in electric, gas, and sanitary fittings, brass-founders, etc.

Taylor's Patent Shunting Lever, Limited.—Capital, £200,000. Objects: to acquire any inventions relating to railways or tramways; to acquire from D. E. Cardinall, of 28, Cromwell-road, Hove, Sussex, the benefit of certain existing inventions relating to improvements in means or appliances for operating points and signals for railways and tramways, and for other like purposes, etc.

R. H. Longbotham and Co., Limited.—Capital, £10,000. Objects: to acquire the business carried on by R. H. Longbotham, at Ings Foundry, Wakefield, and at Newcastle-on-Tyne, as R. H. Longbotham and Co.; to manufacture and deal in machinery, apparatus of all kinds, and to carry on the business of electrical and general engineers, distributors and suppliers of electricity, etc. Registered office: Ings Foundry.

Barber and Colman, Limited.—Capital, £10,000. Objects: to acquire for the purpose of sale in the United Kingdom, the British Colonies, Europe, and Asia mechanical contrivances, patented articles, appliances, devices, and goods manufactured, patented, and supplied by Messrs. Barber and Colman, of Rockford, Illinois; by the International Battery Company, of Chicago; by the Krag Metallic Company, of Chicago; and by the Woodward Governor Company, of Rockford, Illinois, etc. Registered office: 25, South-corridor, Royal Exchange, Manchester.

Liens Registered.

Wexford Engineering Company, Limited, Wexford.—Lien registered July 2 for £1,000, part of £6,000; amount previously issued, £5,000; charged on the undertaking and all the property, including the uncalled capital.

British Electric Calibrated Fuse Company, Limited.—£100 debentures, part of a series created Dec. 4, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Lang, 137, Fenchurch-street, E.C. No trustees. Total amount previously issued of same series, £1,650.

Isle of Thanet Electric Tramways and Lighting Company, Limited, London, E.C.—Trust deed registered July 8 for securing £50,000 debenture stock, supplemental to trust deeds dated Jan. 18, 1902, and Aug. 5, 1902. Trustee: City Safe Deposit and Agency Company, Limited; charged on the undertaking and all the properey, present and future.

Otto Electrical Manufacturing Company, Limited (Manchester).—Issue on June 23 of £1 500 debentures, part of a series created June 22, 1904, to secure £5,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Deakin, The Hall, Wormhill, near Buxton, Derbyshire. No trustees. No previous issue of same series.

New General Traction Company, Limited.—A trust deed, dated June 22, 1904, to secure £80,000 prior lien debentures, has been registered. Property charged: shares in the Norwich Electric Tramways, Coventry Electric Tramways, and Douglas Southern Electric Tramways, bonds of the Philadelphia, Morton and Swarthmore Street Railway Company, Limited, and the Media, Middleton, Aston, and Chester Electric Railway Company, and the company's other assets, present and future, ranking in priority to a trust deed dated June 28, 1901, securing £200,000 debentures, and certain agreements. Trustees: Trustees', Executors', and Securities' Insurance Corporation, Limited, Winchester House, E.C.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Cardiff.—Tenders are invited for two road motor-wagons for the Health Department. Tenders by July 25.

Worksop.—Tenders are to be obtained for cables, etc., for mains, and additional feeder, estimated at £1,000.

Fulham.—Tenders are required for two steam water-tube boilers, steel flues, etc. Tenders by July 27. See advertisement.

Salford.—The Corporation invite tenders for the wiring of the Pendleton Town Hall. Specifications, etc., may be obtained from the Borough Electrical Engineer, Frederick-road Works, Pendleton. Tenders by July 23.

Bromley.—The Council invite tenders for the provision of a 15-kw. electric light installation at the refuse destructor works. Specifications, etc., may be obtained at the office of the Borough Engineer. Tenders by 3 p.m. on July 26.

Glasgow.—The Trustees of the Clyde Navigation invite tenders for two electric 32-ton coaling hoists for Clydebank Dock. Specification, etc., may be obtained from Mr. Geo. H. Baxter, 16, Robertson-street, Glasgow. Tenders by noon on July 25.

Swansea.—Tenders are invited for the supply of sundry fittings for an installation of electric light at the Swansea Working-Men's Club and Institute, Alexandra-road, Swansea. Specification can be obtained from the Steward. Tenders by July 25.

Hackney.—The Guardians invite tenders for fitting up a system of electric fire-alarm bells at their Homerton establishments. Specification, etc., can be obtained from Mr. Frank R. Coles, Clerk's Offices, Sidney-road, Homerton, N.E. Tenders by 2 p.m. on July 27.

Wimbledon.—The Urban District Council invite tenders for extensions to the present refuse destructors at their electricity works. Particulars may be obtained from the Engineer and Surveyor to the Council, Council Offices, Wimbledon. Tenders by 10 a.m. on 25th inst.

Newcastle-upon-Tyne.—The Guardians invite tenders for the installation of the electric light in the hospital block at the workhouse. Specifications may be seen at the offices of Messrs. Newcombe and Newcombe, 89, Pilgrim-street, Newcastle-upon-Tyne. Tenders by 12 noon on Aug. 4.

Plymouth.—The Corporation invite tenders for (25) steam alterrator, etc; (26) Lancashire boilers, with mechanical stokers; steam, exhaust, and other piping; ejector, condenser, valves, etc. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by Aug. 15.

Portsmouth.—Tenders are invited for the supply of 13,000 to 15,00 tons of best Durham rough small and best north country screened nut coal, between Aug. 1, 1904, and Aug. 1, 1905, for the electricity station. Particulars may be obtained from the Town Clerk. Tenders by 10 a.m. on July 26.

Aston Manor.—The Corporation invite tenders for the supply, delivery, and erection complete of pipework, etc. Specifications, etc., may be obtained from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on July 28. See advertisement in former issue.

Hapton (Lancs.).—Tenders are invited for the street-lighting of the parish of Hapton for eight months, commencing Sept. 1 and ending April 30, 1905; also tenders for same period during years 1905, 1906, and 1907. Tenders to Mr. Ed. O'Shaughnessy, clerk to the Hapton Parish Council, 16, Hammond-terrace, Padiham, by July 30.

Dover.—The Corporation invite tenders for the supply and erection of one surface-condenser air-pump, two centrifugal pumps, and pipework, to heat 10,000lb. of steam per hour and to give a vacuum of not less than 28in. Specifications, etc., may be obtained on application to Mr. L. W. Woodman, borough electrical engineer, Park-street, Dover. Tenders by July 30.

Beverley.—The Visiting Committee invite tenders for various work in connection with the provision of new fire appliances at the asylum, including internal electric fire-alarm communications. Specifications, etc., may be obtained on and after 25th inst. at the office of Messrs. Maxted, Knott, and Coles, engineers, Burnett-avenue, High-street, Hull. Tenders by 12 noon on Aug. 10.

Islington.—The Lighting Committee invite tenders for the following: (1) supply of a 25-b.h.p. single-phase 50-period 200-volt alternating-current motor, with all starting gear, etc., complete; (2) supply of three sets of tail-rods and bearings for 1,000-b.h.p. engines. Specifications, etc., may be obtained upon application to the Electrical Engineer, 50, Eden-grove, Holloway. Tenders by 12 noon on July 27.

Chorlton-cum-Hardy (Lancs.).—The Withington Urban District Council invite tenders for the supply and erection complete of one 20in. centrifugal pump and electric motor and one 20in. centrifugal pump and oil-engine at their Chorlton sewage works. Specifications, etc., may be obtained on application to Mr. A. H. Mountain, A.M.I.C.E., Town Hall, West Didsbury, near Manchester. Tenders by July 29.

Perth.—The Corporation invite tenders for the construction and equipment of about 4½ miles of route length of tramways, constructed as single line with passing places—viz.: (1) permanent way and paving, including copper bonding; (2) overhead equipment; (3) cables, ducts, etc.; (4) cars and equipments; (5) car depôt building. Specifications, etc., can be obtained from the Town Clerk. Tenders before noon on Aug. 16.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two n. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

Berga, etc. (Spain).—The *Gaceta de Madrid* for June 26 publishes a Royal decree calling for tenders for the installation and working of a telephone system and central stations at Berga and sub-stations at Gironalla, Puigreig, Balsareny, Sallent, Castelladral y Cardona. Tenders will be received within 30 days' date of publication at the office of the Dirección-General of Posts and Telegraphs, 10, Calle de Carretas, and at the office of the Civil Governor, Barcelona, a provisional deposit of 2,000 pesetas (or about £57) being required from persons tendering. The maximum period for the concession is for 20 years, and the adjudication of tenders will turn on the reduction of this period. The *Gacetas* may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between 10 a.m. and 5 p.m. (Saturdays 10 a.m. to 1 p.m).

Reichenberg (Austria Hungary).—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

RESULTS OF TENDERS.

Bridge (near Canterbury).—The tender of L. Sunderland and Co., Westminster, has been accepted for electric light installation at Bridge-hill House.

Northallerton.—The Urban District Council have accepted the tender of the Northallerton Electric Lighting Company for lighting the town for two years.

Loughborough (Leicestershire).—The Town Council have accepted the following tenders: E. Green and Son, Limited, economiser, £402. 10s.; T. Sugden, Limited, superheaters (2), £142. 10s. each.

Brighton.—The tender of Siemens Bros. and Co., Westminster, at £39,420, has been accepted for the supply and laying of three-core high-tension and other cables from the Southwick works to the North-road sub-station.

Renfrew.—The Town Council have accepted the following tenders: J. and R. Houston, Greenock, purifiers; R. Laidlaw and Son, Glasgow, exhausters; C. M. and J. Hamilton, Hamilton, retort bench; Barrowfield Ironworks, Glasgow, retort bench ironwork; Penman and Co., boiler; Clapham Bros., Limited, Keighley, condensers.

St. Pancras.—The Borough Council have accepted the tender of W. F. Dennis and Co. for the supply of cables at £800. 15s. 6d., an amendment that the next lowest tender—that of Callender's Cable and Construction Company at £885. 11s. 10d.—be substituted on the ground that where possible the Council should take British instead of foreign work, having been lost by a narrow majority.

Air Compressors, etc.—R. W. Blackwell and Co., 59, City-road, E.C., report an order from the Underground Electric Railways Company of London for over 200 50-cubic feet motor-driven compressors for the air brakes on the new trains which are to be operated on the Metropolitan District Railway; they are also supplying the company's electric locomotives with their combined vacuum pumps and air compressors.

Rochdale (Lancs.).—The Corporation have received the following tenders for the supply, delivery, and laying in the borough high and low tension feeder cables, etc.: British Insulated and Helsby's Cables, Limited; W. T. Henley's Telegraph Works; Callenders, Limited; W. T. Glover and Co., Limited, Trafford Park, Manchester (accepted); St. Helens Cable Company, Limited; Western Electric Company.

Swansea.—Sixteen tenders have been received for tramway switchboards at Strand and destructor works generating stations. The lowest for specified instruments were Ferranti Limited—specified instruments £904, alternative instruments £801. The Council have decided to let Mr. Prusmann select the tender of Messrs. Dorman and Smith (£1,027 specified instruments) or British Westinghouse Company (£1,033. 2s. 6d. specified, £1,018 9s. 6d. alternative).

Bursiem.—The Corporation have accepted the following tenders for the supply, delivery, and erection of the following plant, etc.: (A) water tube boilers; (B) steam-piping, pumps, water-softener, etc.; (C) engines

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(D) dynamos, balancer, and boosters; (E) switchboard; (F) cables, including laying; (G) arc lamps; (H) accumulators; (I) refuse destructor plant: Babcock and Wilcox, boilers, £1,087; Sir Hiram Maxim, piping, £1,009; Dick, Kerr, and Co., engines and dynamos (with Howden engines), £1,863; General Electric Company, balancer booster, £337; Crompton and Co., switchboard, £598; Callender and Co., cables, £9,554. 1s. 8d.; Crompton and Co., arc lamps, £443; E.P.S. Company, accumulators, £780. 5s.; Heenan and Froude, destructor, £3,095.

West Ham.—The Education Committee have received the following tenders for the electric wiring and fittings for an installation of electric light at the West Ham Park Elementary Schools, Stratford, E.:

Noble and Co.	£960	10	0
Tamplin and Makovski	769	10	0
J. Winn	661	5	0
Electrical Engineering Company	630	13	0
Lawrence's, Limited	630	0	0
Jackson Bros.	629	0	0
Comyn Ching and Co.	624	0	0
Lightwell Electric Company	620	0	0
J. T. Halsey	603	4	9
Beaven and Son	596	8	8
Wallace and Co.	572	17	6
White and Co.	555	13	0
Wells, Raynor, and Co.	528	15	0
Richmond and Co.	528	0	0
Marshall and Co.	527	13	0
Empire Electrical Company	521	12	9
Nunn, Watts, and Co.	517	4	0
Russell and Co.	505	9	0
Glover and Co.	499	0	0
Murrell Bros.	494	3	0
W. Simmons	490	11	0
Bakewell and Co.	488	13	0
Brown and Rostron	485	8	8
Donnison Sillem, and Co.	465	10	0
Wright, Methuen, and Co.	464	0	0
M. Wiedhofft	441	0	0
Defries and Son	435	10	0
Vulcan Electric Company	400	0	0
Electric Motor Company	324	13	0
District Electric Company (accepted)	320	0	0

BUSINESS NOTES.

TRACTION.

Rawmarsh.—The negotiations with the company are still hanging fire.

Darwen.—The tramways account to March 31 shows a loss of £2,949.

Belfast.—The Corporation's Bill has been read a second time in the Commons.

Luton.—The Town Council have decided to include a route along Dunstable-road in the tramways scheme.

Sweden's Railways.—It is reported that the electrification of the State Railways in Sweden is under consideration.

Colchester.—The Board of Trade inspection of the Colchester tramways is fixed for Tuesday next, the 26th inst.

Darlington.—Saturday was a record day for the new cars, over 13,000 passengers being carried, the receipts exceeding £54.

Prestwich.—The District Council have obtained a definite promise from the Salford Corporation that work on the track from Heaton Park will be commenced shortly.

Newport (Mon.).—With a view of inducing greater carefulness and smartness in looking out for passengers, the Electricity Committee have adopted a system of bonuses for drivers and conductors.

Manchester.—Saturday was a record day on the Corporation tramways. More passengers were carried and more money was received in fares than on any one day since the municipalisation of the system. The earnings were close upon £3,000.

Morecambe.—At a meeting of the Town Council the Tramways Committee reported that negotiations were still proceeding with the local tramway company with reference to the proposed electrification of the trams, and certain proposals were before the directors.

Maidstone.—The Board of Trade inspection and opening of the tramways took place last week, everything passing off satisfactorily. The total cost amounts to £23,000. Half-a-dozen double-deck cars will be in use at first. The authorised speed is nine miles an hour.

Dublin and Lucan Electric Railway Co.—For half-year ended June 30, 1904, the directors propose a dividend of 10 per cent. on the preference shares (reducing the arrears to nine months), placing £100 to reserve account, and carrying forward a balance of £161 to next half-year.

Northampton.—The official opening of the new electric tramways took place yesterday afternoon, the Mayoress starting the first car from Mercer's-row, another following shortly afterwards. The cars proceed to Kingsley, on to St. James's End, and thence to Abington, the guests being subsequently entertained at a garden party.

Sheffield.—At last week's meeting of the Corporation a scheme was foreshadowed for establishing a service of motor omnibuses to run from various termini to populus districts and villages beyond at the cheapest rates. The traffic would not be sufficient to justify the laying down of tramlines, but the running of motor 'buses would pay.

Nelson.—It is reported that numerous complaints are being made at the unsatisfactory nature of the tramways connection at the Colne boundary, passengers from the Nelson district having been put to much inconvenience through the inability of the Colne Tramways Company to meet the Nelson cars as they have arrived at the boundary.

Bettws-y-coed.—The Carnarvonshire County Council have approved the draft order, plans, etc., of the Penmachno, Corwen, and Bettws-y-coed light railway, subject to certain modification, including the insertion of a clause for the avoidance of injury to natural scenery, and changes in the places at which the railway should cross the main road.

Liverpool.—The receipts of the Corporation tramways for the fortnight ended July 9 were £22,542. 7s. 5d., as against £21,722. 17s. 10d. last year, an increase of £819. 9s. 7d. The passengers numbered 4,845,682, compared with 4,660,065 last year, an increase of 185,617, and the mileage travelled by 381 cars, as against 407, showed an increase of 12,289.

Leeds.—The Corporation have come to an agreement with the Wakefield and District Light Railways Company for the through running of trams between Leeds and Wakefield and Leeds and Rothwell. By August next it will be possible to travel by tram from Leeds Corn Exchange to Wakefield, a distance of about 10 miles, for the sum of 6d., which is 3d. cheaper than the present railway fare.

Falkirk.—The Town Council have forwarded the draft conditions as to the running of the electric cars on Sundays to the promoters, the Falkirk and District Tramway Company. The Council reserve to themselves the right to purchase the undertaking from the company on a six days' running basis, and to prohibit the running of the cars during the hours of public worship. They also stipulate that the tramway employés shall be engaged only six days per week.

Central London Railway.—The directors of the Central London Railway Company have declared a dividend for the half-year ended June 30 at the rate of 4 per cent. per annum on the undivided ordinary and preferred ordinary stocks, and a dividend at the same rate on the deferred ordinary stock, provided for and payable at the end of the year's working. The balance to be carried forward is £48,737, in which is included £37,000 from the previous half-year.

City and South London Railway.—The accounts for the half-year ended June 30 show a balance, after providing for debenture stock interest, dividend on the preference stocks, and transferring to renewal fund £1,500, sufficient to allow of a dividend on the consolidated ordinary stock for the half-year at the rate of 2½ per cent. per annum, carrying forward £701. The dividend for the corresponding period last year was at the rate of 2¾ per cent. per annum, carrying forward £1,500.

Electric Railway Lock.—An automatic safety lock for railway carriage doors has just been put upon the market. All the doors of a train fitted with the lock fasten automatically immediately the train starts and unlock automatically when the train comes to a standstill. By the movement of the train a current of electricity is generated, and this is centred on a powerful magnet which draws a bolt into a slot, thus securing the door. When the train stops the current ceases, the bolt drops, and the door is released.

Bath.—Last week Colonel von Donop, representing the Board of Trade, expressed approval of the working and the construction of the new line which has been laid down from High-street, round the Orange-grove, Terrace-walk, and North-parade, and down Pierrepont and Manvers streets to the Great Western Railway Station. The car travelled along the metals smoothly, and all the corners were easily negotiated. The inspector then proceeded in a car to Combe Down to examine the progress of the work in connecting up the track with Combe Down.

Pontypridd.—At the meeting of the Pontypridd District Council Electricity and Tramways Committee a report was read of the negotiations between Mr. Hugh Bramwell, who had been deputed to meet the British Electric Traction Company with a view to the purchase of that company's horse tramways from Pontypridd to Hafod. The company wanted £6,000, and Mr. Bramwell offered £5,000 on behalf of the Council. As there seemed to be no chance of a settlement, it was resolved to refer the matter to the arbitrator appointed by the Board of Trade, Sir C. S. Moncrieff.

Compensation Limit.—The proceedings against Mr. A. Muir Wilson, a member of the Sheffield Corporation, for refusing to accept, and consequently being unable to produce, a ticket came before the Sheffield Stipendiary last week, Mr Wilson's reason for the refusal being that the notice on the back of the ticket sought to limit liability for accidents to £25. The facts were not in dispute, the question being whether the action of the Corporation was *ultra vires*. Ultimately a nominal fine of 1s. was imposed, it being understood that Mr. Wilson intended taking the case to a higher tribunal.

Electric Standards in Roads.—The Assistant Secretary of the Railway Department of the Board of Trade received on Monday a deputation from the Roads Improvement Association, who brought to his notice a number of questions, including the erection of standards in the centre of the carriageway for tramway and light railway purposes. The deputation urged that the standards were unnecessary and dangerous, and pointed to the narrow margin on either side of the tramways. Sir Herbert, in reply, said the representations should receive the careful attention of his department.

Suggested Light Railway.—The report of the Joint Committee of the Gloucestershire and Worcestershire County Councils on the proposed Gloucester to Malvern light railway, which had already been considered by the latter Council, as reported in our issue of the 17th ult., was presented at the last meeting of the Gloucestershire County Council. The committee were unable to recommend that the circumstances would justify the necessary outlay. A suggestion was made that motorcars might be run, and that the Great Western Railway

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should be approached. Ultimately the subject dropped without any action being taken.

Swansea.—The contractors, Messrs. Dick, Kerr, and Co., have completed a section of the tramways, extending to some 3¼ miles, and representing about a third of the system. A communication has been received from the tramway company in respect to the short strip of track beyond the borough boundary. The company state that they are not prepared to run any risk, but would run over this strip at per car mile, they to hand over all the receipts of this section. The company also asked for the payment of £6,640. 10s., agreed upon in connection with the overhead electrical equipment, Neath-road. It was decided to defer compliance with the request for the present, as it was considered that if the amount was paid before a lease has been entered into complications might arise.

Southport.—The year's returns of the Corporation trams show a deficit of £341, against £1,223 last year. The traffic receipts totalled £17,304, against £16,179, and the operating costs were reduced from £11,232 to £10,986, showing a gross profit of £6,660; but interest on loans and lease rentals absorbed £3,803, and sinking fund £3,198. The following is an analysis of the working for the years 1903-4 and 1902-3 respectively: length in miles, 10·77 (10·77); car miles run, 431,019 (418,324); passengers carried, 3,837,208 (3,535,434); passengers per car mile, 8·90 (8·45); traffic revenue per car mile, 9·63d. (9·28d.); operating costs per car mile, 6·12d. (6·44d.); traffic revenue per passenger, 1·08d. (1·10d.); operating costs per passenger, 69d. (·76d.); Board of Trade units used, 492,261 (458,472); population of district, 49,000 (49,000); number of times population carried 78 (72).

Metropolitan Electric Tramways Co.—On Tuesday last Major J. W. Pringle, R.E., and Mr. A. P. Trotter made an official inspection, on behalf of the Board of Trade, of the tramways from Finsbury Park to Wood Green and Seven Sisters Corner, Tottenham, reconstructed for electric traction on the overhead system by the Metropolitan Electric Tramways, Limited. Satisfaction was expressed regarding the manner in which the work had been carried out, and these important sections will therefore be opened for public traffic immediately on the receipt of the Board of Trade certicate. They form the first part of an extensive system, with a total length of about 50 miles of electric tramways and light railways in North London. We understand that the first result of the change from horse to electric traction will be a reduction from 1½d. to 1d. in the fare from Finsbury Park to Wood Green terminus.

Cambridge.—At a special meeting of the Town Council the Law and Property Committee reported that they had had two interviews with Mr. A. A. C. Swinton, M.I.C.E., on behalf of the Cambridge Electric Tramways Syndicate, with reference to the electrification and extension of the borough tramways, and the negotiations had now reached a point when it was desirable to consider the question of routes. As in this matter the interests of the Corporation and the syndicate were equally concerned, Mr. Swinton suggested that if the Corporation would employ an expert to advise them on this question, the syndicate would be prepared on their part to pay the cost of obtaining such expert opinion. Under those circumstances the committee recommended that Messrs. Kincaid, Waller, and Manville, of Westminster, who were employed by the Corporation in 1899, be asked to advise as to the various routes which should be adopted in the event of the electrification of the tramways being carried out. The report was adopted.

"Live Rail" Dangers.—In the course of an interview with a representative of the *Manchester Guardian*, Dr. J. A. Fleming expressed the view that there could be no adequate protection for "live rail" dangers except by covering the line. He remarked that on the Metropolitan District Railway a board was being bolted alongside the rail, the top edge of it being slightly higher than the surface of the metal. Dr. Fleming, however, considered this insufficient, and suggested a device by which the "live" rail would be covered with a wooden shelter arrangement the section of which would resemble a figure 7 or a capital L inverted. The picking-up bar of the motor would then have to be bent so as to pass under the hood of the shelter. Neither the bending of the bar nor the erection of the board arrangement, remarked Dr. Fleming, presents any difficulty, nor would the latter be very costly. "Some such protection," he continued, "would obviate the perils now attending the 'live' rail, for then neither men nor cattle could get against the metal by accident. If a man fell over it he would touch only the harmless wood. Some such protection will, I am sure, soon have to be recognised as a compulsory necessity."

Llandudno and Colwyn Bay Electric Tramway.—At the Colwyn Bay Hotel, last week, Colonel Von Donop, on behalf of the Board of Trade, held an enquiry with reference to the application of the Llandudno and Colwyn Bay Electric Railway Company for an extension till this time next year of the order authorising the construction of the light railway. It was stated on behalf of the promoters that the delay had been owing to various difficulties which the syndicate had to contend with. A contract had now been entered into for the execution of the work, and another contract had been entered into with the Tramways Construction Company, under which the capital required, £40,000, would be supplied. The agreements referred to were produced, and copies of them handed to the inspector. Mr. Leslie, of Liverpool, who appeared for the Tramways Construction Company, confirmed the statement as the capital being forthcoming, and in reply to a question said none of the money his clients would advance was in respect of the expenditure already incurred in the obtaining of the order, etc, which is said to have been about £20,000. At the close of the enquiry the inspector visited those portions of the light railway which had been completed or partially completed between Rhos-on-Sea and the Llandudno boundary.

Tees-side.—The Middlesbrough, Stockton, and Thornaby Electric Tramways Bill, promoted by the Imperial Tramways Company, was before the Select Committee of the House of Lords on Tuesday. The promoters had agreed with Thornaby to pay in lieu of profits £200 per route mile for the tramways in their district. Mr. Hamilton, who opposed on behalf of Middlesbrough Corporation, said he would be content to accept a similar clause to that which had been granted to Thornaby in regard to the 325 yards of tramway which would be made within the Middlesbrough boundary under this Bill. This led to a conference, as the result of which it was announced that it had been agreed that the 325 yards of tramway to the east of Middlesbrough should be purchased on Tramway Act terms by Middlesbrough. After formal proof of the preamble had been given, the Bill was allowed to proceed. The effect of the agreement appears to be that the 325 yards of new line in Middlesbrough will come under the purview of the provisional order of 1897, and be purchasable by Middlesbrough concurrently with the other lines, and that the tramway in Thornaby will, for the purposes of the order of 1897, form a portion of the existing system. The question of the payment to Middlesbrough, on the basis of the promoters' arrangement with Thornaby should, it was agreed, form the subject of future negotiations.

Raworth's Patents.—It is stated that six tramway undertakings have decided to adopt Raworth's patent demi or one-man car. Two of these have already been received at the Skircoat depôt for eventual use between the Post Office and the Old Station at Halifax, where a trial trip was made in one of them last week. The great advantage of this car is that it is inexpensive to work. One man can do both the driving and the conducting. He stands at what is for the time being the front of the car. There is an entrance at each end, and at the back end the gate is kept shut and the steps folded up, so that passengers can only be admitted through the opening where the driver is. No one can get out or in while the car is in motion, as any attempt to lift the bar at the exit at once pulls back the speed lever and stops the car. The fares can be dropped into an ordinary fare box, either on entering or leaving the car, and the driver is able without difficulty to exercise a strict check on the number of passengers. The car, which is, of course, of the single-decker variety, will hold 20 passengers. Patent motors and controller are also being used. If the car is going up hill it does not require so much current as an ordinary car, as it is only half the weight; and when it is running down, instead of its grinding up wheels and brakes, the motors turn into generators and generate current, which goes back into the overhead lines to help the other cars. One object of this trial trip was to register the amount of current saved by the patent motors and controller, and the results are said to have been very satisfactory. It is expected that, compared with an ordinary car, which weighs double and requires two men, the saving will be one half, while as the new cars are fitted with regenerative control, it is anticipated that the cost will be further reduced to one-third.

Metropolitan Railway Co.—At the meeting of the St. Marylebone Borough Council the Legal and Parliamentary Committee presented a report stating that they had received a further letter from the engineer to the Metropolitan Railway Company, with reference to the company's proposals to erect an electrical sub-station in Upper Baker-street. The company are very anxious to proceed with the erection of the sub-station, and state that, unless the work can be proceeded with at once, there will be considerable delay caused in running the electric trains over the railway. Although the company feel sure that building shops at the north end of Upper Baker-street will not be remunerative work for them, they undertook to submit for approval a revised plan showing shops facing the street at the side of the sub-station. The committee had also received a further letter from the agent to the Portman Estate, stating that he has had further communication with the railway company as to their proposals, and has seen the engineer, who submitted to him an amended plan, following up the lines of the discussion at the recent conference, by which the company will continue the shops and business premises for the whole length of their buildings on the ground floor at least, and will rearrange the construction of the sub-electrical station so as to only occupy the upper part or back part of their building, and that, under the circumstances, he thinks that this proposal might be accepted. Mr. Seaton, the company's engineer, attended before the committee, and submitted the amended plan showing a new elevation, with shops along the whole length of the buildings, and gave an undertaking that the depth of the shops proposed to be built would not be less than 10ft. and endorsed the plan accordingly. The committee recommended that the Council approve of the proposals of the company to erect a sub-station in Upper Baker-street in accordance with the amended plan.

London County Council.—The Highways Committee submitted a recommendation at Tuesday's meeting of the Council that (*a*) the erection of a pump-house and an outside coal bunker, (*b*) the preparation of the foundations for the turntables and cranes, and (*c*) the making-up of the levels of the road in connection with the generating station at Greenwich, be entrusted to Messrs. Lovatt and Co., who have the main contract, and who were prepared to carry out the work at price ½ per cent. less than the schedule prices specified in their present contract. The expenditure is estimated at £29,000. A further vote of £1,500, beyond the £3,000 already granted, was asked for in order to supply the tools required in connection with the electrical working of the tramways. A sum of £1,250 was applied for to rebuild and extend the car-sheds at Wandsworth. The Highways Committee further recommended that the contract for the sub-station at Greenwich be awarded to Messrs. Lovatt and Co., the work to be completed by the same date as the first portion of the generating station. The cost is put at £18,500. Approval was also asked to an estimated expenditure of £15,000 for the plant required at the sub-station. The receipts for the week ended 9th inst. amounted to £14,117, against £11,187 last year, and for the period from April 1 to that date they totalled £171,048, against £141,966 last year. An elaborate form of top-covered car has been inaugurated on the

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Peckham route. It was stated at Tuesday's meeting of the Council that in order to realise the tramway estimates for the present financial year a sum of £66,788 more than the receipts of last year would be required, and of this £32,107 had already been realised. It was hoped that the Council's electricity generating station at Greenwich would be at work early in 1906. At the present time the Council is being supplied with current from three stations, costing double the amount it would if supplied from their own generating station, making a difference on the past year of £15,000. The Brixton night trams are not, contrary to reports, to be discontinued, at any rate for the present, though the receipts have been only moderate.

Salford.—The annual report, just issued, describes the new routes opened during the year, and points out that so soon as the lines now being laid along Great Cheetham-street East and Leicester-road are completed—connecting the Bury New-road route with Bury Old-road—a direct route from the districts of Salford and Broughton will be obtained in Heaton Park. The total length of tramways now worked by the Corporation is 59½ miles of single track. Of this 35½ miles are owned by the Corporation. Besides running powers over 5½ miles belonging to Manchester, the following lines are leased to the Corporation: Eccles, 6½ miles; Swinton and Pendlebury, 7 miles; Prestwich, 3½ miles; and Whitefield, 1¾ miles. The total electrical energy used during the year was 6,102 524 units, of which 5,251,055 units were supplied by the Salford electricity undertaking, for which 2d. per unit was charged, less 2½ per cent. discount. The remaining 851,469 units were supplied by Manchester, for which only 1·49d. per unit was paid. The stock of cars on March 31 last was 150, of which 100 were of the double-decked single-truck type and 50 double-decked bogie cars, all having staircases of the reversed type. During the year 20 of the single-truck cars were covered with outer-deck coverings, and have proved of much benefit to the travelling public. The traffic returns show largely increased receipts in the gross, though there has been a decrease in the earnings per car mile, probably as a result of the unfavourable weather of last year. The number of passengers carried, the mileage run, and the traffic receipts were: passengers carried, 36,956,405; receipts, £198,422. 7s. 6d.; earnings per car mile, 10·07d.; miles run, 4,726,446. In the next previous year the figures were: passengers carried, 28,150,675; receipts, £144,486. 2s. 6d.; earnings per car mile, 10·25d.; miles run, 3,380,590. The highest weekly receipts were those for Whit-week, when they amounted to £5,606. 16s. 6d., the sum earned during Whit-week of the previous year amounting to £3,632. 9s. 3d. The year's working to March 31 last has resulted in a gross profit of £60,105. 14s. 11d. The total capital expenditure, including original outlay, amounts to £620,069.

Newcastle.—At the conference between the Tramways Committee and the Tyneside Tramways Company on Saturday the following terms were agreed upon: The Corporation shall run a service of cars beyond Wallsend boundary to Park-road in Wallsend, both on what is known as the low and high lines, and they shall retain their own drivers and conductors. This means linking up Wallsend with the Newcastle system. The Corporation may increase their service with Wallsend at their option. The Corporation to pay in the way of rent for the Wallsend line four-fifths of ½d. for every passenger carried, the sum to be reduced *pro rata* in respect to workmen and children. The fares charged on the through traffic to Wallsend will be ½d. for every half mile, but no fare in Wallsend will be charged less than 1d. The Tyneside Tramway Company will run a car with their own driver from North Shields through to Stanhope-street, or some other point on the Stanhope-street route, but each car is to be in charge of a Corporation conductor from the Wallsend boundary. The car is to be run every 16 minutes to and from Newcastle. This will work in with the present Corporation eight minutes' service, and a Tyneside Tramway Company's car will take the place of one of the Corporation cars. The Corporation to retain the whole of the receipts taken on account of passengers carried in the Newcastle area, and in turn to pay over to the company 2d. per car mile for the rent of car and use of driver. The company undertake to run punctually their cars to the satisfaction of the Corporation, and all cars have to be maintained in good order to the satisfaction of both parties; to be free from advertisements similar to the Newcastle cars as far as possible. With reference to Gosforth Park traffic, the Corporation undertake to look after all the race traffic to Gosforth Park from the Central Railway Station, the special fares to be divided according to the length of mileage run on the two systems, which is about ten-seventeenths for the Corporation and seven-seventeenths to the Tyneside Tramway Company. The company to run not more than four cars on their own lines from Lansdowne-terrace boundary to Gosforth Park. The Corporation undertake to run on ordinary days at least one car every hour to Gosforth Park, and to increase such service as the traffic requires; all-through traffic fares to be divided in proportion to mileage. The agreement to last 10 years, and to be revised every five years afterwards. During the continuance of the agreement neither party shall, without the consent of the other, make any application to Parliament, or to the Board of Trade, or the Light Railway Commissioners, in relation to running, fares, or traffic facilities generally, over the lines of either party, for alteration of powers obtained at the present session of Parliament. This agreement was submitted to the House of Commons Committee on Tuesday, when the matter was adjourned until to-day, another point arising. The committee had suggested that the parties should draw up and submit a clause providing that no increased value should accrue in case of sale from the granting of the running powers. The Corporation of Newcastle, not being the purchasing authority, could not acquire the undertaking of the company, and if the Corporation of Wallsend should in the future desire to purchase the undertaking they would obtain no benefit from the agreement, not being parties to it. Counsel are to formally draft the agreement for incorporation in the Bill, and the provision in regard to purchase is to form a separate clause.

LIGHTING AND GENERAL.

Hove.—The Hove Electric Lighting Company are about to extend their mains.

Acton.—The subject of lighting the courts has been referred back to committee.

Shildon.—The Northern Counties Electric Supply Company are making a start. A site for a station has been surveyed.

Electric Supply Corporation, Limited.—Allotment letters of the issue of 46,600 shares of £5 each were posted on Monday.

Falmouth.—The Empire Electric Light and Power Company intend to apply for a provisional order with regard to Falmouth.

Margam.—The agreement entered into with the South Wales Electrical Power Distribution Company for the supply of electric current is being revised.

Poplar.—The freehold of premises abutting on Eliza-place, Wick-lane, is to be acquired at the price of £1,400 as a site for the proposed northern sub-station.

Harpenden.—The Mutual Electrical Supply Company intend to apply for a provisional order to supply electricity within the Urban District Council's area.

Swansea.—The Town Council have decided to carry out, when necessary, certain works in connection with switches and cables at an approximate cost of £500.

Southill Nether.—Under their recent Bill the Council will acquire powers to build a refuse destructor, and its construction is to be taken into immediate consideration.

Poplar.—The Borough Council have resolved to form a reserve fund with the profit of £4,474 made by their electrical installation during the past financial year.

Louth.—The Town Council have confirmed the agreement with Messrs. Handcock and Dykes as consulting engineers on terms which the mayor said were favourable.

Wolverhampton.—The Town Council have approved of extensions of the electric lighting mains in Waterloo-road from Whitmore Hill to Christ Church, at a cost of £750.

Stoke Newington.—The Council will support the London County Council's proposed application to Parliament re wiring and fitting of consumers' premises for electric light.

Cardiff.—With regard to the erection of an electric distributing sub-station for the docks, it has been agreed to accept tenders subject to the approval of the Local Government Board.

New Address.—Messrs. Rashleigh Phipps and Co. are moving their business of artistic electric fittings, etc., to larger premises at 147, Oxford-street, on Saturday next, the 23rd inst.

Surbiton.—Messrs. Callender have obtained permission and directions to lay cable in Ewell-road at a cost of £449, a road at present outside the area comprised in the electric lighting order.

Holidays.—We are informed that the Brook Green Works of the Robertson Electric Lamps, Limited, will be closed for the annual holidays from Saturday, July 30, until Monday, Aug. 8.

Oban.—The arc lamps are to be lighted from Aug. 1. A main is to be extended for private lighting at an estimated cost of £75, and the public lamps along the route converted to electric lights.

Hindley.—Offers from the Lancashire Electric Power Company and the South Lancashire Tramways Company, Limited, for supplying electrical energy to the township are under consideration.

Goole.—An enquiry has been held into the application of the Urban District Council for sanction to borrow £1,000 for the purchase of property for the purpose of electric lighting and a depôt.

City of London Electric Lighting Co.—Warrants in payment of dividends on account of the distribution for the year 1904 on this company's preference and ordinary shares have been posted.

Hucknall.—The Urban District Council are conferring with the National Electric Construction Company, Limited, and the Southern District Electricity Corporation with regard to electric lighting.

Dewsbury.—The tradesmen's association have written to the Corporation stating that the charges for electricity in Dewsbury were in excess of neighbouring towns, and asking that a reduction be made.

South London Electric Supply Co.—The company reports that the accounts for the half-year ended June 30 show a net profit of £14,149 against £5,210 for the corresponding six months of last year.

Abingdon.—The Abingdon Electric Supply Company intend to apply for a provisional order to authorise them to supply electricity for public and private purposes within the area of the urban district and borough.

Chichester.—The Board of Trade's approval of the draft deed of transfer of the electric lighting order, as slightly altered, has been accepted by the Town Council, and referred to the company's solicitor for approval.

Hornsey.—The Borough Council have decided to borrow £75,083, at 3¾ per cent. interest, repayable in half-yearly instalments, to cover the cost of road widenings, road improvements, and electric lighting extensions.

SS. "Caronia."—We are informed that the United States metallic packing is to be fitted to all the rods on the main and auxiliary engines of the above steamer of record size, which has just recently been launched at Clydebank.

Redditch.—The Urban District Council intend to apply for sanction to a further loan of £7,500 to meet the expenses of installing additional steam plant. A motion to employ a consulting engineer has failed to pass in committee.

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Scarborough Telephones.—The Municipal Telephones Sub-Committee have now reported to the Corporate Property Committee their decision to defer further consideration of the question of establishing a system of municipal telephones in the borough.

Friern Barnet.—The Electrical Supply Company intend to apply for permission, under the Council's provisional order, to supply electric light within the Council's area. Application is to be made to extend the time of the Urban District Council's order.

Durham College of Science.—Matriculation and exhibition examinations begin Sept. 26 for the departments of mechanical and marine engineering, naval architecture, electrical engineering, mining, metallurgy. Particulars appear in another column.

Rangoon.—At a recent general meeting of the Municipal Committee it was resolved to adopt, on the Local Government's recommendation, the alternating-current system for the electric lighting of Rangoon by Messrs. Darwood and Co.—*Indian Engineering.*

London Electric Supply Co.—The number of units sold for the half-year ended June 30 was 4,494,220, producing a gross revenue of £54,776, compared with 1,927,876 units sold in the corresponding period of the year 1903, producing a gross revenue of £36,825.

Stratford.—The Stratford-on-Avon Electric Supply Company and Mr. G. Vaughan Fowler, of Warwick, and Messrs. Foote and Milne, Limited, of Princes-mansions, 66, Victoria-street, London, intend to apply for provisional orders to supply electricity for public and private purpose.

Harrow Telephones.—The survey of the area to be served by the proposed Post Office exchange has now been completed, and steps are being taken to acquire suitable premises for an exchange, and to carry out the construction of the system of wires as soon as possible.

St. James's and Pall Mall Electric Light Co.—The amount of electricity sold for the quarter ended Midsummer, 1904, is returned at 1,431,553 units, estimated to produce £22,964, as against 1,450,572 units, which produced £23,612 for the corresponding period of last year.

Taunton.—It has been decided, in consequence of the increased demand for the supply of current in the Station-road and Rowbarton district, to at once lay a low-pressure feeder main at a cost of £130. The connections to the mains during the past quarter were equivalent to 304 8-c.p. lamps.

Shildon.—The Northern Counties Electric Supply Company having informed the Council that they had secured a new site for the proposed electric light works, which would be completed without delay, it has been decided not to proceed at present with the action now pending against the company.

Norwich.—The agreement between the Corporation and the National Telephone Company, Limited, with reference to placing telephone wires underground contained a clause for the purchase of the exchange system from the company. This has now been limited to the conduits and manholes in the streets.

Clyde Valley Electrical Power Co.—A committee of the House of Commons on Tuesday adjusted clauses in a group of electric lighting provisional orders relating to Barrhead, Eastwood, and Cathcart, Kilpatrick, Renfrew, Johnstone, and Shettleston. The preamble of the Bill was passed last week.

Shrewsbury.—The accounts of the electricity works for the year ended March 31 show that the costs have been reduced by ·07 per unit, and now stand at 1·85d. per unit. The charges having been reduced, a decrease of ·42d. per unit is shown in the receipts, and £500 has been carried to reserve fund.

Fleetwood.—The suggestion of the electric lighting company of Fleetwood to supply electricity for public lighting purposes in the town at a reduced rate, providing the local Council agree to increase the candle-power in the public street lamps by 50 per cent., has been very well received by the Council.

Swanage.—The Swanage and District Electric Supply Company and the Southern District Electricity Corporation intend to apply to the Board of Trade during the ensuing session of Parliament for provisional orders to empower them to supply electricity for public and private purposes within the district.

Gravesend.—The surveyor is preparing estimates for lighting the bandstand with gas and electric lighting. The Northfleet Council is to be offered a sum of £250 on certain terms for their consent to the extension of the Gravesend electric lighting order, so as to include the urban district and parish of Northfleet.

Hampton.—The District Council have accepted the terms of the General Post Office for an exchange circuit between the public offices and the Kingston post office exchange and a private telephone circuit between the isolation hospital and Dr. Atkinson's residence, a five years' agreement to be entered into in each case.

Govan.—The Town Council have accepted the offer of Messr. Jas. Allan, sen., and Sons, Elmbank Foundry, for the supply of lamp pillars. Mr. Parsons's first annual report on the working of the electricity department is very satisfactory. The capital outlay up to date has been £71,246 and the borrowing powers are £80,000.

Liverpool.—We are informed that the bulk of the £400 000 loan already referred to in these columns, is required for extensions of Lister-drive and other existing stations and mains of the Corporation, principally in connection with additional high-tension system of distribution of 6,000 volts, which was commenced last year.

Lowestoft.—There are now 523 consumers connected to the mains, representing 25,598 8-c.p. lamps. During the month 10 new consumers have been connected, representing 308 8-c.p. lamps. It has been referred to the Electric Lighting Committee to submit an estimate of the cost of lighting the Denmark-road with electric lamps to be fixed to the tramway trolley poles.

Blackpool.—The returns for the month of June at the electricity works show a decrease in the works output of 7,451 units, as compared with the corresponding month last year. For the quarter ending June 30, the works output showed an increase of 69,878 units. The new consumers for the June quarter of this year were 20, as against 30 for the same quarter last year.

Tiverton.—Mr. G. Vaughan Fowler, Warwick, intends to apply for a provisional order under the Electric Lighting Acts for the supply of electricity in the borough. The Council have already adopted a scheme and accepted a tender. Last week they approved of Messrs. Suter's offer to deposit £1,000 as security for the due fulfilment of their electric lighting installation contract.

Cambridge.—The Cambridge Electric Supply Company, Limited, announce a reduction in price of electrical energy from 7d. to 6d. per unit: for any quantity up to 1,000 units yearly, and for any quantity exceeding 1,000 and not exceeding 2,000 units yearly, 6d. per unit, less 5 per cent. discount; 2,000 to 3,000, 7½ per cent.; 3,000 to 5,000, 10 per cent.; and above 5,000 units yearly, 12½ per cent.

Wisbech.—The Electric Lighting Committee's recommendation to adopt an agreement retaining the services of Messrs. Robert Hammond and Son as consulting engineers for the electric lighting scheme will come before a special meeting of the Council shortly. The Board of Trade have approved of the system for the supply of electrical energy for the purposes of the Wisbech Electric Lighting Order, 1901.

Eastern Telegraph Co.—The accounts show, after payment of interest on the debenture stock, dividend on the preference stock, and the interim dividend of £1. 5s. per cent. on the ordinary stock, a balance available sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both tax free, on the ordinary stock, making a total distribution of 7 per cent. for the year ended March 31.

Walsall.—An arrangement has been arrived at between the Electricity Committee and the Tramway Committee allowing of a reduction of the price of electricity down to 1½d. per unit to the Tramway Committee for the working of the tramways. The total number of consumers supplied on June 30 last was 350. During the past month the total units generated at the station were 101,514. The total output from the main generators was 98,355 units.

Hull.—An enquiry has been held into an application of the Town Council for a loan of £10,000 required for the purchase of two additional Lancashire boilers and settings; additional mechanical stoking and elevating gear; an additional armature of 510 kw. capacity; and for the construction of a bridge and railway sidings from the adjacent lines of the Hull and Barnsley Railway to the electric lighting station so as to be able to handle the coal more cheaply and expeditiously.

Electric Motors.—We have received a well-got-up and beautifully-illustrated booklet on "Electric Motor Driving," which Mr. S. E. Fedden, A.M.I.C.E., M.I.Mech.E., general manager and engineer of the Sheffield Corporation electric supply department, has drawn up for circulation amongst power users and intending consumers. It not only contains all the necessary particulars, but also a number of flattering testimonials received from many of the motor users in Sheffield.

Dudley.—The report on the year's working of the electric undertaking shows an increased annual output of 470,000 units, subsequent to a reduction in the price of current per unit to 1d. during the 22 light-load hours, and 6d. for the remaining two hours. The income has been £10,662 and the working expenses £5,650. The gross profit was £5,012, of which £4,356 was paid in principal and interest of loans, leaving a net profit of £655. This made a total net profit for the past two years of £1,451.

Lothian Electric Power Bill.—When this Bill came before Mr. Lowther's Committee on Saturday it was explained that the promoters had agreed with the opponents to reinsert the clause which was struck out by the chairman of the House of Lords, the object of which was to give compensation for any injury arising from the escape of electricity. They had resolved upon this course in order to get the opinion of the House of Commons Committee on the subject. The committee agreed to insert the clause, and the preamble of the Bill was proved.

Ashton.—The private consumers at 4d. per unit are to be allowed a discount of 5 per cent. if the account be paid within 21 days of its being presented. The power consumers will be given the option of being charged on the maximum demand system at the rate of 3d. for the first hour's daily use and 1d. after, or the present flat rate of 1½d. per unit. The following figures are available: electricity estimates for 1905, £12,008; actual expenditure for 1904, £11,278. 0s. 4d.; balance to profit and loss account, £1,270. 8s. 9d; amount received for sale of current, £11,046. 12s. 8d.

Electrical Driving and Cotton Mills.—There has just been published in pamphlet form a paper read before the Manchester Insurance Institute on Dec. 8, 1903, by A. Kelly, A.M.I.E.E. (Kelly and Hide, consulting electrical engineers, 36, Dale-street, Liverpool). It is well supplied with illustrations and diagrams, and shows that the advantages of electrical driving in cotton mills has been well appreciated in the United States under conditions which are identical to those obtaining in Lancashire. The manufacturers in this country will no doubt find the little volume useful.

Whitehaven.—Negotiations are still proceeding between the Town Council and the Harbour Commissioners as to the lighting of the harbour, as has been the case for some years now. They now turn upon the question, it appears, whether the Corporation should be held liable for any harbour accident that might result by failure of the lighting or by reason of defective lighting. The best terms the Council can make with the Harbour Commissioners is that this liability should be insured against, and that the Council and the Commissioners should halve the cost of insurance.

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Stock Exchange.—The Stock Exchange Committee has appointed July 27 special settling day for Metropolitan Railway Company's £500,000 3½ per cent. convertible preference stock, and have ordered the undermentioned securities to be quoted in the official list: Anglo-Argentine Tramways Company, Limited, 120,000 ordinary shares of £5 each, fully paid, Nos. 260,008 to 380,007; British Electric Traction Company, Limited, further issues of 1,235 ordinary shares of £10 each, fully paid. Nos. 232,067 to 233,301; and Metropolitan Railway Company's £500,000 3½ per cent. convertible preference stock.

King's Lynn.—The engineer's last report shows that applications have been received from 10 additional consumers, making a total of 474, and that there are 180 extra lamps, making 19,206 connected for private consumers. He also submitted the following statement—viz.: Units generated, May, 1904, 28,424 (1903, 22,856); units sold to private consumers (light and power). 13,584 (7,603); units sold at power rates, 9,059 (3 427); cost of fuel, stores, repairs, and wages at station, £118. 15s. 2d. (£119. 8s. 10d.); cost of units generated, 1·0027d. (1·2542d.); wages of lamp-lighters and outside staff, £28. 10s. 9d. (£19. 19s. 7d.).

Eastern Telegraph Co.—The revenue for the six months ended March 31 amounted to £635,884, from which are deducted £175,160 for the ordinary expenses and £40,759 for expenditure relating to maintenance of cables, etc., leaving a balance of £419,965, to which is added £32,867 brought from the preceding half-year, making £452,832. After placing £8,000 to the reserve fund for maintenance of ships, and £170,000 to the general reserve fund, a final dividend of 1¼ per cent. is recommended on the ordinary shares, and a bonus of 2 per cent., making a total distribution of 7 per cent. for the year. This will leave £1,233 to be carried forward.

Aberdeen Telephones.—At a recent joint meeting of the Finance and Streets and Roads Committees, the amended agreement, which had been sent back from the National Telephone Company, as to the laying of underground wires for the telephone service in Aberdeen, was considered. It was reported that Mr. Gaine, the general manager of the National Telephone Company, had made very considerable and material alterations on the Edinburgh agreement. After discussion, the joint committee unanimously resolved to recommend that the Council should make no departure from the original agreement which was submitted and was known as the Edinburgh agreement.

Finchley.—The Electrical Committee reported last week that they had expended out of the £17,000 loan £3,347 for a kilowatt set, £289. 7s. for switchboard extension, £700 for a new boiler, £226 for two superheaters, and £49. 15s. for a temporary iron building. They also recommended that the contract with the Callender's Cable and Construction Company for mains included in the extension loan of £17,000 be continued at existing rates, with substitution of "7½d." for "6½d." as the price of copper per pound owing to rise in price since acceptance of original tender, such arrangement to be subject to revision at the end of 12 months from the date of acceptance.

Dundee.—At a special meeting of the Town Council a draft agreement submitted by a company to be promoted to supply electric power to millowners and manufacturers in the city was considered. The capital of the proposed company is a quarter of a million, and they offered to supply power at ¾d. to 1½d. per unit, but not to interfere with the city's present method of supply. The city's electrical engineer reported against the scheme on the ground that, with a new power station, which would have to be erected in a short time, and the present plant, the city could supply power on better terms and in better circumstances than a private company. The Council declined to enter into an agreement with the promoters.

Mackenzie and Moncur, Limited.—We are informed by Messrs. Mackenzie and Moncur, Limited, Edinburgh, that they have added an electrical engineering department to their business under the supervision of Mr. A. Donald Mackenzie, who has been chairman of the Electric Lighting Committee of the city of Edinburgh since its inception in 1894. Mr. Mackenzie will be assisted by Mr. J. A. M'Laren, of the late firm of M'Aulay, Clark, and M'Laren, electrical engineers, 10, Dixon-street, Glasgow, who has had a large and varied experience in mechanical and electrical engineering in all its branches. The company have already received instructions to instal electric light in Appleton House, Sandringham, the residence of Prince Charles of Denmark.

"Thieves Waste Their Valuable Time."—Under the above heading the *Daily Dispatch* comments upon an attempt to melt some of W. T. Glover and Co.'s cables as follows: "Some thieves have had a trying experience in Trafford Park. A quantity of fire-resisting electric cable was carried away and put on a fire to burn, so that the insulating material over the copper might be burnt away, and the copper itself more readily melted for sale. The thieves apparently had not seen a guarantee given by the makers that the covering would resist fire, and it is feared that a considerable amount of time, patience, bad language, and fuel were used before the futility of the operation was discovered. The cable was found in a very sooty condition, but otherwise uninjured."

Caerphilly.—The Bill to confirm a provisional order of the Board of Trade for the supply of electric light to Caerphilly and district came before Mr. Agg Gardener's Select Committee of the House of Commons on Monday. A petition against the Bill had been lodged by the Rhymney and Aber Valleys Gas and Water Company. Mr. Rose, K.C., on behalf of the promoters, said the object of the Bill was to enable the Caerphilly Urban District Council to supply electricity to Caerphilly, Aber, Senghenydd, and Llanbradach, which was the area over which the Council had jurisdiction. It was not intended by the authority to generate their own electricity, but it would be bought from the Electric Power Distribution Company of South Wales. A certain minimum quantity of electricity would have to be taken, and the district it was proposed to supply had a population of about 10,000 people. The committee passed the Bill.

Shoreditch Electrical Exhibition.—It is proposed by the Lighting Committee of this Borough Council to hold an exhibition of electric lighting apparatus, accessories, machinery in motion, etc., at the Pitfield-street Baths in October next. The exhibition will be open for two weeks from Oct. 10 to 22. The Pitfield-street Baths are well adapted for such purposes, being only 15 minutes' walk from the City, within four minutes of the North London Railway Shoreditch Station, and the South London Electric, also the Great Northern and City Electric Railway Stations; the building is close to 'bus and tram routes from the City, Islington, Hackney, and Bethnal Green. Being so easy of access, it is anticipated that many visitors will attend from the neighbouring districts. We are informed that applications for space should be sent in not later than Aug. 15 next, addressed to Mr. C. Newton Russell, borough electrical engineer, Coronet-street, Shoreditch, N.

Hastings.—The Town Council have adopted a report in which the Electricity Committee stated that they had considered the matter of the desirability of establishing an alternative method of charge for current to the existing maximum demand charge of 10s. per 8-c.p. lamp per annum, plus 1½d. per unit for current consumed, the effect of which latter charge the committee find does not seem to be generally appreciated by consumers, and recommended that in future such consumers as express a desire to do so be allowed to take current under what is known as the summer and winter system of charge, by which system a charge of 6d. per unit would be made for the maximum number of units which would be consumed by an entire installation during one hour's burning per day (including Sunday) in each of the two summer quarters, and during three hours' burning per day in each of the two winter quarters, and in addition a charge of 2½d. per unit for all current consumed in any quarter over and above the maximum number of units

Sydney (N.S.W.).—The *Sydney Newsletter* says: "The work of laying on the electrical supply for the lighting of Sydney has been carried along with surprising speed since the weather took up, and both public and private contractors have been somewhat surprised. In point of fact, the work has been closely watched, owing to the methodical and thoroughly well-planned style in which it has been carried out. As a sample of this, it may be mentioned that last week in five days as much as 9½ miles were laid and the whole work of covering and restoring pathway completed. Of course, during the continuous wet weather, and owing to our narrow streets and pathways, a good deal of inconvenience was felt by business people in different parts of the city owing to the extensive disturbance of the footways. Still, the situation was fairly recognised, and the City Council officers expressed themselves as thoroughly satisfied with the efforts of W. T. Henley's Telegraph Works to vigorously execute their contract."

Manchester.—The annual report of the Electricity Committee shows a considerable increase in the demand for electric energy. Two years ago the quantity of current generated was 10 million units; in the year just closed it amounted to 29 millions, owing principally, however, to the completion of the tramways. The total number of units sold for lighting and power purposes was 11,799,214, and for traction 17,125,857. As barely 17½ millions were sold during the previous year, it is readily seen what splendid progress has been made. The plant has now capacity for generating 40 million units. The sinking fund and interest in connection with the department during the last 12 months amounted to £106,000. The price of current has been reduced, and the committee have set aside £25,000 for renewals and suspense account, and have added £6,000 to the reserve account, which now stands at £32,000. The total length of street mains now laid is about 285 miles. The area supplied at present is about 20 square miles, but the Corporation have authority to extend the area to 44 square miles.

Burton-on-Trent.—An exhibition of electrical appliances and motors was opened in the town hall last week by the Mayor (Mr. A. J. Roberts), who said that they now had 24,135 8-c.p. lamps, an increase of 12 per cent. on the year, and there were applications in hand for 459 more, equivalent to 15 per cent. increase There were also 33 motors among 18 consumers, amounting to 230 h.p., which, together with applications in hand, made an increase on the year of 255 per cent. for motor power. There was a good field for motor power in Burton, and its advantages and cheapness were only required to be known for a more extensive adoption. The trams afforded a practical illustration of the benefits of electrical power. The exhibitors included Mr. J. Richards, 48 and 49, High-street; Langton-Davies Motor Company, Limited; the United States Metallic Packing Company, Bradford; Mr. T. Williams, West Smithfield, London; Messrs. Joshua Pickles and Son, Hebden Bridge; Messrs. F. W. Flower and Co., Shaftesbury; Brush Electrical Engineering Company; Mr. W. H. Allen, Bedford; Barnett and Soans, Arcade-buildings, Burton, and George-street, Kettering; Mr. C. M. Livens, High-street, etc.

Alloa.—The negotiations between the Town Council and the British Electric Plant Company have resulted in an offer by the Council to lease the electricity undertaking to the British Electric Plant Company for the remaining years of the agreement on the basis that the company pay interest on the cables, and after the first six years pay sinking fund in addition. The original terms made with the company were £9 per kilowatt and 1½d. a unit. The Council subsequently requested a reduction of the kilowatt charge to £6, and after prolonged negotiations the company definitely intimated that they were not prepared to lower the kilowatt charge, but, if the Council adopted a new system of charging at a fixed rate per ampere per quarter, the company would be prepared to reduce the unit rate to 1d., conditional on the Council selling the current at 1½d. in addition to the fixed ampere charge. The Council consulted Mr. Hansen, electrical engineer, Stirling, on this point, and he drew up a statement showing what the chief consumers had paid for the previous year and what they would have paid on this basis, and the Council in consequence offered as a

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counter proposal that if the company would give a flat rate of 2½d., they would sell to the public at an average flat rate of 3½d. per unit. This was not accepted.

Swindon.—The following are extracts from Messrs. Lacey and Co.'s recent report: "Having carefully considered the requirements of the area, we advise that the system which will give the best results, both from an engineering and commercial point of view, is a system of direct-current three-wire supply, with a difference of potential of 440 volts between the outer cables throughout the whole area, and a 220-volt service to customers. The generating station, if properly designed, will allow of a low capital expenditure, and the plant can be such as to secure immunity from failure. The pressure of supply is sufficiently low to minimise trouble in both generating machinery and distribution. Further, the use of accumulators for storage purposes provides a most valuable safeguard, which is practically unattainable with alternating-current plant. The system of distribution will be such as to give the least possible transmission loss of any system in your particular case, and both the first cost and cost of future extensions will be exceptionally low, if sufficient care be given to the initial arrangement. The annual works costs for current production will be kept at a minimum, as the ease of regulation and the absence of transformers, of any complicated apparatus for maintaining the required pressure, will enable the system to be worked with the least possible amount of skilled labour, and at the same time avoid the many attendant losses between the generation and the consumption of current. The plant could be so designed and arranged that additional machinery can be put down without interference with the original installation or system of supply."

St. Marylebone.—The Electric Supply Committee last night presented the following report: "We have considered in their financial bearings estimates of expenditure by the Electric Supply Committee, based upon the amounts of the tenders recommended by that committee to the Council for acceptance in connection with the erection and fitting up of the electric generating station, and submit the same to the Council. This expenditure will be chargeable against the loans to be obtained for the purposes of the undertaking, and if approved by the Council, the acceptance of the tenders should be subject to the sanction of the London County Council to the amounts proposed to be borrowed for the several purposes. F. G. Minter, High-street, Putney, S.W., building new generating station, including constructional steelwork, £57,524; C. A. Parsons and Co., Newcastle-on-Tyne, electrical machinery, including electric crane and cooling towers, £79,598; St. Helens Cable Company, Limited, Warrington, cables, £78,165. 12s. 9d.; Babcock and Wilcox, Limited, Farringdon-street, E.C., steam generating plant, £55,202. We considered as to the desirability of taking any further steps for securing the advance from the County Council of £1,415,000 in October next. The County Council have given an undertaking that the money shall be forthcoming at the date required, and that it will be provided, in the first instance, by an issue of London County Council Bills, but the terms, etc., were left for further consideration. We ascertained that the terms proposed were very favourable, and we authorised the town clerk to make any formal application which the Finance Committee of the County Council might desire."

Oldham.—From the accounts for year ended March 25, 1904, we obtain the following particulars: Loans—sanctioned, £244,510; borrowed, £223,175; repaid, £13,094. Capital expenditure, 1903-4 £242,974, 1902-3 £216,882; revenue from electricity supply, £25,431 (£25,764); revenue from meter rents, etc., £386 (£408); total revenue, £25,818 (£26,172); total costs, £12,815 (£13,560); gross profit, £13,003 (£12,612); percentage of ditto to capital (averaged), 5·65 per cent. (7·75 per cent.); interest on loans, less interest receivable, £7,868 (£4,429); sinking fund, £5,906 (£2,854); percentage of ditto to capital (averaged), 2·57 per cent. (1·75 per cent.); financial result, loss £771 (profit £5,329); 8-c.p. lamps connected, 58,207 (54,154); units sold—private supply, 848,095 (762,213); public supply, 17,362 (16,972); traction, 2,177,309 (2,090,125)—total, 3,042,766 (2,869,312); units sold per 8-c.p. lamp (averaged), 15·4 (14·4); maximum load, 1,765 kw. (1,743 kw.); load factor, 19·62 per cent. (21·68 per cent.); capacity of dynamos, 5,232 kw. (5,232 kw.); statutory maximum price, 8d. (8d.); price charged—private supply, 4d. to 1½d. (4d. to 1½d.); public supply, 2½d. (2½d.); power and heat, 2d. to 1½d. (4d. to 1½d.); traction, 1½d. (2d., 1⅞d., and 1½d.); average price obtained—private supply, 3·29d. (3·41d.); public supply, 2·50d. (2·50d.); traction, 1·50d. (1·69d.); population of area of supply, 1901, 137,238 (137,238). Generation and distribution costs—coal and other fuel, 1903-4 £5,566, per unit 0·44d. (1902-3 £5,975, per unit 0·50d.) – 0·06d.; oil, water, and stores, £702—0·06d. (£551—0·05d.) + 0·01d.; wages, £2,658—0·21d. (£2,199 – 0·18d.) + 0·03d.; repairs and maintenance, £1,321 — 0·10d. (£2,617 — 0·22d.) – 0·12d. — works costs, £10,247—0·81d. (£11,342—0·95d.) – 0·14d. General costs—rents, rates, and taxes, £1,260 — 0·10d. (£1,197—0·10d.); management expenses, £1,308—0·10d. (£1,021 —0·08d.) + 0·02d.—total costs, £12,815—1·01d. (£13,560—1·13d.) – 0·12d.

Salford.—The borough electrical engineer, Mr. C. D. Taite, in his annual report states that the whole of the machinery has been taken over from the contractors, and that the engines continue to give satisfactory results. During the year 7,321 yards have been added to the distributing mains previously in use. Besides 156 new consumers connected to the main, there was a large number of extensions to installations by old consumers. The new connections are equivalent to 19,009 8-c.p. lamps and 997 h.p. in motors. Amongst the new tenders accepted is one by the committee for the supply of power to some 3,000 b.p. to be installed at the new dock of the Manchester Ship Canal Company, together with current for the lighting. It is estimated that at the end of five years the annual consumption at this dock will not be less than 1¾ million units. The motor-hiring business made great progress. There are out on hire 105 motors, aggregating 954 b.h.p., as compared with 39 motors of 336 b.h.p. in the previous year. The number of consumers who have motors on hire is 66. The gross profit for the year was £42,860, being at the rate of 8·36 per cent. on the average capital invested. This has been appropriated as follows: interest on loans, £16,020; sinking fund, £15,066; net profit, £11,774. This was thus allocated: depreciation and reserve, £8,000; debit balance from 1902-3, £2,394; contribution in reduction of rates, £1,380. The total paid to the sinking fund since the commencement of the undertaking now amounts to £47,999. The number of units sold had increased from 4¾ million units to 7½ million units, or 58 per cent., while the maximum load had only advanced from 2,490 kw. to 3,200 kw., or 28·5 per cent. The average price for private supply had fallen to 2·36d., due to the development of the demand for electricity for power purposes. The total capital expenditure to March 31 last was £530,446, of which £42,738 was expended during the financial year. The sale to lighting consumers increased from 908,354 units for the year ending 1903 to 1,140,244 units for the year just ended. The units sold for tramway purposes had increased from 3,370,434 units the previous year to 5,251,055 for the past year.

London Gazette.—The last day for receiving proofs in the estate of Thomas Williams, electrical engineer, 54, Bridge-street, Llandaff, lately residing at 13, Despenser-street, Cardiff, Glamorgan, is July 30; Mr. S. David, official receiver, 117, St. Mary street, Cardiff. Mr. A. Mackintosh, 24 Railway-approach, London Bridge, S.E., has been released from trusteeship in the estate of John Pierrepont Child, electrical engineer, 150, Powis-street, Woolwich, and 109, Piedmont-road, Plumstead, Kent. Mr. W. F. J. Hunt, Midland Bank-chambers, High-street, Southampton, has been released from trusteeship in the estate of Edwin Ward (trading as E. Ward and Co.), plumber and electrician, 38, Osborne, Southampton, late of 108, Bevois-valley and 47, Lodge-road, Southampton. The first meeting of creditors in the estate of the Electro-Voelker Syndicate, Limited, 65, George-street, Croydon, Surrey, will be held at 11.30 a.m. on July 29, and the meeting of contributories at 12.30 p.m. on July 29, at 24, Railway-approach, London Bridge, S.E. The first meeting in the estate of Frederick William Parkes and Edward Sadleir (trading as Parks and Sadleir), electrical fitters and engineers, The Dingle, Colwyn Bay, will be held at 11 a.m. on July 27, at Crypt-chambers, Eastgate-row, Chester. The last day for receiving proofs in the estate of the Electrical Timber Seasoning and Preservation Company, Limited is Aug. 4; Mr. Harold de Vaux Broughan, official receiver, 33, Carey-street, Lincoln's-inn, W.C. The partnership between Percival Joseph Buddery and Horace William Van der Pant, electrical and motor engineers, 5, Kingston-road, Wimbledon, Surrey, trading as Percy J. Buddery and Co., has been dissolved by mutual consent. A bankruptcy petition has been presented against Warner and Co., 12, Holbein-place, Sloane-square, London, builders and electricians, and will be heard at 11.30 a.m. on July 28. The petition to reduce the capital of the Edison and Swan United Electric Light Company, Limited and Reduced, from £1,000,000 to £941,090, is directed to be heard before Mr. Justice Buckley on July 26. The Electrical Machinery Developments Company, Limited, will be wound up voluntarily; Mr. F. W. Lowther, 151, Cannon-street, London, E.C., has been appointed liquidator. The London Telegraph and Steam Gauge Electric Company, Limited, will be wound up voluntarily; Mr. J. R. Reedman, 2, Bradley-street, Canning Town, E., has been appointed liquidator.

London County Council.—On Tuesday it was agreed to lend the Islington Borough Council £15,636 and the Poplar Borough Council £25,000, and sanction was granted to the first-named Council to borrow £15,675 for electric light installations. The Highways Committee reported that they stated on June 21, 1904, that it would be necessary, in connection with the establishment of the Council's electricity generating station at Greenwich, to proceed at an early date, in connection with the provision of a water supply for the station, with (*a*) the erection of a pump-house and an outside coal-bunker, (*b*) the preparation of the foundations for the turn-tables and cranes, and (*c*) the making-up of the levels of the road. The Council accordingly on that date authorised them to arrange, during the summer vacation, for tenders for this work to be obtained, and for the necessary steps to be taken to accept such tender as might be considered most satisfactory, and to arrange for the execution of a contract to give effect thereto. The Council also approved of a clause for insertion in the form of contract for the work, providing for it to be carried out within 12 months, and for a penalty of £50 a week in respect of the period by which the time of completion might exceed the time fixed in the contract, and, should the work be completed in less than that time, for the payment to the contractor of a bonus at the rate of £25 a week in respect of the time between the actual date of completion and that specified in the contract. It had since occurred to them that it would be of advantage if this work could be carried out as part of the contract of Messrs. H. Lovatt, Limited, entered into in pursuance of the Council's resolution of May 3, 1904, for the erection of the superstructure of the first portion of the generating station. The work in connection with the erection of the pump-house, etc., must be carried out in intimate connection with the erection of the superstructure of the station, and would be greatly expedited, therefore, if it was placed in the hands of the same contractors. They had ascertained that Messrs. Lovatt were willing to carry out the additional work at prices ½ per cent. less than the schedule rates specified in their present contract. Messrs. Lovatt, Limited, were also prepared to carry out the work upon the conditions approved by the Council on June 21, 1904, as regards the time of completion, etc. The offer was accepted. In another report, which is to be considered next week, the committee will also recommend that the offer of Messrs. H. Lovatt, Limited, to carry out, at a reduction of ½ per cent. on the schedule rates under their existing contract with the Council for the erection of the superstructure of the first portion of the Greenwich generating station, the erection of the electricity sub-station at Greenwich, be accepted.

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Earl's Court.—Few of the visitors who are daily enjoying the unusual summer amongst the sights of the Italian Exhibition are probably aware of the largely extended use to which electricity has been put this year, both in the electric lighting, concealed and otherwise, and in the working of the various entertainments. A number of extensions have this year been carried out under the supervision of Mr. W. R. Wynne, the chief electrical engineer of London Exhibitions, Limited. Although the load on the station is now 525 kw., equal to 15,000 8-c.p. lamps, a considerable supply is also taken from the Brompton and Kensington Company's mains. Quite recently 1,600 5-c.p. lamps were placed around the eaves of the Queen's Palace with admirable effect. This is a permanent installation on the three-wire system, in casing enclosed in zinc troughing which has been specially passed by the London County Council. This installation being rather far from the engine-house, current is supplied by the above-mentioned company. The old theatre has been entirely rewired for "Venice by Night." The night effect has been rendered especially true to nature. The ceiling, 80ft. from the ground, is dotted with tiny stars, represented by a number of 5-c.p incandescent lamps on 10 circuits. The canals are lighted by incandescent lamps fitted in iron brackets fixed to the walls. On the streets and piazzas cast-iron standards have been erected. Each standard bears three lanterns, in shape imitating gas lamps, but in reality containing a 100-c.p. lamp each. All the shops are wired on the usual house-lighting rules. There is a 100-volt supply from insulated cables laid in iron tubes underground, in seven circuits, controlled by the old switchboard in the theatre. This installation contains 24 100-c.p., 50 50-c.p., and hundreds of other incandescent lamps, varying from 5 c.p. to 32 c.p. The panoramic effects are obtained by arc lamps. All the side shows are supplied from the station by meter. We note that the macaroni factory is driven by a direct-current motor of 200 volts. A mercury contact switch of peculiar construction, supplied by Harrod's Stores, controls the aurora borealis in "Furthest North." The effect in the electric fountains is due to a large number of arc lamps fixed high above the water. The blue effects in the Blue Grotto are due to Nernst lamps. The beautiful "Electric Butterflies" are produced by means of a variety of incandescent lamps on the bodies of the performers, controlled by a switchboard in the wings. An idea of the extensive use made of electric light this year, as far as the side shows are concerned, may be gathered from the fact that the Roman Forum, in a comparatively very small space, has 82 8-c.p. lamps, and St. Peter's uses four 100-c.p. and two 200-c p. lamps, while four arc lamps are required for taking short-exposure photographs, etc. Mains have recently been laid for charging the four electric launches on the lake. All the cables laid are 600 make, and they are laid in wood casing treated with fire-resisting compound.

PROVISIONAL PATENTS, 1904.

JULY 11.

15396. **Improved means for protecting the insulation of electric light flexible cords from dust, flies, and such like vermin.** John Young, 21, Gloucester-walk, Campden-hill, Kensington, London.

15419. **Improvements in laminated iron sections for alternating-current transformers.** John Howarth Bainbridge, 24, Endsleigh-villas, Southall, Middlesex.

15411. **Automatic firing apparatus for guns and firearms having electrical or electro-mechanical ignition.** Heinrich von Péchy and Victor Rea, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15452. **Improvements in systems of electrical distribution.** John Sedgwick Peck, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Aug. 8, 1903, being date of application in United States.) (Complete specification.)

15453. **Improvements in or relating to electric arc lamps.** Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

15455. **Improvements in relays for automatic circuit breakers.** Michael Birt Field, Charles Cornfield Garrard, and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

15467. **Improvements in vapour electric conductors.** Osias Otto Kruh, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 11, 1903, being date of application in United States.) (Complete specification.)

15468. **Improvements in vapour electric lamps or rectifiers.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1903, July 11, 1903, being date of application in United States.) (Complete specification.)

15469. **Improvements in and relating to vapour electric conductors** Osias Otto Kruh, 83, Cannon-street, London. (Date applied for under Patents Act. 1901, July 13, 1903, being date of application in United States.) (Complete specification.)

15472. **Improvements in electric incandescent lamps.** Armand Frey, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 12.

15517. **Dynamo-electric engines.** Julius Lommatzsch, Bernhard Mensch, and Oscar Siegert, 81, High Holborn, London. (Complete specification.)

15495. **Improvements in dynamo-electric machines for regulating the charge and discharge of storage batteries used in combination with main generators.** The Lancashire Dynamo and Motor Company, Limited, and Robert Stafford McLeod, 34, Castle-street, Liverpool.

15512. **An improved lid for accumulator and other acid-containing boxes or tanks.** Edward James Clark and Hart Accumulator Company, Limited, 165, Queen Victoria-street, London. (Complete specification.)

15529. **A system of wire entanglements and electrically-operated apparatus for the protection of the mouth of a harbour in war time.** Edward Gordon Stuart McClellan, 22, Southampton-buildings, Chancery-lane, London.

15551. **Improvements relating to the prevention of fires caused by short-circuits or by injury to electric conducting wires or cables.** Otto Wilhelmi, 37, Essex-street, Strand, London.

15561. **Improvements in indicators for electric oscillations.** William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

15563. **Improvements in electromagnetic signalling devices for operating two or more alternate signals.** Joshua Willis, 6, Lord-street, Liverpool.

15567. **Improvements in electric or telephonic transmission.** Henri Carbonnelle, 7, Ely-place, Holborn, London. (Complete specification.)

JULY 13.

15581. **Improvements in telephone, telegraph, and other call systems.** Alfred Charles Brown, 7, Queen's-square, Finsbury-avenue, London.

15599. **Metallic thermometrical electrical indicator.** Alexander Beard Thompson, 11, Cheapside, Oldham.

15612. **Improvements in means for changing or reversing the direction of electric currents.** Edward George Paul Bonsfield and the Ozonised Oxygen Company, Limited, 4, South-street, Finsbury, London.

15614. **Improvements relating to dynamos used with other dynamos or cells.** Walter Langdon Davies and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

15616. **Improvements in single-phase alternate-current motors.** Crompton and Co., Limited, and Rudolf Goldschmidt, The Arc Works, Chelmsford, Essex.

15617. **Improvements in electric contact or supporting gears.** Crompton and Co., Limited, and Ernest William Abbott, Arc Works, Chelmsford, Essex.

15618. **Improvements in and relating to electric circuit breakers.** Crompton and Co., Limited, and Robert Charles Harris, Arc Works, Chelmsford, Essex.

15626. **Improvements in dynamo-electric machines.** William Brooks Sayers and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

15627. **Improvements in electric clocks.** George Bennett Bowell, 40, Chancery-lane, London.

15632. **Improved system of protection for parallel electric feeders.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15634. **Improvements in systems of electrical distribution.** Samuel Ferguson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 13, 1903, being date of application in United States.) (Complete specification.)

15637. **Improvements in regulating mechanism for arc lamps.** William Tichborne Upton, John Edward Elliott, and Hubert Bevan Pratt, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 14.

15646. **Improvements in and in the production of electrical fuse, distribution, and like boxes.** Verity's, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham.

15648. **Improvements in electric motor starters and electrical resistances.** Verity's, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham.

15651. **Improvements in lifeguards for electrically-propelled vehicles or the like.** Edgar Ashley Greaves, 9, Tempest Hey, Liverpool.

15677. **"Shouldergrip" telephone receiver rest.** William Henry Danson, 21, Cole-street, Borough, London.

15691. **An improvement in electric lighting and advertising.** Alfred Edward Mead, 51, Leinster-square, Hyde Park, London.

15692. **An improvement in collecting electric currents from armatures of unipolar dynamo-electric machines.** Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

15701. **Improvements in instruments for determining the drop of potential in electric transmission systems.** Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 14, 1903, being date of application in Germany.) (Complete specification.)

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15699. Improvements in or relating to electrical resistances. Wilhelm Boehm, 18, Buckingham-street, Strand, London. (Complete specification.)

15704. Improvements in electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

15708. Means for electrically controlling phonographs and cinematographs in combination. La Société L. Gaumont et Cie., 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 17, 1903, being date of application in France.) (Complete specification.)

15712. Improvements in or connected with wireless signalling. Louis Heathcote Walter, 92, Victoria-street, Westminster, London.

JULY 15.

15732. Improvements in electric light fittings. Verity's, Limited, and J. Sothcott, Plume-street, Aston, Birmingham. (Complete specification.)

15770. Improvements relating to boxes, covers, or containing cases for electric switches, fuses, and the like. Thomas Herbert Marsh and Albert Brown Mudie, 18, Southampton-buildings, Chancery-lane, London.

15771. An improved connector for the armature and commutator of dynamo-electric machines. Siemens Bros., and Co., Limited, and Hereford Berry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

15772. Improvements in the manufacture of insulated electric conductors and apparatus therefor. Siemens Bros. and Co., Limited, and William Dieselhorst, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15778. Improved contact stud and switch for use with surface-contact systems of electric traction. William Griffiths and Benjamin Harry Bedell, 22, Southampton-buildings, Chancery-lane, London.

15796. Improvements in or relating to alternate-current distributing systems. Charles Hesterman Merz and Bernard Price, 46, Lincoln's-inn-field, London.

15802. Improvements in or relating to conduits for underground electrical wires or cables. Martyn Judson Stone and Edward Taylor Fenwick, 6, Lord-street, Liverpool.

JULY 16.

15869. Improvements in installations for electrically operating railway points. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Actiengesellschaft, Germany.) (Complete specification.)

15872. Improvements in arc lamps. Georges Viarmé, 7, Southampton-buildings, Chancery-lane, London.

15874. Electrical fire extinguisher. Hans Ruppert, 81, High Holborn, London. (Complete specification.)

15879. Improvements in alternating electric current meters. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 17, 1903, being date of application in Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 4, 1904.

1903.

15218. Electrical apparatus operated by the expansion and contraction of a controlling member. Swanton.

15463. Electric circuit controlling apparatus. Garrard, and Ferranti Limited.

15569. Production of alternating electric currents. Poulsen.

15817. Electrically-actuated musical instruments. Dickson.

15872. Switches and rheostats for starting and controlling electric motors. Hunt.

16113. Mode of and apparatus for producing and detecting Hertzian oscillations. Maskelyne.

17563. Electrical heating devices. Huntley.

21068. Telephone connections on the party-line system. Oppenheimer. (Aktiengesellschaft Mix und Genest.)

1904.

1205. Telephonic apparatus. Höflinger and Wolffhardt.

3737. Electric railway and tramway systems. Shobe and Embley. (Date applied for under International Convention, April 10, 1903.)

4020. Electric switches. Reyrolle.

6116. Electrical apparatus for aiming and shooting practice. Firm of C. Lorenz. (Date applied for under International Convention, Dec. 21, 1903.)

6332. Electro-mechanical cut-outs. Spagnoletti.

6334. Means for automatically controlling the passage of electric currents. Spagnoletti.

7021. Means for controlling electrically-operated elevators. Klein.

8007. Friction gear for driving electrical generators. Whiteman. (Henricks Novelty Company.)

7977. Receiving devices for use in wireless telegraphy. Möller. (Date applied for under International Convention, May 2, 1903.)

11651. Portable insulated support for double-wire electric lines. Collett. (Date applied for under International Convention, Aug. 4, 1903.)

12977. Telephones. Nye and Peck.

13332. Manufacture of electric cables. Beaver and Claremont.

13423. Electrical locomotive. Fairweather. (Brown Hoisting Machinery Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	¾-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5⅞-6¼
—— 5 per cent. Cum. Pref., 1-100,000	5	–	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	101-103
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	–	3¼-3⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731 ..	2	..	¾-1
—— Non. Cum., 5 per cent. Pref.	2	–	¾-1¼
—— 4½ per cent. 1st Debenture Stock.....	100	–	94-99
—— 4½ per cent. 2nd Debenture Stock	100	–	71-76 xd
Callender's Cable, Debentures	100	–	100-104
—— Ordinary	5	–	9¼-10¼
—— 5 per cent. Pref.	5	–	5¼-5⅜
Crompton and Co.	3	–	1⅞-2¼
—— 5 per cent. Debentures.....	100	–	94-97
Edison and Swan United, "A" Shares, 1-99,261	3	..	⅛-¼
—— "A" Shares, 01-017,139	5	..	⅛-¼
—— 5 per cent. Debentures.....	100	–	78 82
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	–	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	11-12
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-19¼
—— 4 per cent. Debentures.....	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance.....	12	–	36-39 xd
—— 5 per cent. Bonds	100	–	99-102
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200 ..	1	–	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv. ..	100	–	122-127
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	–	101-104
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary.....	5	–	10⅜-11¼
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 ..	5	–	7-7¼
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	105-108
Charing Cross and Strand, Nos. 1-70,000	5	–	7¼-8
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-6⅜
—— 4½ per cent. Debentures	100	–	106-109
City of London, Ordinary.....	10	–	10¾-11¼
—— 6 per cent. Cumulative Pref.....	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	101-104
County of London Electric Supply, Ordinary	10	–	7¼-8¼
—— 6 per cent. Cum. Pref.	10	–	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	100-103
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6 6¼
—— 6 per cent. Cum. Pref.	5	–	5¾-6
—— 4½ per cent. First Mort. Deb.	100	–	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
—— per cent. Debenture Stock Red	100	–	102-105
Kensington and Knightsbridge and Notting Hill	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1¼-1⅜
—— 6 per cent. Pref.....	5	–	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	94-97
Metropolitan Ordinary	10	–	20¾-21¼
——4½ per cent. First Mortgage Debenture Stock	100	–	108-112
——3½ per cent. Mortgage Debenture, Red.	100	–	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	13-14
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) ..	100	–	100-103
Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,510.....	5	–	5¼-6
—— 4 per cent. Debenture Stock	100	–	97-100 xd
Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	3¾-3¾
—— 4 per cent. Debenture Stock	100	–	95-98
South London, Ordinary	–	–	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	14¼-15¼
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	96 98
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¼-5
Westminster, Ordinary	5	–	12¼-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251.....	5	–	6-6¼ xd

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Name.	Amount paid.		Last price.
Electric Railways.—	£		£
Central London, Ordinary	100	–	83 92
—— 4 per cent. Pref.	100	–	102-105
—— " " deferred	100	–	79-82
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid).	100	–	106-109 xd
City and South London, Consolidated Ordinary	100	–	47-49
—— 4 per cent. Debenture Stock	100	–	106-109
—— 5 per cent. Pref. Stock '91	100	–	123-126
—— " " " '96	100	–	120-123
—— " " " '01	100	–	118-122
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10¼
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	–	99-101
Waterloo and City, Ordinary	100	–	89-92
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	–	5-5¼
—— Permanent 5 per cent. Debenture Stock, 1888	100	–	137-141
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103
—— Ord Pref.	100	..	99-102
—— Non-Cum. 5 per cent. Pref.	10	–	10-10¼ xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	–	105-106 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	.	97-100 xd
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	8¼-9 xd
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100	–	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	–	2¼-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	101-104
Cape Electric Tramways, Nos. 1-480,000	1	–	1⅞-2 xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	100-103

Name.	Amount paid.		Last price
	£		£
Cork Electric Tramways and Lighting Co., Ordinary	10	–	9¼-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100	–	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	–	3¼-4
—— 4 per cent. Debenture Stock	100	–	88-91
Kidderminster and District Lighting and Traction, Pref.	5	–	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10¼-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103-104
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1	–	⅛-¼
—— 5 per cent. Cum. Pref., 500,001-814,016	1	–	¾-1
New General Traction, Ordinary	5	–	¼
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.).	100	–	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12-12½
—— 5 per cent. Cum. Pref.	10	–	9¾-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	–	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	9-10
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	–	1
—— £101,132 6 per cent. Preference	1	–	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	–	100 p.c.
Telephones.—			
National Telephone, Preferred	100	–	106-108
—— Deferred Stock	100	–	90-93
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5¾
—— 5½ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	103-105
Oriental Telephone and Electric Company	1	–	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 16	1,758	1,318	+ 439	+ 2,012*h*	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	,, 16	39	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 17	1,127	1,106	+ 21	– 30	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 16	5,771	5,179	+ 592	+10,035	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 15	1,087	871	+ 216	+ 1,310	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 14	1,419	1,355	+ 64	+ 726	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 16	964	1,124	– 160	– 345	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 17	2,033	1,931	+ 102	+ 51	38	38	March 31*g*	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 13	1,265	1,105	+ 160	+ 954	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 16	5,211	4,078	+1,133	+12,449	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 17	1,213	982	+ 231	+ 697*h*	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 15	5,645	5,376	+ 269	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 16	1,263	935	+ 328	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 17	425	—	—	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 10	2,223	2,061	+ 162	+ 785	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 16	232	224	+ 8	+ 317	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 16	6,232	6,547	– 315	– 855*h*	6	6	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City & South London Railway	,, 17	2,274	2,490	– 218	– 299*h*	6⅝	6⅝	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 14	612	680	– 68	– 1,054	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	June 24	225	234	– 9	– 131	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	July 16	290	264	+ 26	+ 313	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 15	144	125	+ 19	+ 85*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 15	4,324	4,190	+ 134	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 15	1,203	1,068	+ 135	—										
Dundee City Tramways	,, 13	814	874	– 20	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 16	804	719	+ 85	+ 1,087	10·75	10·75	March 31*g*	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 16	15,109	13,565	+1,534	— *h*	124	124	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	June 1	224	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	July 13	3,495	3,048	+ 447	+ 1,594	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 16	1,428	1,329	+ 99	—	34	34	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·32
Hull Corporation, E. S.	,, 16	2,268	1,874	+ 394	+ 3,970	25	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 9	528	552	– 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 14	160	207	– 47	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 13	246	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 16	6,400	5,710	+ 690	+94,168	77	77	March 25*g*	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 16	1,456	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 9	11,199	10,602	+ 597	+ 6,404	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 18	1,722	1,742	– 20	– 49*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	,, 2	13,329	11,435	+1,894	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 16	231	—	—	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 16	13,486	12,069	+1,417	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 16	128	97	+ 31	+ 783	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 16	4,148	3,287	+ 861	—	38½	38½	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 16	556	465	+ 90	+ 1,766	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 16	2,567	2,201	+ 365	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 14	504	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 18	4,402	4,139	+ 263	+ 5,259	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 16	298	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 17	4,901	4,483	+ 418	+ 2,510	53½	53½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 14	1,080	1,183	– 103	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 13	506	448	+ 58	+ 432	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 15	743	336	+ 406	+ 3,937	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	June 26	1,361	1,405	– 44	+ 343	18·48	18·48	,, 31*g*	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	July 16	927	852	+ 74	+ 595	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·05
West Ham Corporation	,, 14	1,149	—	—	—	1⅜	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 13	843	581	+ 262	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Errata.—In our last issue we noticed the receipt of a book entitled "An Enquiry into and Explanation of Decimal Coinage, etc." The publishers should have been stated as George Routledge and Sons, Limited, London, and not Messrs. Anthony Bros., Limited, as in our last issue. The object of the book is to popularise the decimal system.

The Diesel Oil-Engine.—At a recent consumption trial of a Diesel oil-engine of 160 b.h.p., the extremely low consumption of 0·37lb. of crude petroleum per brake horse-power was obtained. Other fuel comes out as low as $\frac{1}{12}$d. per brake horse-power hour. The use of the Diesel oil-engine seems to be extending, and we note that the City of Birmingham Tramways Company have recently given a repeat order for two engines, each of 160 b.h.p.

Sheffield University.—We note that Prof. William Palmer Wynne, D.Sc., London, F.R.S., F.I.C., senior hon. secretary of the Chemical Society, in succession to Prof. Carleton Williams, has accepted the Firth chair of chemistry offered to him by the council of Sheffield University College. Prof. Wynne is at present professor of chemistry in the school of pharmacy of the Pharmaceutical Society of Great Britain, and was four years ago editor of the *Journal* of the Chemical Society. He will commence his Sheffield duties at the end of September.

The New Magnetic Observatory.—The first contract in connection with the erection of the new magnetic observatory by the Government at Eskdalemuir, Dumfriesshire, has been let to Messrs. Henderson and Duncan, Morningside, Edinburgh. The work embraces the making of a road and some foundations, the provision of a water supply, and building of a boundary wall, and it has to be carried out within three months. This observatory is to replace the one at Kew as far as magnetic observations of the earth's field are concerned.

Bradford Finance.—Alderman J. A. Godwin, the chairman of the Bradford Finance Committee, is to be congratulated on the success of his efforts to keep the financial policy of the Bradford Corporation on sound lines. He has succeeded recently in getting the rates increased 2d. in the £, and at the same time reduced the price of gas supplied from the Corporation works. The net result of these two alterations practically cancels out, but the change is in the direction of sound municipal trading. The general charges are now borne more equally by all the ratepayers, and the users of gas are not penalised for the public good.

Rochdale Accident.—Our attention has been drawn to the fact that our leader in our issue of July 15 might be read as though the electricity department of Rochdale had not records of the positions of their cables in the streets or of the joints in the same. This, of course, is quite an inaccurate rendering, as Mr. C. C. Atchison has complete plans of all his cables in his office. In the case in question, however, the damage was done, not by men directly under the control of the electrical engineer, but by employés in the surveyor's department. We believe we are correct in stating that duplicate records of the positions of mains are sent regularly to the surveyor.

Bombay Lighting.—Bombay has been behind one or two cities in India in taking up electric lighting and power distribution, but there is every sign that now the work is to be carried out on most modern lines, and that electrical energy will soon be available. According to our contemporary, the *Indian Electrical, Mechanical, and Textile News*, it is confidently expected that the current will be available in October. The system of distribution to be used is one suited to a large and straggling area where the demand will be chiefly around certain well-defined centres. Current will be generated at the central station in Wari Bunder at a pressure of 6,000 volts three-phase, and will be transmitted to sub-stations at the chosen centres, where it will be transformed by means of rotary converters to continuous current at 2 × 230 volts, and distributed around the centres by means of a low-tension network of three wires laid solid after the Callender system. The work now being carried out is the transmission line to Tata's Hotel, where the first sub-station will be situated. Afterwards another sub-station in Apollo-street, near the Great Western Hotel, will be equipped, and will serve the business portion of the fort.

The Johannesburg Lighting and Tramway Scheme.—It will interest those of our readers who have not the matter already in their minds to know that the total capacity of the new generating station which Messrs. Mordey and Dawbarn are putting down, as consulting engineers, for the Johannesburg Corporation, is no less than 9,000 kw. Part of the machinery will supply direct current and the other alternating current. The prime movers will be gas-engines worked by producer gas. As regards distribution, the inner area of the town will have a supply on the three-wire, direct-current system, with 460 volts between the outers. In the outlying suburbs alternating current will be supplied from a two-phase system. The voltage on the primary will be 3,000 per phase and the frequency 50. The secondary voltage will be 400 between the two outers of a three-wire system, and in most places only one phase will be available. The first portion of the electric tramways will have 24 miles of track. It is gratifying to note that the bulk of the contracts have been placed with English firms, and that Messrs. Siemens Bros. are supplying the electric plant in the power station.

The Rochdale Arbitration.—The company have emerged very favourably from the arbitration proceedings which have been held to determine the price to be paid for their undertaking by the various local authorities. The award has fallen a good deal below the £205,401 representing the exalted valuation of the concern as submitted on behalf of the company, but they have obtained £35,291 more than the £123,784 which the experts for the local authorities put the value at, exclusive of a sum of £3,600 for street improvements, which is still unsettled. In respect of the main item — the permanent way — the company claimed £103,459, while the authorities estimated the value at £64,142, contending that the track had been indifferently maintained, and was in a very worn condition. Voluminous expert evidence of a conflicting character was tendered on behalf of the respective parties, and in the end the arbitrator has practically split the difference, though the amounts awarded in respect of the individual items do not appear. The amount which the company will receive is slightly nearer to the valuation of the local authorities than to that of the company, but the result has probably afforded more satisfaction to the shareholders than to the new undertakers.

Lead-Boring Insects.—The China and Japan Telephone Company, of Shanghai, China, has had an extraordinary experience in cable trouble, caused by the attack of an insect which pierced the lead covering of its telephone cables. It was noticed several years ago that the lead sheathing of the aerial cables was perforated by holes, which admitted water and gave rise to much trouble. It was assumed that the injury was caused by small rifle bullets, and a reward of 50 taels was offered for information

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that would lead to the punishment of the wrongdoers. Later it was established that the holes were the work of wasps of a species that lays its eggs in the living bamboo. These wasps gather around bamboo groves in July and August to lay their eggs inside of the cane, where they will be well protected from attacks of hungry enemies. The cables were never attacked any distance away from bamboos. As immediate protection linseed oil boiled to the consistency of birdlime was used, and later all cables in the localities where damage had been done were covered with hemp cloth so as to present a soft surface which the insects do not attack. The *Electrical World* gives several illustrations of injured cables, which show that the insects made several attempts before they succeeded in biting through the sheathing.

Telephone Purchase.—Sir Henry H. Fowler, M.P., when presiding over the meeting of the National Telephone Company this last week, gave details of the progress of the undertaking. Speaking as to the negotiations with the Government, he said that under the company's license the Government had power to give notice on June 30 last of its desire to acquire the company's undertaking compulsorily on Dec. 31 next, the terms of purchase in the event of difference between them to be decided by arbitration. That notice had not been given, and consequently the compulsory rights had ceased, but the Postmaster-General had intimated his desire to come to an arrangement with the company by agreement, and negotiations with that object in view were now in active progress. The matter involved intricate calculations, and many difficult questions would have to be considered which could not be hurriedly determined. He believed that the Postmaster-General would credit the Board with the desire to meet him in a fair spirit, and he hoped that the negotiations would result in a satisfactory arrangement which would enable a great public service to be adequately and properly developed, and which at the same time would be one that was equitable and fair to the shareholders. The directors deprecated discussion, and asked that the shareholders would evince their confidence by leaving the negotiations in the hands of the Board.

Terrestrial Magnetism Researches.—The June issue of *Terrestrial Magnetism and Atmospheric Electricity* (Baltimore) gives a brief account of the work which has been planned for the department of international research and terrestrial magnetism of the Carnegie Institute for 1904. Besides the work of organisation of the department, the compilation, discussion, and preparation for publication of the data for the complete presentation of existing knowledge of the earth's secular magnetism over the entire globe, for the determination of the points at which it will be necessary to repeat observations at suitable intervals, for the successful scientific investigation and determination of the causes and their modes of action, and for ascertaining the proper corrections to magnetic charts, to refer them to a desired date, have been authorised and begun. These researches are a continuation of Dr. L. A. Bauer's studies. The department has been authorised also to take up the discussion and publication of the data on the magnetic perturbation observed during the eruption of Mont Pelée, Martinique, in 1902; further, the compilation, discussion, and publication of the existing data concerning the variation of the earth's magnetism other than the secular variation already provided for, and the perturbations of the earth's magnetism will be carried out. Authority has also been given to enable the department to make the necessary preparations for future observational work, and to take part in the observation of such of the earth's magnetic or electric phenomena of momentary occurrence as are of the highest importance to the advancement of our knowledge.

Society of Engineers.—A highly interesting visit was made by the president (Mr. D. B. Butler) and members of the Society of Engineers on Wednesday to the shipbuilding and engineering works of Messrs. Yarrow and Co. at Poplar, where they witnessed the building and engineering of light-draught high-speed craft of all kinds, notably torpedo-boats, destroyers, and light-draught gunboats. Electrical driving has been adopted in the works, the main motive power being supplied by three Bellis and Morcom compound condensing engines, which drive three Parker dynamos direct, each dynamo being capable of an output of 430 amperes at 210 volts. Steam is supplied by three Lancashire boilers. Over the boiler-house is a cast-iron tank in which is a Ledward evaporative condenser. The drainage from the main roofs is collected in the tank and is used for condensing purposes, an economy in the use of the town water thus being effected. Most of the machine tools in the various shops are of the latest pattern and are placed in groups, each line of shafting being driven by its own motor. The shafting is 3in. in diameter, and runs at 140 revolutions per minute. The larger machines, which are not continuously at work, are driven by independent motors. The shops are fitted throughout with electric travelling cranes made by Messrs. Adamson. The air-compressing machinery is also driven electrically, a very complete pneumatic system being laid down throughout the works.

United Engineering Building.—This new building for the engineering associations of New York, and for an engineering club, is to be the gift of Mr. Andrew Carnegie. The United Engineering Building will occupy land 125ft. front by 100ft. on West Thirty-ninth-street, while the club, with a frontage of 50ft. and a depth of 100ft., will face on Bryant Park and the new public library. The United Engineering Building, apart from quarters for the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Mining Engineers, as well as other societies enabled to participate in the accommodation, will have several fine auditoriums and a magnificent library. The club building will be about 11½ storeys high, with the usual accommodation of a club and some 60 or 70 bedrooms for members. The work of tearing down the old buildings and the construction of the new is to be pushed vigorously, and will begin forthwith. From the *Electrical World* we gather that competitive designs were asked for for each building from a limited number of architects. As a result the successful competitor for the United Engineering Building is Mr. Herbert D. Hale, of Boston, with Henry G. Morse, of New York, as associate architect. The successful competitors for the engineers' club are Whitfield and King, of New York, who have done a large amount of work in New York city and on some Carnegie libraries, and were also associated in work on the buildings of the Pan-American Exposition.

Electrostatic Motors.—Mr. Clark, the editor-in-chief of the *Polytechnic Engineer*, of Brooklyn, contributes to the 1903-4 issue an interesting article on electrostatic generators, which gives a brief historical sketch of these machines and the results of efficiency tests. The maximum voltage generated by the Holtz machine is not determined by the maximum speed of rotation of the plates but increases the distance between the discharge knobs. It is also dependent upon the location of the spark-gap with respect to the large stationary balls attached to the collecting combs. The Holtz machine is reversible in its action in the same sense as a dynamo-electric machine—that is to say, it will operate as a motor if supplied with

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electricity from another influence machine. No previous excitation is requisite. The efficiencies of several machines were determined by operating one machine as a generator, and driving a second from this as a motor. The power input to the generator was determined by measuring the power supplied to the driving motor. The output of the static machine running as a motor was determined by means of a strap brake. The following are some of the efficiencies obtained: With a needle-point gap of 6in. the useful output of the generator was 71,200 volts; the current 0·000482 ampere, equal to 34 watts; the efficiency, 27·1 per cent. With a spark gap of 12in. the voltage was 122,000; the current, 0·000319 ampere; watts, 39; efficiency, 22·2 per cent With a gap of 18in. the voltage was 180,000; current, 0·000194; power, 35 watts; efficiency, 19·5 per cent.

Central Technical College.—At a meeting of the council of the City and Guilds of London Institute, held on Monday last, the diploma of "Associate of the City and Guilds Institute" was awarded to the following matriculated third-year students of the Central Technical College who have completed a full course of instruction as prescribed by the council: civil and mechanical engineering—H. D. Creedy (Siemens medal), J. M. de Artola Soruco, W. G. Banister, A. A. Barnes, G. A. Beggs, F. S. Bond, L. J. G. Bowers, S. Bowen, A. Carmichael, E. M. Cory, O. C. Daniell, J. A. V. Dupré, S. S. Elliott, T. G. Garforth, C. W. Gibbs, G. R. Griffin, H. R. Liebstein, N. N. Maas, F. Neuhaus, H. A. Newton, R. H. Osler, R. Peters, E. F. R. Pole, R. B. Robinson, W. S. Strachan, A. H. Street, O. H. Teulon, O. W. Thomas, S. M. Udale, A. E. M. Van der Meersch, R. F. Vogel, E. G. Walker, F. E. Walker, H. J. Wheaton, H. H. Wilder, J. W. Wooding; electrical engineering—H. W. Purle (Siemens medal and premium), A. M. Beale, A. Cunnington, C. H. Davidson, O. I. Davis, C. F. Edwin, E. Fisher, C. J. Guttmann, R. A. Harris, M. Hayashi, H. W. Kefford, W. C. C. Langdon, H. C. Lott, W. H. Lowe, C. B. R. Merton, C. J. C. Moon, A. R. Palmer, L. M. Rampal, L. I. Solomon, T. D. W. Weston, J. L. Wilson; chemistry—P. S. Arup, T. R. Lucas, Miss M. N. Reid, R. W. Tonkin. In addition to the above, certificates have been awarded to 32 matriculated third-year students who have completed a full course of instruction at the Central Technical College and to 61 students who have completed a full course of instruction at the Finsbury Technical College.

Hand and Mechanical Stoking.—At the recent convention of the National Electric Light Association at Boston, U.S.A., a paper, of which an abstract appears in the *Western Electrician* of Chicago, was read by Mr. Edwin Yawger dealing with the relative merits of the mechanical stoker and the human operator—a subject which came in for considerable discussion in connection with the paper presented to the Institution two or three months back by Messrs. Merz and McLellan on "Power Station Design." Mr. Yawger does not express a decided opinion on the superiority of one method or the other, though he is inclined to favour the automatic form, but comments on some of the features which distinguish them. He remarks that a universal result of the substitution of mechanical for manual methods is greater uniformity of product, and that from the nature of the operation it is possible to maintain an automatic stoker at or near its maximum efficiency. A point which the author emphasises is that the efficiency of the human operator varies in a very appreciable measure. Taking some comparative economy tests on traction engines which he conducted, the author states that he found a difference of 10 per cent. in the results even between expert firemen. Another matter to which he alludes is the variation in dranght with different furnaces where a number are connected to the same stack, and he remarks that all the losses attributable to improper manipulation of the air supply are magnified in the case of hand firing. The author considers that it is in its capability of yielding the maximum efficiency by responding to intelligent supervision that the mechanical stoker exhibits a superiority over its human rival.

Electrical Tanning.—An account is given in the *Electrical World* of New York of a tannery electric power equipment at Newark, N.J., where leather of the highest grades is manufactured. A plant of this sort must necessarily spread over a considerable area. When steam-driven, at least 40 per cent. of the power is required to set the belts and shafting in motion before the machines can do any work at all. In the transmission of power from generator to motor there is only a fraction of this loss, and it is no longer necessary to crowd buildings together for the purpose of saving power. Many of the processes require light, which is easy to supply when countershafts and belts are eliminated and electric lamps can be hung at convenient points. The electric power plant, which superseded the old steam plant, consists of two compound-wound 75-kw. Crocker-Wheeler generators of the direct-connected type, but arranged, with a central pulley, for belting. These are driven at a speed of 275 revolutions per minute by a Watts-Campbell 200-h.p. 18in. by 42in. steam-engine, with a 16ft. by 30in. flywheel at 75 revolutions per minute carrying the belt. The switchboard is built in three panels. The left-hand one supports a Walker Keystone ammeter, a Ward Leonard rheostat, an 800-ampere Cutter "I. T. E." circuit breaker, and an equalising switch for one of the generators. The right-hand panel is similarly equipped for the other generator. On the centre panel is a Walker Keystone voltmeter, 12 250-volt switches, six of 100 amperes, two of 200 amperes, two of 300 amperes, and two of 400 amperes rating. The 150-h.p. tubular boilers supply steam to the engine, and serve to maintain a high temperature in the japanning ovens. The boilers are for the most part stoked with damp bark that has been used for tanning, supplemented with soft coal. Exhaust steam is used to heat the buildings in winter and the hide-drying lofts all the year round. The whole time spent in producing a perfectly cured patent leather hide is about six weeks, as against as many months by the old methods, and there is probably no one factor which has contributed so much towards modernising the tanning process as the use of electric power.

Junior Institution of Engineers.—The members of this institution, through the courtesy of Messrs. Coode, Son, and Matthews (the engineers) and Messrs. S. Pearson and Son (the contractors), were recently afforded the opportunity for inspecting, under special facilities, the National Harbour works at Dover. Permission was also kindly given for the works of the Dover Harbour Board, of which Mr. A. T. Walmisley is the engineer, to be seen, and the turbine S.E. and C.R. Channel steamer, "The Queen." Subsequently the members were welcomed at the town hall by the Mayor and Mayoress of Dover (Sir William and Lady Crundal), and an organ recital was rendered there by the borough organist, Mr. H. J. Taylor. To all who had assisted in the arrangement of the interesting day's programme the chairman (Mr. S. Cutler, jun.) expressed the hearty acknowledgment of the institution whilst the members were assembled in the Council chamber. On arrival at Dover the party (about 100 in number) went aboard "The Queen," just previously to her starting for Calais, the chief interest, of course, being centred in the engine-room, containing Parsons turbines of 8,000 i.h.p.,

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capable of propelling the vessel at 21·73 knots. From the Admiralty Pier the members were taken by a tug belonging to the Dover Harbour Board across to their Prince of Wales Pier, where the big Atlantic liners of the Hamburg-American line now call. This pier was built by Sir John Jackson, Limited, to the designs of Messrs. Coode, Son, and Matthews. The swingbridge on the connecting railway was shown in motion. After luncheon the Admiralty Harbour works were seen, the members being conveyed along the east arm by the contractors' railway. All the operations in the preparation of materials and in the processes of construction were explained in detail. Some of the party viewed the work from one of the Harbour Board's tugs. The total length of sheltering works is 9,520ft., and the area enclosed will be 610 acres at low water. All the under water work of the Admiralty Pier extension and of the east arm is practically completed, and a commencement has been made on the island breakwater, which is to be built in a similar manner by concrete blocks, the bedding of the first course being prepared by means of grabs and the use of diving bells.

Books Received.—The Western Society of Engineers have sent us from Chicago the third part of their ninth volume, giving their papers and discussions and also some abstracts. The particular features in this number are two papers on "Reinforced Concrete" and the discussion on the same. There is, however, an interesting communication on the hydro-electric power development at and near Joliet (Ill.), using Chicago drainage canal water, by Thos. T. Johnston, M.W.S.E. This installation is peculiar in many ways, as the power scheme makes use of the water from the Chicago drainage canal. The author describes the installation in detail and illustrates the power house. It is seen from the commercial troubles overcome that there was no little difficulty in getting the necessary agreements with conflicting authorities. The fifth volume of the *Transactions* of the American Electrochemical Society has just come to hand. It is quite up to the standard of its predecessors, and contains a large amount of original matter. The following extracts from the index of papers show what a wide range electrochemistry enjoys nowadays. Thus, these papers are: "The Continuous Advance of Electrochemistry" (Richards), "The Standard Cell" (Wolff), "Preparation of Materials for Standard Cells and their Construction" (Carhart and Hulett), "Single Potentials of the Halogen Elements" (Mott), "The Composition and Resolution of Voltages" (Richards), "Molecular Conductivity" (Reed), "The Economic Balance in Electrolytic Copper Refining" (Addicks), "Remarks on Prof. Jos. W. Richard's Theory of Heat of Neutralisation as presented to the Society, Sept. 19, 1903" (Westman), "The Energy of Ions" (Parsons), "The Aluminium Electrolytic Condenser" (Zimmerman), "A Contribution to the Study of the Electric Arc" (Weedon), "Some Phenomena Observed in Connection with the use of a Copper Voltameter" (Adams and McNutt), "Electrolytic Iron" (Burgess and Hambuechen), "Thermo-Electric Determinations of the Reduction Temperature of Zinc Oxide" (Johnson), "Exhibition of Porous Plates" (Sadtler), "An Index to Electrochemistry and its Application" (Voege), "Observations on the Preparation of Electrolytic White Lead" (Carrier), "Electric Smelting Experiments for the Manufacture of Ferro-Nickel from Pyrrholite" (Sjöstedt), "Dissociation by means of the Alternating Electric Current" (Davis), "Notes on the Industrial Electrolysis of Water" (Landis), "The Thermo-Chemistry of Electrolytic Dissociation" (Reed), "A Strange Observation" (Moltkehansen), "Exhibit of Ferro-Metals, made Electrically, and of other Electric Furnace Products" (Rossi).

The Inverted Repulsion Motor.—A recent issue of the *Electrical World* of New York contains an article on this subject by Mr. Karl Faber. The author states that the commutation of the inverted motor is inferior to that of the repulsion motor, due to the absence of the revolving field in the former machine. As far as concerns the commutation, the circuits of the inverted machine are similar to those of a compensated series motor, and experiments show that in neither the case of the inverted nor the repulsion motor is the sparking destructive, and the difference in the commutation of the two machines is inappreciable. As stated by the author, the inverted motor should be much lighter than the repulsion motor, and for traction service the former machine seems to be superior to the latter, which necessitates both a transformer and a motor located in the limited space available upon a car truck. The editorial comment of this article is as follows: Since the circuits of a repulsion motor are in many respects similar to those of a stationary transformer, it seems at first glance quite obvious that, if a proper value of impressed E.M.F. be used, the machine can be operated inverted—that is, with primary and secondary circuits interchanged. To one giving merely a passing thought to the subject, it might appear that the performance in the one case would be quite similar to that in the other; and since only a relatively low E.M.F. could be impressed upon the commutator, that a decided advantage would be gained by using as primary stator coils capable of being wound for any convenient E.M.F. A more careful study, however, reveals the fact that, when operated inverted, the repulsion motor develops distinctly different characteristics from those under normal conditions, and the difference in performance is attributable to the counter E.M.F. of rotation produced at the commutator. With the rotor stationary, the repulsion and the inverted motors show equal torques per kilovolt-ampere input and equal power factors, the motor windings in each case being those of a stationary transformer with secondary on short-circuit. With the inverted motor the counter E.M.F. of rotation produces an effect similar in all respects to the insertion of resistance in the primary circuit of the transformer, decreasing the current and the core magnetism and increasing the power factor indefinitely with increase of speed. With the repulsion motor the effect of the motion of the secondary is not only not to cause a decrease in core magnetism, but also to allow the magnetism to increase, and the exciting ampere-turns must, therefore, be increased. Since, however, the secondary current is caused to lead the primary E.M.F. in phase, the exciting ampere-turns need not be supplied wholly by primary current, and the effect of speed on the motor circuits is similar to the insertion of resistance and some condensance in the secondary circuit of the transformer. The repulsion motor is practically a constant magnetism machine, while the inverted motor is of the variable magnetism type.

Measurement of Insulation Resistance by means of an Electrostatic Voltmeter.—In an article which appeared in a recent issue of the *Elektrotechnische Zeitschrift*, Dr. J. Sahulka describes how insulation resistances of dead cables may be measured by means of an electrostatic voltmeter. It is requisite that the instrument should possess a range equal to the working potential; also that a resistance be provided of a value determined by that of the resistance to be measured. The accompanying diagram shows the arrangement for measuring the insulation resistance of a cable. As in the case of measurements by means of a direct deflection, one pole of the battery or dynamo is connected to earth, while the other pole is connected through a resistance, *w*, with the core of

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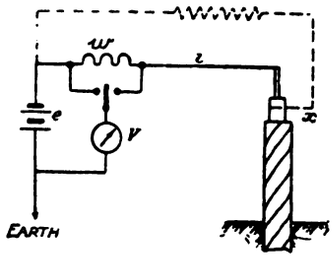
the cable. In order to prevent a leakage of current from the core into the cover of the cable, a guard wire may be employed as shown by the dotted line. The insulation resistance to be measured is represented by x. The electrostatic voltmeter, V, may be so connected by means of a switch that it measures either the potential, e, at the terminals of the testing battery, the potential at the resistance $(w+x)$, or the potential, e', at the insulation resistance, x. The resistance, w, must suffice to cause an appreciable loss of potential, so that $e' < e$. Since the same current, i, flows through the resistances, w and x, it follows that

$$w+x : x = e : e',$$

whence

$$x = \frac{w e'}{e - e'}.$$

In this case the measurement of the insulation resistance is effected similarly as the determination of a resistance by a comparison of the difference of potential on the same with that on a known resistance in series, except that a fraction only of the working potential is compared. For example, a very well insulated installation of house wiring for a



three-wire system (2 × 110 V.) was tested with the wires dead. The installation was connected through a suitable resistance box to one pole of a testing battery, whose second pole was earthed. The working potential was

$$e = 110{\cdot}8 \text{ V.}$$

Inserting resistance $w = 100{,}000\ \Omega$, the potential obtained at the insulation resistance was

$$e' = 101{\cdot}4 \text{ V.}$$

Hence

$$x = \frac{100\,000 \,.\, 101{\cdot}4}{110{\cdot}8 - 101\,4} = 1{,}072{,}000\ \Omega.$$

In the case of another installation on the three-wire system

$$e = 111{\cdot}0 \text{ V};$$
$$w = 11{,}000\ \Omega;$$
$$e' = 91{\cdot}7 \text{ V};$$

whence

$$x = 110{,}000\ \Omega.$$

Testing Live Mains for Insulation Resistance.—In a previous note we have referred to an article by Dr. J. Sahulka, in which the author describes how an electrostatic voltmeter may be employed for measuring the insulation resistance of dead cables. In the same article the author shows how insulation measurements may be made on continuous-current two-wire and three-wire networks, while alive, with the aid of a similar instrument. In the accompanying diagrams (Figs. 1 and 2) the separate conductors are marked L_1, L_2 . . . ., the fault resistance of the same to earth f_1, f_2 . . . ., and the leakage current flowing through these resistances in the direction of the conductors to earth, i_1, i_2 . . . The total insulation resistance of the network, x, is always given by the formula

$$\frac{1}{x} = \frac{1}{p_1} + \frac{1}{f_2} + \ldots .$$

The potentials existing between the individual conductors and earth, when no artificial resistances are inserted, are marked V_1, V_2 . . ., the values for the same depending entirely upon the resistances of the faults and the working potentials between the conductors. As a rule these are not equal, and may be represented by e_1, e_2, . . . The author goes on to describe how known methods of measuring the insulation resistance may be facilitated by using an

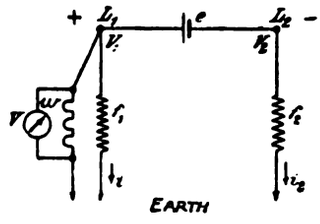


Fig. 1.

electrostatic voltmeter, V, with a resistance, w, in parallel, as shown. By connecting the voltmeter, without the resistance, between one of the conductors and earth, the difference of potential existing between the conductor and earth may be at once determined. We now connect a resistance, w, in parallel with the voltmeter of sufficient value to

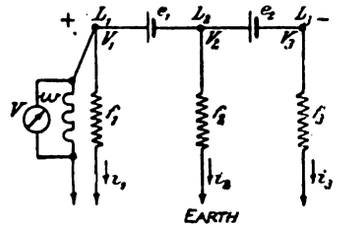


Fig. 2.

cause an appreciable reduction in the reading obtained. The measurement may be further simplified by employing the Frölich method, while using an electrostatic voltmeter instead of a galvanometer. But in measuring the insulation resistance of a multi-wire system the instrument must be connected between an outer and earth—not between the middle wire and earth. The Frölich method consists in connecting a galvanometer of high resistance, g, between a conductor—for instance, L_1—and earth. By switching in the galvanometer, the potential between the conductor and earth is varied. Let us suppose the reading obtained be V_1'. We now connect in parallel with the instrument a resistance, w, of such value that the deflection obtained is reduced to a value, V_1''. The insulation resistance, x, of the system may then be determined with the aid of the formula,

$$\frac{1}{x} = \frac{V_1''}{w\,(V_1' - V_1'')} - \frac{1}{g} \quad . \quad . \quad . \quad . \quad (a)$$

If we employ an electrostatic voltmeter, V, instead of the galvanometer, $g = \infty$. By connecting this voltmeter between the conductor, L_1, and earth, a direct reading is obtained of the potential, V_1, between the conductor and earth corresponding to the resistances of the faults alone. We now connect a resistance, w, in parallel with the voltmeter, so as to reduce the reading given by the instrument. If the value be V_1', then

$$\frac{1}{x} = \frac{V_1'}{w\,(V_1 - V_1')},$$

and therefore

$$x = w\left(\frac{V_1}{V_1'} - 1\right) \quad . \quad . \quad . \quad . \quad . \quad (b)$$

The advantage of employing an electrostatic voltmeter consists in that the formula (b) then serves instead of the more complicated formula (a). The author refers to a method explained in a previous article for determining the fault resistances of the individual conductors of a three or five wire system,

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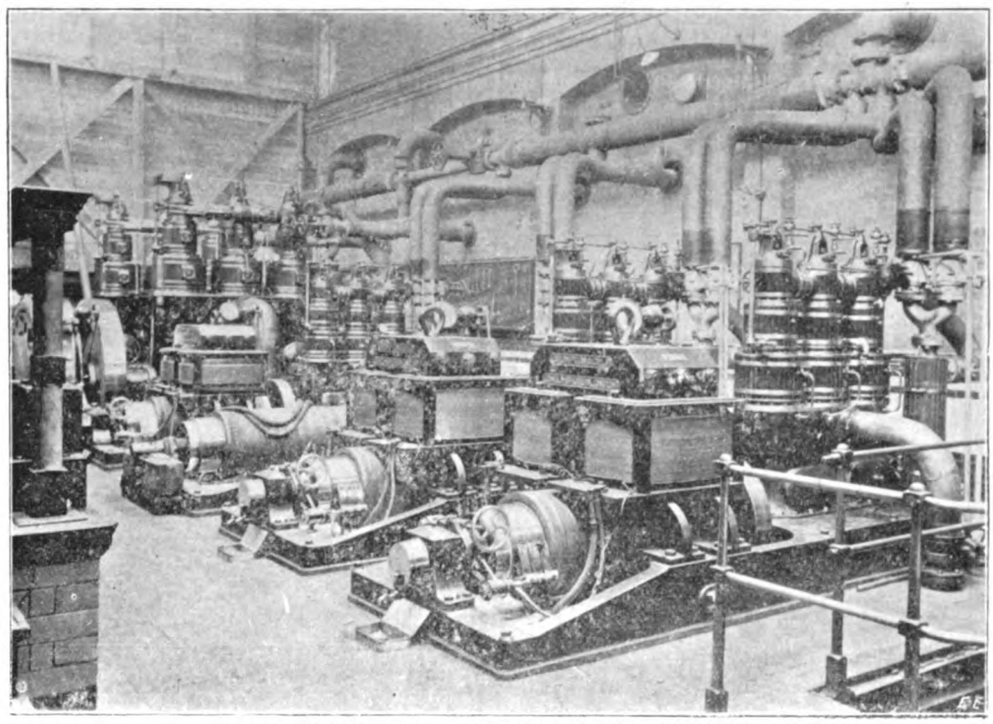
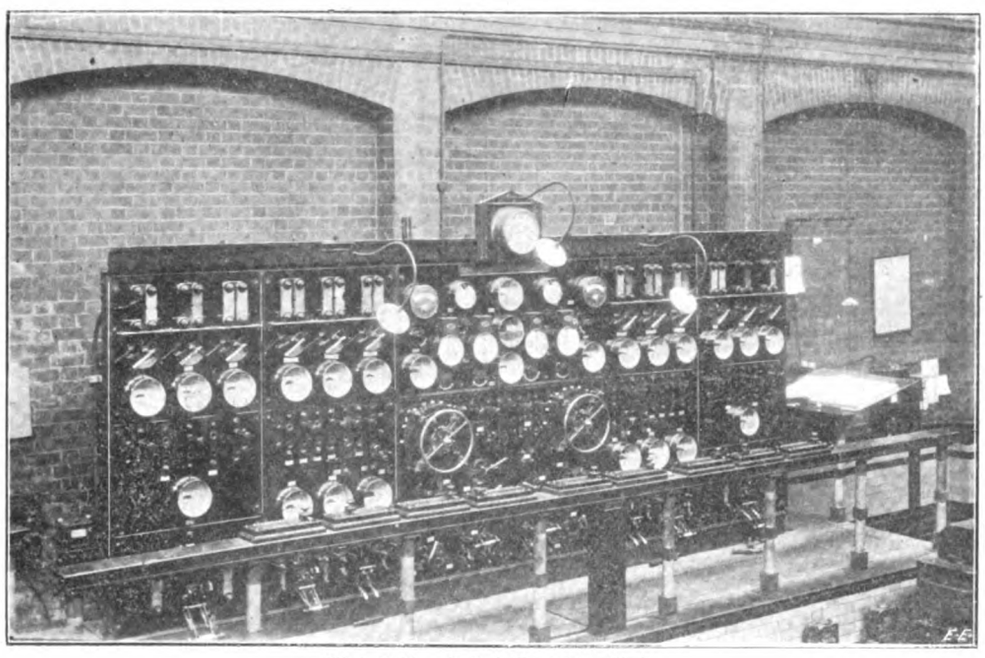
EXTENSION OF THE ELECTRIC LIGHTING STATION OF THE YORK CORPORATION ELECTRICITY DEPARTMENT.

Municipal trading in the ancient city of York is very limited, and it is, therefore, not surprising to find that a great deal of interest is taken in the first undertaking governed by the public body. When first the authorities unfolded their scheme for the supplying of electric light in the city, there were, as is usually the case, a certain section of the community who prophesied that the concern would serve to increase the rates, but although much opposition from this party has not aided the growth of the undertaking, it is being fully borne on the ratepayers that they have now in their possession a well-organised department, which, it is confidently anticipated, will in the near future prove to be a most valuable asset to the city. The growth of the undertaking has been phenomenal, as, although it was only inaugurated four years ago, the number of units generated during last year amounted to nearly a million, and it reflects great credit on the city electrical engineer, Mr. C. A. Midgley, seeing that the very low price of gas in York makes the local gas company a very formidable rival.

The ceremony which took place at the electricity works on Monday, the 18th inst., when the formal opening of the extensions was performed by Mrs. H. V. Scott (wife of Mr. Councillor H. V. Scott, chairman of the Electric Lighting Committee of the York Corporation), is the result of the greatly increasing demand on the station. On this occasion there were also present the members and officials of the Corporation, representatives of the contractors engaged on the extensions, and a large number of the prominent citizens and principal consumers.



Interior of Engine Room—Old Portion—York Electricity Works.



Old Switchboard, York Electricity Works.

Mrs. H. V. Scott having been presented by the building contractors (Messrs. Arnold and Son, of Doncaster) with a handsome gold key, on the handle of which was engraved the city arms, unlocked the door and the company entered the building. Mr. Councillor H. V. Scott then addressed the assembly from a large platform in the new building, and, after welcoming them on behalf of the Electric Lighting

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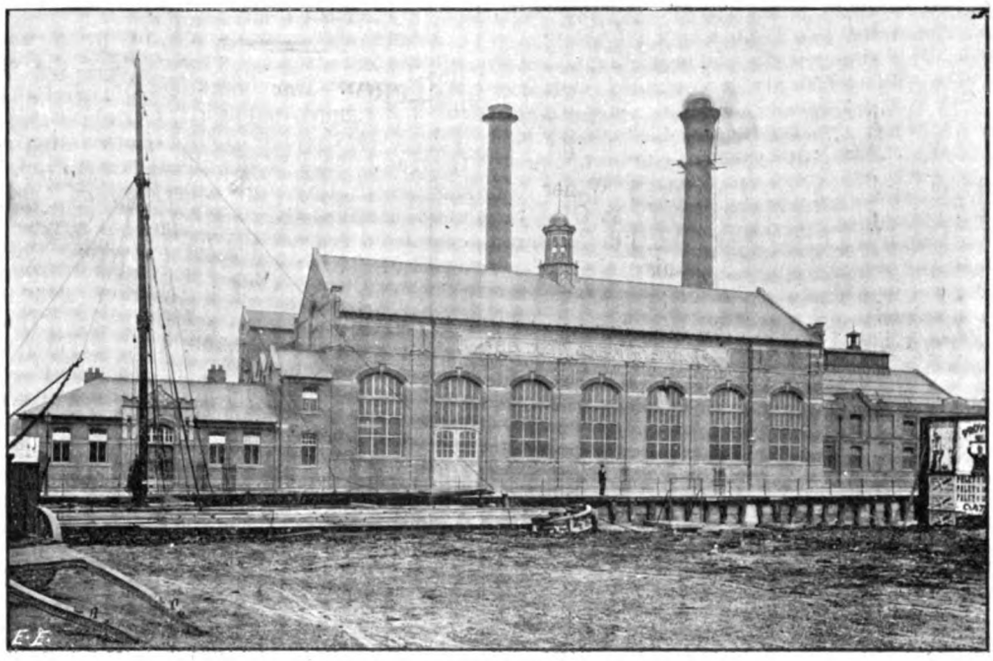
Committee, gave a brief history of the undertaking. The works were opened on April 2, 1900, and the initial instalment of generating plant put down was capable of supplying some 6,500 lamps; but, owing to the large demand, additional plant had to be installed, and the generating capacity was increased to 13,800 lamps By the winter of 1900-1 a further extension had to be carried out, and in March, 1902, the capacity of the station had increased to 24,000 lamps (1,200 h.p.). At that time it was fully

The plant in the new engine-room consists of two Willans and Robinson's high-speed engines of the vertical compound type, developing 850 h.p. when running at full load, and they are each coupled direct to a 520-kw. dynamo of the continuous-current shunt-wound type, of Messrs. Dick, Kerr, and Co.'s manufacture. Messrs. Allen and Sons have supplied a surface condenser which is capable of condensing 30,000lb. of exhaust steam per hour, and the motors used in connection with the condenser are of the enclosed

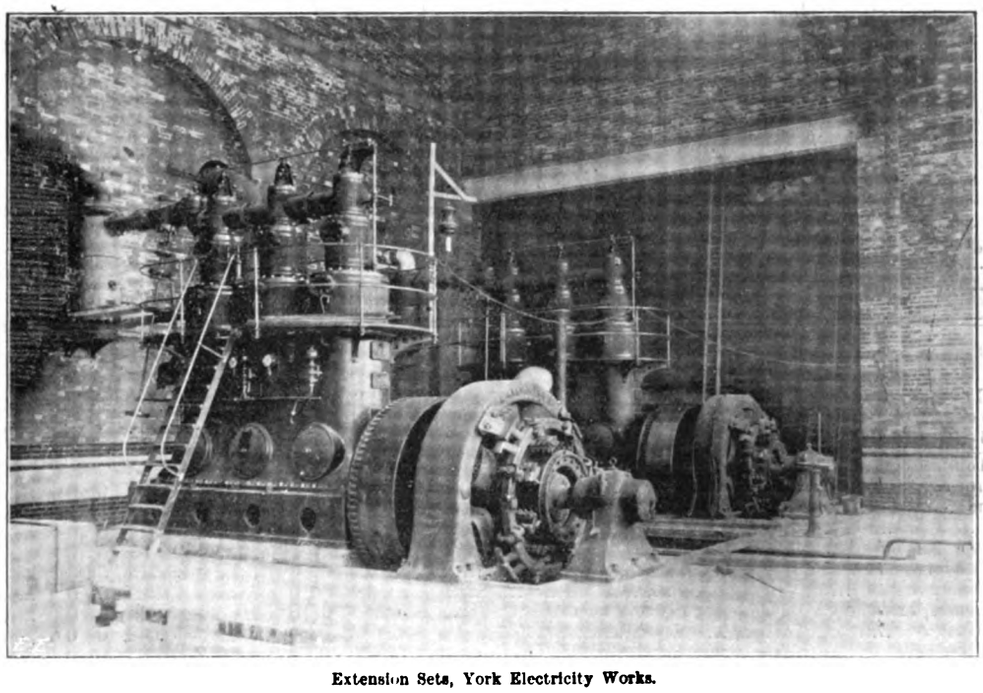


Engine Room Extension, York Electricity Works.

recognised that, owing to the great demand for energy, a further large extension would have to be made, and in October, 1901, the Council resolved to extend their buildings on a large scale. The completion of this extension was marked by the opening ceremony on Monday last.

The extensions have been carried out to the designs of the city electrical engineer (Mr. C. A Midgley), and the

shunt-wound type, and have been supplied by Messrs. Dick, Kerr, and Co., who have also supplied the switchboard for same. A 20-ton hand travelling crane, by Messrs. Higginbottom and Mannock, of Manchester, runs the full length of the engine-room, and the stone blocks on which the rails for the crane are fixed are fitted with hand-rails; a platform running along both sides of the building has thus



Extension Sets, York Electricity Works.

city surveyor (Mr. A. Creer) is responsible for the structural alterations. To the old engine-room, which was 68ft. long by 32ft. wide, has been added a lofty, well-lighted room, 122ft. long, 47ft. wide, with a height of 36ft. to the eaves, adjoining which are offices for the city electrical engineer, assistant engineers, and clerks, also well-equipped testing, motor, and meter rooms, stores, etc., have been provided.

been made at a very small extra cost. The switchboard, which is of white marble, is on a platform at the end of the room, 13ft. above floor level, and is so arranged that a complete view of the old engine-room, as well as the new room, can be obtained. Accommodation has been made for further extensions of plant, foundations having been built for two sets of 1,000 h.p. each, and one set of

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2,000 h.p.; the necessary condensing chambers have also been constructed.

In the new boiler-house are three Babcock and Wilcox boilers of 1,000 h.p. each when working at 130lb. steam pressure. They have each a grate surface of 4,872 square feet, and are capable of evaporating 15,000lb. of water per hour. They are fitted with Babcock and Wilcox chain-grate stokers and superheaters. The superheaters are capable of adding 80deg. to 100deg. F. to the temperature of the steam at the engine stop valves. The boiler-house is divided into two banks of four each by the pump-room, which at present contains two Weir steam pumps of the vertical double-acting type, which are so arranged as to allow of them being worked singly or in parallel, and they are designed to lift and deliver to the boilers, against 130lb. of steam, 2,500 gallons of water per hour. Above this room is a large cast-iron tank, 18ft. square by 6ft. deep, and the plates of the tank are $\frac{5}{8}$in. thick. When full, the tank holds 75 tons of water. The water used at the works is obtained from the River Foss, which flows alongside, but in case the supply from this source should fail, the town's water can be utilised, a special main having been brought into the works.

All the pipework has been supplied and erected by Messrs. Dick, Kerr, and Co, and the lagging of the boilers and steam-pipes has been carried out by Messrs. Hickson's, Limited, of Bradford. Between the engine room and the boiler-house is a steel chimney by Messrs. Head, Wrightson, and Co., of Thornaby-on-Tees, 116ft. high from the ground level, and lined to within 50ft. of the top with firebricks. The induced-draught arrangement in connection with the chimney has been carried out by Messrs. Davidson and Co., Limited, of Belfast. A further economiser of 480 tubes, which are arranged in four groups of 120 tubes each, has been installed. This work was carried out by Messrs. Ed. Green and Sons, Wakefield.

The supply of coal for the boilers will be brought along the Corporation's rails from the railway company's siding to the coal store, and will then be conveyed by the coal conveyor and elevator direct to the stokers. Messrs. Gibbons Bros. and Co., of Dudley, are now engaged on this work, and when this is completed, the whole of the work in connection with the extensions will have been carried out, and the station will be within reasonable bounds of meeting the demand, and the Corporation may well claim to be the happy possessors of a thoroughly modern and well-equipped electric generating station.

TELEPHONY AT GLASGOW.

Before these words are in print we hope to have another opportunity of inspecting the telephone system at Glasgow. Our immediate object, however, is to refer to the recently-published report of the Committee on Telephone Service to the Corporation of the City of Glasgow. This is the third report, and, considering the criticisms hitherto levelled against the work, deserves most careful consideration. It deals with the second completed year of the undertaking, and gives the position as at May 31, 1904. The total borrowing powers authorised now permitted a total of £350,000, as against £300,000, the extent last year. The total capital expenditure is £320,782. 12s., an increase of £50,050. 8s. 4d. during the year, and what the Corporation gets for this expenditure is shown in the accompanying Table A.

With the report is a summary of noteworthy points, which to a certain extent forms a reply to the many adverse criticisms against the undertaking. Why it is thought necessary to emphasise the points in the report is difficult to say; they speak for themselves. Nothing succeeds like success, and Glasgow telephony is successful. The revenue increased from £35,014. 2s. 9½d. to £49,639. 1s. 2d.; the balance to net revenue from £14,143. 0s. 7½d. to £20,519. 18s. 2½d. Why will accountants bother about this halfpenny? The net revenue has to provide interest and sinking fund. Anything remaining beyond the sum of these can be dealt with as the authority pleases. In Glasgow the balances have been appropriated to a general depreciation fund. The interest requires £8,537. 9s. 8d., sinking fund takes £8,343. 6s. 8d., leaving a balance for

TABLE A.

Work.	Original scheme.	Actually completed 1901-02.	1902-03.	1903-04.
Completed instruments	5,250	5,479	9,122	11,405
Partially completed lines	1,200	8,787	7,387	9,065
Switchboard accommodation	6,050 lines	7,060 lines	10,826 lines	12,062 lines
Pairs of cable wires	6,450	14,572	18,171	21,874
Mileage of pairs of wires in cables	4,938 miles	11,061 miles	14,029¼ miles	17,597 miles
Length of trenching	22 miles	94 miles	127¾ miles	143 miles
Pipes going out of exchanges	32	126	135	150
Capacity of pipes going out of exchanges	6,900 pairs of wires	27,000 pairs of wires	31,000 pairs of wires	36,000 pairs of wires
Length of pipes	32 miles	104½ miles	127¼ miles	140 miles
Length of underground cable	31 miles	113¾ miles	162 miles	205¾ miles
Ground poles	2,326	691	1,799	2,544
Roof standards	456	228	243	239

TABLE B.

	1901-02.	1902-03.	1903-04.
1. Total capital expenditure	£192,693 0 0	£270,938 0 0	£320,782 0 0
2. Average gross cost per station	35 3 4½	29 14 0½	28 2 6¾
i.e. {Total capital expenditure / Total number of stations} (including spare plant and preliminary expenses).			
3. Amount borrowed and not repaid	172,240 0 0	242,533 0 0	285,490 0 0
4. Gross revenue	26,513 0 0	55,729 0 0	73,809 0 0
5. Net revenue	14,096 0 0	35,014 0 0	49,639 0 0
6. Net revenue per station	2 11 5½	3 16 9	4 7 0½
7. Rentals carried forward to following year	12,417 0 0	20,715 0 0	24,170 0 0
8. Public telephone receipts	29 0 0	225 0 0	776 0 0
9. Working expenses, excluding Post Office royalty and terminals	6,832 0 0	15,968 0 0	23,154 0 0
10. Interest paid	2,682 0 0	6,642 0 0	8,537 0 0
11. Sinking fund paid	1,960 0 0	5,806 0 0	8,343 0 0
12. Depreciation fund	398 0 0	1,694 0 0	3,650 0 0
13. Loss on terminal fees	725 0 0	1,131 0 0	299 0 0
14. Royalty to Post Office	1,379 0 0	3,405 0 0	5,007 0 0
15. Total expenditure	13,698 0 0	33,320 0 0	46,000 0 0
16. Total expenditure per station	2 10 0	3 13 0¾	4 0 7½
17. Percentage of sinking fund paid, plus depreciation fund to total expenditure	Per cent. 3·93	Per cent. 4·2	Per cent. 4·67
18. Percentage of total expenditure to net revenue	97·17	95 16	92·66
19. Percentage of net revenue to capital expenditure	7·31	12·92	15·47
20. Percentage of outstanding rentals to gross rentals	13·95	9·91	7·44
21. Stations working	5,479	9,122	11,405

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general depreciation or general purposes of £3,650. 17s. 10½d., there being to credit of net revenue in addition to the above balance a sum received for interest of £11. 16s. The accompanying statistics relating to the undertaking will be interesting (see Table B).

These figures will want a lot of disputing, and till they are shown altogether incorrect we must congratulate Glasgow and its engineer with having successfully proved in the concrete what was academically argued to be impossible. When the successful man is told he does not know his business, he can afford to laugh.

THE WESTINGHOUSE UNIT-SWITCH SYSTEM OF MULTIPLE-UNIT TRAIN CONTROL.

(*Contributed.*)

It is now acknowledged by all classes of engineers that electricity offers the only satisfactory solution of the problem of the quicker working of city and suburban railway traffic, and there is no doubt that we are on the eve of a general, though necessarily gradual, conversion of local lines from steam to electric working. The chief reasons for this are two in number—firstly, the possibility of quickly building up or splitting up trains with one or more motor-cars combined with trailer or non-motor cars just as the density of the traffic requires; secondly, the high rate of acceleration which is obtained by having a number of pairs of driving wheels distributed along the length of the train. Each motor coach may be looked upon as a combination of an electric locomotive and a passenger car, but the driver's portion of such a car occupies so little space as to be almost unnoticeable, the motors, controlling gear, and brake gear being conveniently stowed away beneath the car body. As already mentioned, a car may be built up of one or more such driving units interspersed with trailers or non-motor coaches, this constituting the multiple-unit system of electric train working. One has only to consider the time occupied in getting up speed and in slowing down, say, on a run through a dozen city or suburban stations in order to appreciate the vital importance of rapid acceleration and retardation. That rapid acceleration can be obtained much more easily through the distribution of the driving power over many wheels (which is made possible by an efficient and reliable multiple-unit system) than through the usual concentration of the driving power in a steam locomotive, must be clear to anyone.

In this article we shall deal not so much with the multiple-unit train as with the method of *controlling* the driving power, as exemplified in the Westinghouse multiple-unit train-control system, which is the result of several years' experience of electric railway work. As evidence that this system of electric train control fully meets the requirements of up-to-date practice, it is only necessary to mention that among the railways which have already adopted it are the following: the Brooklyn Heights Railway, 514 sets of motors and controlling gear; the West Side Elevated Railway of Chicago, 156 sets; the Metropolitan Railway, Paris, 102 sets; and the entire contract for the Metropolitan Railway, London. These contracts alone aggregate, together with the Mersey Railway, some 1,364 motors, with a total of nearly 210,000 h.p. The following descriptions and illustrations refer more particularly to the apparatus with which the cars of the Metropolitan Railway of London are being equipped. The Westinghouse system has proved highly successful in the United States, and is also in satisfactory operation on the Mersey Railway in this country, which, it will be remembered, was converted to electrical working by the British Westinghouse Company.

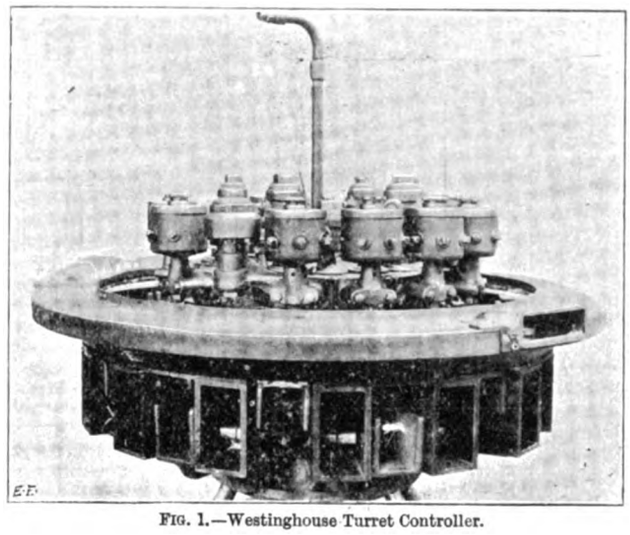

FIG. 1.—Westinghouse Turret Controller.

For large and heavy cars requiring very powerful motors, the latest and best form of controller is the Westinghouse turret controller. This takes its name from the fact that it is turret shaped. It consists of a number of radially-grouped circuit breakers or unit switches, which are closed by air pistons working against powerful springs, which open the switch contacts when the air pressure is removed. Fig. 1 shows a turret controller with its cover removed, and Fig. 2 illustrates its position on the underside of a motor coach. The 15 separate circuit breakers or "unit switches" which are employed are secured to a circular base, and are provided with a common magnetic blow-out coil at the centre. This single blow-out coil is a special feature, as it secures the ideal condition of maximum blow-out effect with minimum weight and space, and the number of parts and the amount of wiring necessary is very much reduced. Further, the use of a single coil enables it to be made of greater magnetic strength than could be the case if a number of smaller coils were used—one to each switch. The air pistons actuating the radial switches work in vertical cylinders, and the air admission is controlled by needle valves operated by iron-clad electromagnets, which,

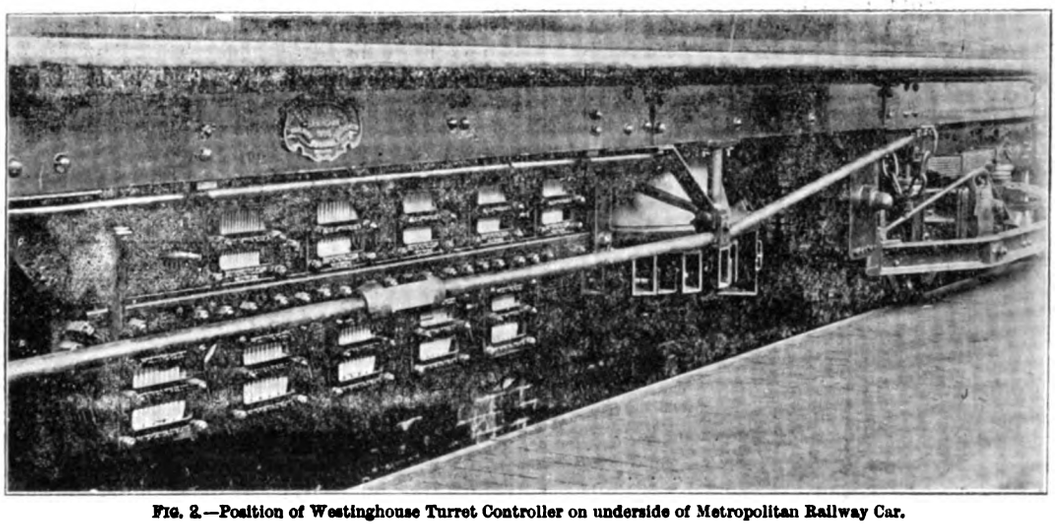

FIG. 2.—Position of Westinghouse Turret Controller on underside of Metropolitan Railway Car.

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together with the cylinders, project above the main base casting of the turret, as seen in Fig. 1. A single pipe connection supplies compressed air to a central reservoir chamber, and ports around the latter admit air to the various magnetic valves, and thence to the cylinders, this construction reducing the amount of air-piping and joints to a minimum.

down from the main casting, and supports the spider and also the attachment for the bottom cover. It may be mentioned that the general arrangement of parts has been somewhat modified since Fig. 3 was drawn, but the latter is near enough for the purposes of a general description. The contents of each switch are enclosed in a vulcabeston box or arc shield (Fig. 1), and the magnetic lines from one

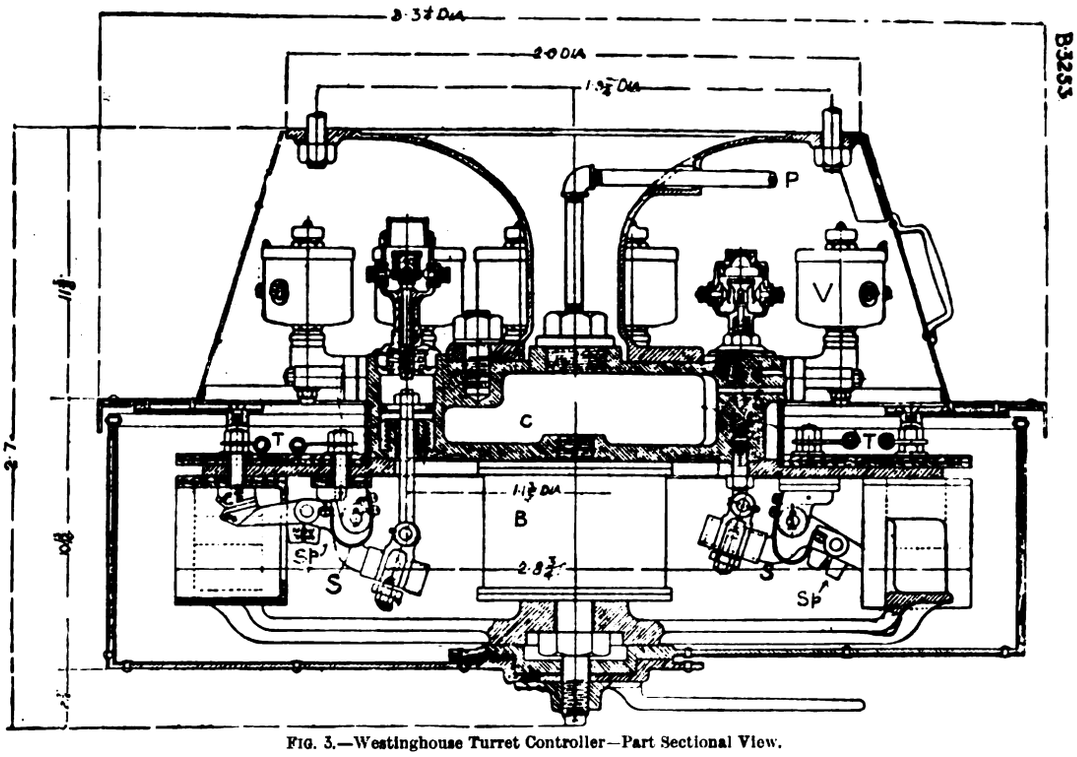

FIG. 3.—Westinghouse Turret Controller—Part Sectional View.

A view of the turret controller partly in section is given in Fig. 3. Here P is the compressed-air supply pipe, C the air reservoir, p the port leading to the magnetically-operated valve, V, and p' the port leading from the valve to the cylinder operating the switch, S, which is shown in the open position. Another of the switches, S', is shown closed,

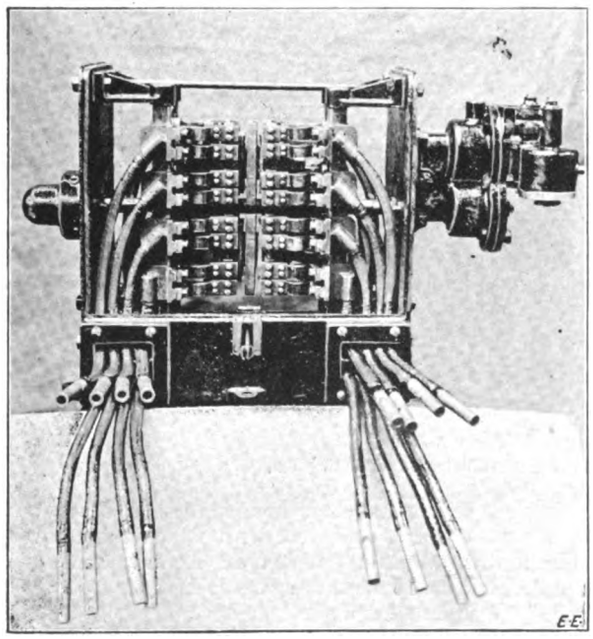

FIG. 4.—Westinghouse Unit-Switch System of Multiple-Unit Control. (Interior of Pneumatically-Operated Reversing Switch.)

and a section of the cylinder and piston operating it is given. B is the large blow-out coil, and two of the iron pole-pieces emanating therefrom may be seen to the right and left of the figure. These pole-pieces, which are more clearly shown in Fig. 1, are U-shaped, and point alternately up and down; the top ones being bolted to the main iron casting, and the bottom ones to the extremities of a cast-iron spider. The core of the magnet is fixed to and hangs

top and one bottom pole pass through each such box in a direction normal to that of the line of break of the switch—that is to say, horizontally. The strength of the blow-out field is such that test currents up to 18,000 amperes have been repeatedly and successfully broken, the burning at the switch contacts being negligible.

There is, of course, no limit to the length of break or the power of cylinder that may be employed when switches are operated pneumatically. Each switch is closed by the action of the air pressure in its cylinder, a powerful helical spring behind the piston being compressed at the same time. When the switch contacts are brought together, and also when they are separated, a spring in the moving arms

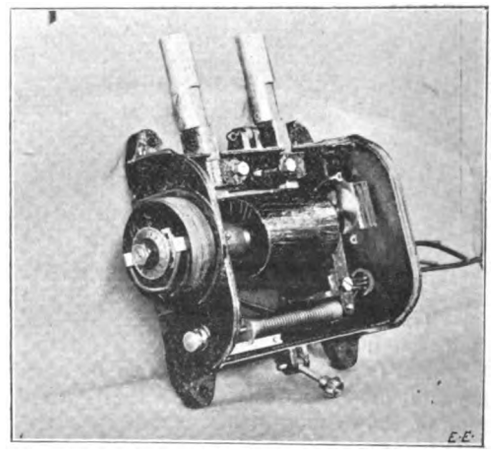

FIG. 5.—Overload and No-Voltage Return Relay used in the Westinghouse Unit-Switch Multiple-Control System (case open).

comes into play and brings about a rolling and sliding motion of the contacts, and so keeps their surfaces in good condition and prevents all tendency to burn or weld. This spring is shown at $s\,p$ in Fig. 3. Copper shunts are provided for all working pins and bushings in the switches, and the contact plates—which are easily renewable—are of ample area. When the exhaust port of the cylinder is opened, the spring under the piston drives the latter up and

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opens the switch. The switch terminals are shown at T T in Fig. 3, both these and the switch parts being insulated from the circular base-plate of the controller by sheets and bushings of vulcabeston. It is a good point that the terminals are on the opposite side of the base to the switches, the cables being thereby divided off from the latter. Another good point is that the low-tension circuit terminals on the magnet valves are well separated from the comparatively high-tension switch terminals. The magnets

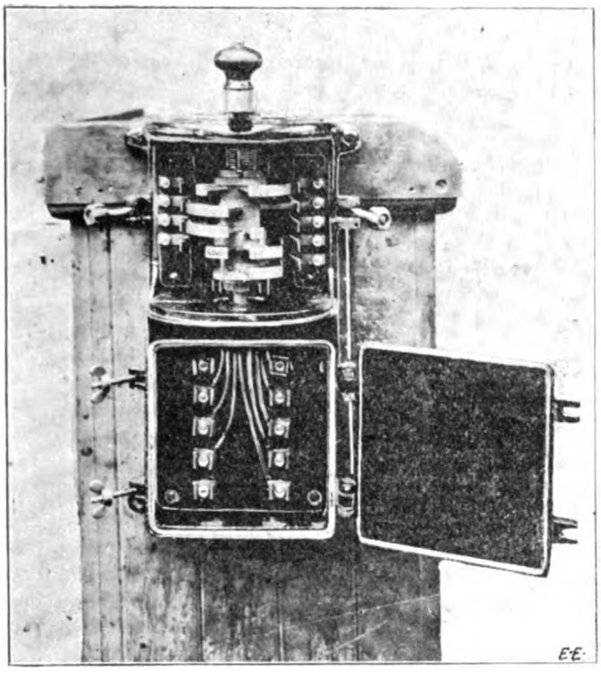

FIG. 6.—Master Controller used in the Westinghouse Unit-Switch Multiple-Control System.

and valves are enclosed by a hinged truncated cone-shaped cover, which can easily be removed, and the switches are enclosed by a revolving cover, the halves of which slide or telescope within each other.

In addition to the turret controller just described, a complete motor coach equipment includes a reverser, an automatic excess-current and no-voltage return relay, one or more small master controllers, and a switchboard for the controlling of the car-lighting, compressor, and battery circuits, this switchboard being depicted in Fig. 7. The reverser, which governs the direction of current through the motors, and, consequently, the direction of motion of the car, is operated by an air motor, the admission of air being controlled by electromagnetically-operated valves, similar to those on the turret controller, and is of substantial and simple design. Fig. 4 shows its construction. The overload and no-voltage return relay, which is shown in Fig. 5, is connected with the operating magnet of one of the cylinders in the turret, this cylinder actuating the switch which acts as main circuit breaker. The no-voltage part of this relay, which is mounted on the end of the case, no-voltage device acts, it causes the controller to go back to a point with high resistance in circuit, the latter then gradually and automatically "notching out" the resistances as soon as the supply is resumed. It should be noted that the no-voltage action of the relay is not so instantaneous as

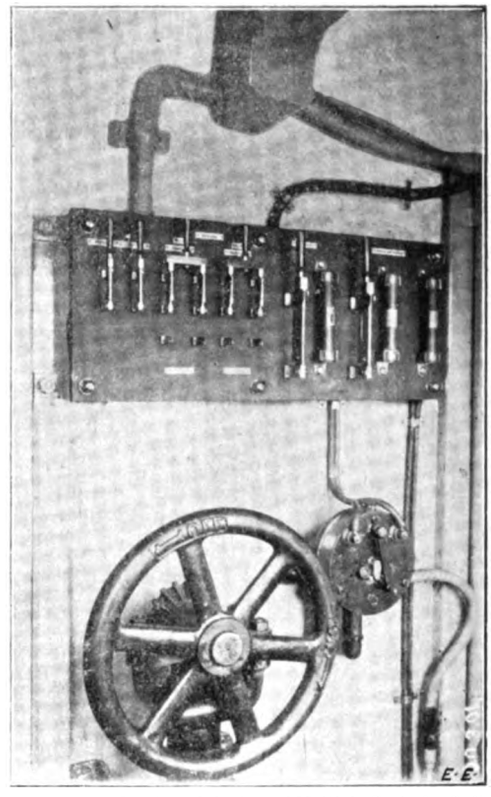

FIG. 7.—Westinghouse Unit-Switch System of Multiple Control.—Switchboard for Car Lighting, Air Compressor, and Battery Circuits.

to take notice of instantaneous interruptions due to the car contact shoe passing over points or crossings, and also that it does not act when the supply is suddenly cut off and

FIG. 8.—Westinghouse Multiple-Control System.—Low-Tension Circuit Connectors.

then suddenly comes on again; hence the term no-voltage return relay.

The connecting link between the electric and pneumatic gear and the human agent—the driver—now claims our

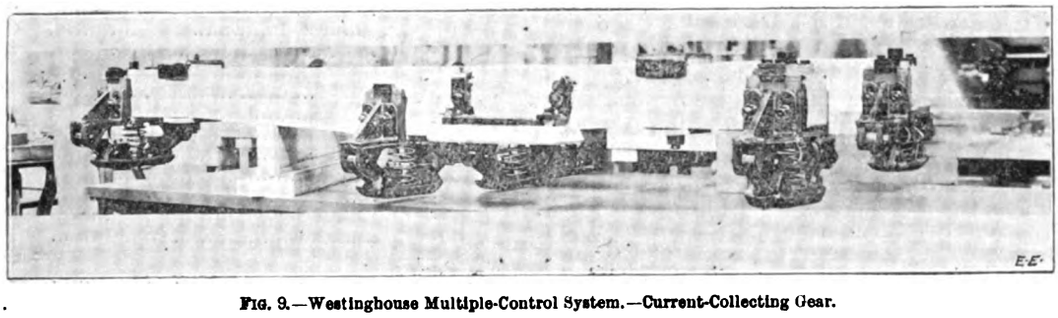

FIG. 9.—Westinghouse Multiple-Control System.—Current-Collecting Gear.

is of considerable importance, its function being to prevent the sudden restoration of full voltage to the motors and consequent flashing thereat, after any unforeseen interruption in the supply of power due to a break in the third rail, something going wrong with the contact shoes, a momentary interruption of the supply to the line, etc. When this attention. This—the master controller—is wonderfully compact, as will be seen by the accompanying illustration. Fig. 6 shows it in elevation, temporarily bolted to the side of a bench, and with its top and bottom casings opened out. The small size and light weight of the master controller, which is so called because it governs the

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operation of the turret controller, is due to the fact that the currents operating the valve magnets of the latter are very small, and as they are derived from a low-voltage (seven-cell) storage battery, there is no necessity for arc shields or blow-out coils. The master controller has five notches for forward running and five for backward running, in addition to the neutral point. At the first "forward" notch, the emergency brake valve is set. At the second, the main supply circuit is closed and the reverse set. At the third—known as the shunting notch—the motors are connected in series with all resistances in. At the fourth, an automatic acceleration device comes into action, and the controller goes on notching up, provided it is not checked by the limit switch, till the eighth and last series notch is reached, the limit switch coming into play in order to maintain a uniform accelerating current. As the master controller drum is rotated, the pistons in the turret are actuated in due order, and the corresponding switches are closed. When the master controller handle reaches its last notch, the turret switches which have already been put on are simultaneously opened, and a number of others simultaneously closed, this making the parallel connections for the motors. Then, subject to the action of the limit switch, the controller automatically notches up to full parallel, and the highest speed point is reached. It is of special importance to note that should the driver throw his handle over to full parallel at the start, the controller will still work automatically and gradually through all the series and parallel positions, so that no harm can come to the motors. A further advantage of this automatic acceleration is that it ensures the utmost economy in power consumption. Thus, with non-automatic control, it has been found that from 10 to 15 per cent. more energy is consumed.

An ingenious safeguard is provided in case the motorman should lose his hold of the controller handle through inadvertence, accident, or sudden illness. The handle, when released, flies back to its neutral position by spring action, and in so doing interrupts a circuit through the magnets above the air-pipe. The effect of this is to open a valve and allow the air in the main pipe of the air-brake system to escape, with the result that the brakes are applied immediately throughout the train. When the brakes are not required to act, however, as in reversing, their above-mentioned automatic application may be prevented by passing the controller handle rapidly over the neutral notch. In running backwards, the operation of the controller is similar to its operation with forward running.

The motor coaches that are being equipped for the Metropolitan Railway (London) will be fitted with four 150-h.p. motors—*i.e.*, 600 h.p. in all—and each coach will weigh approximately 39 tons. The full-length train will consist of two motor and four trailer coaches; and it will be possible to split it up into five, four, three, two, or single coach trains as the density of the traffic decreases. The unusual power of these equipments is the reason for the large number of resistance steps in the controller, there being eight series and eight parallel positions. Nevertheless, the weight of the turret resistance, reverser, and pneumatic controlling gear is less than that of an ordinary electromagnetic control equipment. The cables are encased in asbestos slate mouldings, so that the fire risk is practically negligible. Fig. 8 depicts the nine-way low-tension controlling circuit sockets and plugs, which constitute the only electrical connection between neighbouring cars.

Fig. 9 gives a side view of the collector gear for one car. The two outer beams are fixed one each end of the car, and are provided with a positive collecting shoe at each extremity and a negative shoe in the middle. The shorter middle beam is placed at the centre of the car length, and carries a negative or return-current shoe only. The necessity for having collector shoes at each side of the car is explained by the fact that the conductor rail is sometimes on one side of the track and sometimes on the other.

Swinton.—In reference to the negotiations which have been proceeding between the District Council and the promoters of the proposed electric tramway, an interview was held a few days ago between the parties, when the company asked the Council to abandon the proposal that the town be lighted by electricity, offering as an inducement for this concession an annual rental of £100 or a payment of £1,000. The Council declined the offer.

THE RAWORTH REGENERATIVE CONTROL FOR TRAMWAY MOTORS.

On Wednesday last a demonstration was given at Gravesend both of the Raworth regenerative control for electric tram motors and also of the Demi-car on which the same was used. The trials were made on the lines of the Gravesend and Northfleet Electric Tramway Company, and the chairman of this company, Mr. W. G. Bond, was present throughout the trials. The Raworth generative control consists essentially of the use of shunt-wound motors on the tramcar instead of motors of the series type. This is not a new feature, but Mr. Raworth has carefully worked out the details and obtained successful regenerative results. For the convenience of those witnessing the trials, instruments were placed on the cars in order that the current taken from or returned to the trolley could be noted. There was also in the circuit a Vulcan electricity meter which measured the total draft of energy from the trolley wire. The armature of this meter revolved in the backward or negative direction whenever the car was returning energy to the line. In order to find out what percentage of the energy taken was returned, we counted throughout the return journey the revolutions of the brake disc of the meter in each direction. On the outward journey we also took the revolutions of the meter in each direction when descending the steep grade on Stone Bridge-hill to Plough Ponds It was then found that the car took electrical energy equivalent to 1½ revolutions of the meter when starting, and that on the hill it returned the equivalent of 22½ revolutions. The net return was, therefore, 21 revolutions. On the other journey this hill had to be ascended, and, as is shown in the following figures, the car took electrical energy for which the meter recorded 59 revolutions. In other words, in descending the hill this Demi-car, holding 20 passengers, returned 35·75 per cent. of the energy which it took when ascending the hill. The figures for the whole of the return journey are as follows:

TABLE I.

Return Journey from George and Dragon to Plough Pond, mostly down grade (about ¾ mile). Revolutions of meter representing energy taken from and returned to trolley wire.

Energy taken.	Energy returned.
3	—
·3	·33
·2	23
4·5	·75
Totals... 8·0 revs.	24·08 revs.

Plough Pond to top of Stone Bridge-hill (about ¼ mile).

Energy taken.	Energy returned.
Total ... 59 revs.	0 revs.

Top of Stone Bridge-hill to near Windmill-street (about 2 miles).

Energy taken.	Energy returned.
45·5	·33
22·25	2·75
1·25	·33
12·5	1·00
2·25	1·00
·5	1·25
1·0	·75
11·25	·75
22·5	4·75
—	2·00
—	2·50
—	·25
—	1·75
—	1·50
—	2·25
—	·50
—	2·5
—	·33
—	·50
—	1·50
Totals...119·00 revs.	28·49 revs.

Grand total—186 revolutions of meter in positive direction.
52·52 ,, ,, negative direction.
28·3 per cent. of energy taken is returned by the regenerative motors.

From this it is seen that on the whole of the return journey of about three miles, 28·3 per cent. of the energy drawn from the line was returned by means of the regenerative control. These figures, which were taken by us quite independently of anyone interested in the undertaking, show that Mr.

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Raworth has succeeded in his attempt to return to the mains a very considerable proportion of the energy which is usually wasted at the brake blocks or wheels of a tramcar in descending hills or in stopping the car to pick up passengers. The figures given us by Mr. Raworth are as follows. He stated that the Demi-car at Gravesend took on the average 0·380 per unit per car mile. The car weighs 5·6 tons, and carries 20 passengers. It is equipped with two Brush motors rated at 28 h.p. each.

As compared with this, the large cars now in use weigh 9·11 tons and carry 48 passengers. They are equipped with two Walker motors rated at 25 h.p., and consume 0 97 unit per car mile. In order to make these figures comparable, it is necessary to calculate how much energy the Raworth car would take if its weight and carrying capacity were the same as the larger car. Assuming that the energy taken goes up in proportion to the weight, the energy consumed would increase from 0·38 to 0·62. This latter figure is 64 per cent. of the energy consumed by the larger car, or it shows a saving of 36 per cent. for the regenerative control. These figures are most interesting, but before we give the advantageous points to be noted with respect to this system of control, we think it only fair to draw our readers' attention to the following. In the first place, the shunt-wound motors on these cars are always in use, either receiving current from the line or returning current to it. In consequence, they have to be considerably larger than those required on the series-parallel system. Thus at Gravesend the small car has two motors of 28 h.p. each, while the larger car, carrying 48 passengers as against 20, can be worked on the series-parallel system with two motors of 25 h.p. each. This increase of size, of course, only affects the first cost of the car, and the saving in electrical energy more than justifies the increased cost of the larger motors. Another question at issue is as to the cost of upkeep of shunt motors on tramcars used, as they have to be used, under regenerative conditions. These conditions are much more unfavourable as regards the commutator troubles than with series-wound motors. We trust, however, that by good design this difficulty will be overcome. There is one point yet to be considered, and that is the acceleration obtained from the shunt motors. Any comparative figures in which exactly similar conditions as regards acceleration are not obtained are open to criticism. In the trials on Wednesday last we had not to stop in order to pick up passengers, and we kept on the routes occupied by cars with series-parallel control without interfering with the traffic. From rough observations of the time taken to go the distance between two tramway poles, when starting from rest, the acceleration was about the same as on cars equipped with series motors, but the motors were larger for the work to be done.

The points to which our attention was especially drawn by Mr. Raworth are the following:

1. The Demi-car with regenerative control uses less than half the energy per car mile than the ordinary cars with series-parallel control. (N.B.—We make the figure 64 per cent. from results given for equal weight of car and carrying capacity.)
2. The driver can control the car with one finger.
3. The car can run up to facing points at full speed until the buffer is over the points.
4. The brakes are never used except on an incline to hold the car after retardation.
5. There are three definite braking effects: (*a*) regenerative, which will reduce the speed to four miles an hour; (*b*) the ordinary braking stop, which reduces the speed to about 1½ miles an hour; (*c*) the emergency stop, which pulls the speed up to half a mile an hour.
6. Sand is seldom required, because the adhesion is not overtaxed.
7. The maximum call on the power station is reduced by 40 per cent.
8. The maximum speed of the car can be fixed in the depôt. The driver cannot possibly exceed this speed, even on a descending grade.
9. The controller is extremely simple, and is sparkless if properly worked—*i.e.*, without hesitation.
10. There is no advantage gained by shutting off power at section insulators. The car lamps remain bright.
11. Every power position of the controller handle is also a braking position on a down grade or on a level by retiring the lever one notch.
12. The act of shutting off the power applies the brake, and the braking effect is continuous throughout the movement.
13. The motors are in series, and remain so. They might equally well be in parallel, but the windings would have to be finer and more expensive.
14. The power circuit is never shut off until it is necessary to stop. In the meantime the car can take power, can coast or regenerate as the road requires.
15. The feeder losses are reduced by one-half, and the size of the power station by one-third.

ON SINGLE-PHASE COMMUTATING MOTORS.*

If an ordinary direct-current series motor with laminated magnets is supplied with an alternating single-phase current, it would very soon become evident that it is not suitable for working under these conditions. The direct-current motor, in fact, belongs to a particular class of machines which may be called high magnetic resistance machines, in which it is the rule to make the exciting ampere-turns considerably greater than the armature ampere-turns. To this class belong the ordinary direct-current machine and the synchronous alternate-current machine. A second class is formed by the single and polyphase induction motors. In such machines the excitation of the field only requires from one-third to one-fifth of the full load armature ampere-turns. Machines of the first class are known to work better the greater their magnetic resistance is made, whilst the ideal machine of the second class is the one with the smallest possible magnetic resistance.

All workable alternate-current motors necessarily belong to the second class, as it is only by keeping the magnetic resistance low, and consequently reducing the field-turns, that a reasonable power factor can be obtained. In order to obtain a given torque with a weak field, a powerful armature must be employed having more ampere-turns than usual. These ampere-turns must, however, be prevented from interfering with the magnetic circuit, as any flux set up by them simply acts as harmful self-induction. The two requirements of a low magnetic resistance and a powerful armature which shall not produce a harmful field are contradictory, and investigators soon found it necessary to prevent the production of the armature field, or at least reduce it to a minimum, by the employment of compensating windings, such as that patented by Stanley and Kelly in 1892, consisting of short-circuited coils with their axis identical with that of the brush line. Currents were induced in these coils, by transformer action, opposing and more or less cancelling the armature field. In other designs the compensating winding was traversed by the armature current itself, and was connected so as to cancel the effect of the armature ampere-turns. With such motors the magnetic resistance could be reduced to a minimum, and the armature self-induction could still be kept reasonable, though it could never be entirely cancelled, as no compensating winding could deal with the armature leakage flux. The compensating coils themselves also set up a leakage flux, so that there still remained the armature leakage, the compensating coil leakage, and the main flux as causes for the flow of a wattless current.

It is, however, easy to understand that the compensated motor would be preferable to the uncompensated one. The three essential circuits—A, the armature winding, C, the compensating winding, and E, the exciting winding—can be arranged in various ways. The armature or rotor circuit must, of course, always remain an ordinary direct-current winding. The stator can be arranged either with practically continuous iron—*i.e.*, with many slots per pole—or with definite polar projections. The compensating winding should, however, be arranged to be as nearly as possible

* Translation in abstract from the *Elektrotechnische Zeitschrift* for June 2, of a paper read by K. Pichelmayer before the Elektrotechnische Verein, Berlin.

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identical with the armature winding—*i.e.*, it should be distributed. Excitation and armature, or excitation and compensation, may, under certain circumstances, have a single common winding, so that the motor need only have two independent windings. The three circuits will, however, always be traceable. For the sake of simplicity, the motor with only two windings will be considered. Motors with independent exciting windings are, however, essentially the same. The three windings may be divided between

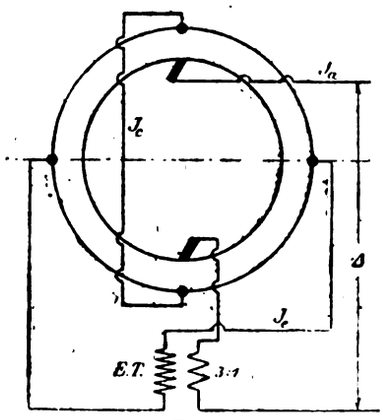

FIG 1.

the rotor and stator in various ways. The following are the possible combinations :

	Stator.	Rotor.	Type of motor.
I.	C E	A	Ordinary compensated series motor.
II.	A	C E	Winter-Eichberg-Latour motor.
III.	A E	C	Thompson's repulsion motor.
IV.	C	A E	Reversed repulsion motor.
V.	A C	E	Impossible combinations.
VI.	E	A C	Impossible combinations.

The combinations under V. and VI. are obviously impossible, since the armature winding and compensating winding cannot both be mounted on either the stator or rotor, as they form the primary and secondary of a transformer. There are, therefore, only four broad types of compensated motors. The arrangements I, II., and III. are of particular interest, and will be compared below. It

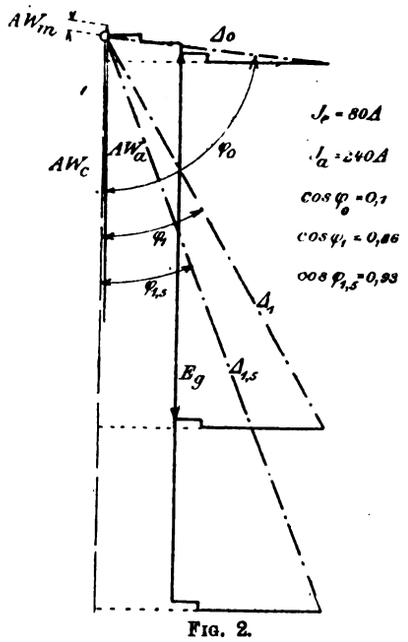

FIG. 2.

will, however, be impossible to give the complete theory of these three motors here, so that for simplicity we will consider a motor of definite dimensions and construction arranged, first, as a compensated series motor, then as a Winter-Eichberg-Latour motor, and, finally, as a repulsion motor. The diagrams for these three arrangements of a motor having an armature diameter of 485mm. and an armature core length of 300mm., are given below with as great accuracy as the present state of the theory will permit. The frequency is taken as 25, and all these motors are supposed to run at 750 revolutions when in synchronism—*i.e.*, they are four-polar motors. The armatures will have ordinary lap windings—*i.e.*, they will have four parallel circuits. The number of total armature-turns will be taken as about 300, giving about 300 commutator segments. The number of stator turns will be taken as equal to those on the rotor, so that stator and rotor both have identical direct-current windings so as to permit of easier com-

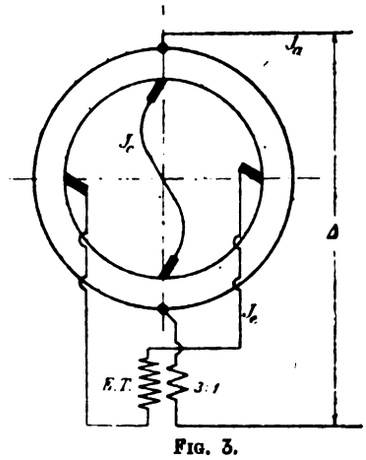

FIG. 3.

parison of the different types. The diagrams are for equal excitation and for an armature current of 60 amperes per circuit, giving a power of about 100 h.p. when running at synchronous speed. The single air-gap between stator and rotor is 2mm.

Consider first the compensated series motor whose connections are shown in Fig. 1. The compensating circuit is coaxial with the armature circuit, whilst the exciting current is introduced at right angles to these by means of a series transformer. This exciting current will be taken as equal to one-third of the main current. The introduction of the transformer is necessitated by the fact that rotor and stator have equal number of turns. In practice, of course, no such transformer would be employed, but the same result would be attained by putting only one-third as many turns on the stator as on the rotor. We are, therefore, dealing with a motor whose field exciting ampere-turns are only one-third of the armature ampere-turns. The armature and compensating circuits form a short-circuited transformer under all conditions of working. The magnetising current—*i.e.*, the resultant number of ampere-turns, A W_m (Fig. 2)—is very small, as the

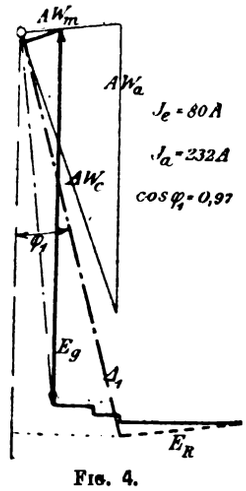

FIG. 4.

resultant field has only to make up for the E.M.F. of the compensation leakage and the ohmic drop in the compensating winding. The action of this transformer remains unchanged under all conditions of motor load. Armature current and compensating current are almost equal, and practically in exact opposition. In the voltage diagram, consequently, all the wattless voltages are almost unidirectional, and at right angles to these two currents. The wattless components of the voltage are obviously the E.M.F.'s of the leakage fields of the armature

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current, the compensating current, the exciting transformer, and the self-induction of the exciting current itself. The useful component, or counter E.M.F., E_g, is the voltage induced in the rotor by rotation in the main field. The short power components represent the resistance losses. All the power components are shown vertical. The indices 0, 1, 1·5 represent standstill, synchronous speed, and 1·5 times synchronous speed. The diagram shows that at standstill with 240 amperes input the motor requires a voltage $\Delta_0 = 230$ volts, and that at synchronism this voltage must be increased to 460 volts. The value of cos ϕ is satisfactory even at synchronism, and at 1·5 times syn-

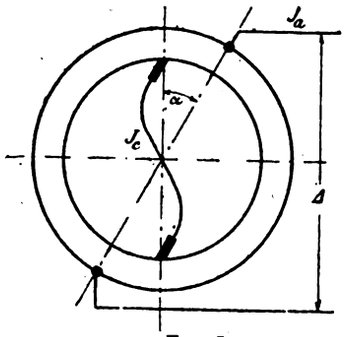

FIG. 5.

chronism the relation of power counter E.M.F. to wattless components is so good that cos ϕ reaches the value of ·93. The motor is, therefore, quite satisfactory as regards power factor. This result is not only theoretically correct, but has been confirmed by tests on a motor of smaller dimensions.

The results are still better if the motor is given the Winter-Eichberg arrangement, as in Fig. 3. It will be seen that with this arrangement compensation and excitation occur on the rotor whilst the armature circuit is on the stator. This apparently small change has a considerable effect on the behaviour of the motor. The chief differences as compared with the series motor is the fact that the field in the compensation axis is very considerable. At standstill the armature circuit and compensating circuit behave like a short-circuited transformer. The torque is produced by the interaction of the armature current and the field (to be called the main field) set up by the exciting circuit, which is, in this case, situated on the rotor. As soon as the motor commences to run, the voltage between the compensating brushes rises and reacts on the stator by transformer action. This reaction can only occur through the cross field, which is practically proportional to the power

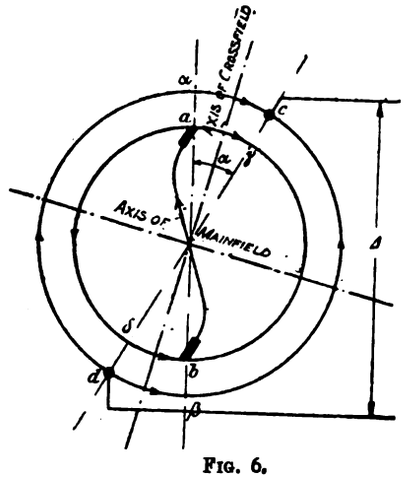

FIG. 6.

component of the voltage, and, therefore, for a given excitation, proportional to the speed. At synchronism the cross field is equal to the main field. If, therefore, the motor is saturated by the main field at synchronism, it cannot very well run above synchronism, even if a greater voltage than that required for synchronism is applied.

In order to use the motor to the best advantage it should, therefore, be built so that its synchronous speed is the highest speed at which it has to run when developing its full torque. Since the cross field ampere-turns are derived from the resultant action of the armature ampere-turns and the compensation ampere-turns, a phase displacement occurs between these two magnetising forces—in other words, between the armature and compensating currents. The diagram (Fig. 4) shows the ampere-turn triangle for the armature current, the compensating current, and the ideal magnetising current for the cross-field. An inspection of this diagram shows that the power component, E_g, of the

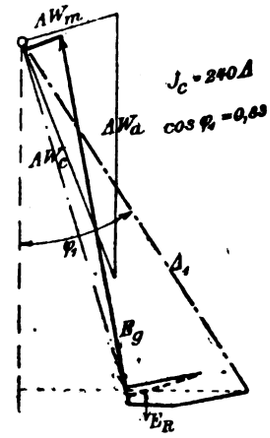

FIG. 7.

voltage is parallel to the primary current or the armature current. It is, in fact, produced by the field set up by the armature current, and any field and the current producing it are necessarily in phase. Of the wattless components, the leakage voltage of the compensating winding is at right angles to the compensating current, and the leakage voltages of the armature and the exciting windings are at right angles to the armature current. The characteristic point of this motor is the production of a wattless counter E.M.F., E_R, by the rotation of the armature in the compensating field. This voltage is in phase with the compensating field, and therefore parallel to the resultant magnetising current or ampere-turns acting along the compensation axis. It will be seen that this wattless component improves the power factor very considerably, so that, at least at synchronism, practically the only wattless components left are those due to the leakage fields, which are naturally very small compared with the power component of the voltage. The field inductance is completely cancelled, and this accounts for the very high power factor. At synchronism, as has been shown by Dr. Eichberg, this motor has a compensating field almost equal to the exciting

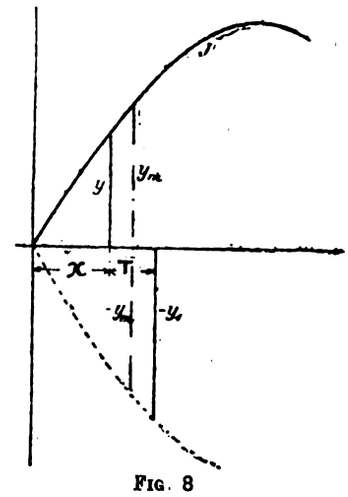

FIG. 8.

field, and approximately at 90deg. phase displacement from the latter. These two fields displaced 90deg. in time, and, in a two-pole motor, also 90deg. in space, produce a rotating field which revolves with the armature, and has an effect on the commutation, as will be shown below.

Considering the same motor next as a repulsion motor (Fig. 5), instead of feeding the armature and exciting circuits independently from four points, they may be fed from only two points situated at an angle to the compensation axis. The amount of this angle depends on the relation

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of the exciting ampere-turns to the armature ampere-turns. When, for instance, this ratio is 1 : 3, as in the motor in question, this angle would be about 27deg. This angle, as shown in Fig. 6, cuts the portions $a\ \gamma$ and $b\ \delta$ out of the rotor, and in the same way the portions $\alpha\ c$ and $\beta\ d$ out of the stator. In the portions $\alpha\ c$ and $a\ \gamma$ the direction of current is the same, so that this belt of conductors obviously forms the exciting circuit, whilst the conductors lying within $180 - a$ form the transformer or compensating circuit. The field is, therefore, half excited from the stator and half from the rotor. The diagram for this motor is shown in Fig. 7, where the power component of the voltage is made parallel to the average direction of excitation, and is, therefore, somewhat displaced relatively to the primary and secondary currents. The wattless counter E.M.F., E_R, now only compensates for about half the field inductance, whilst that part of the excitation which is due to the stator remains uncompensated, so that the motor should have a somewhat worse power factor than the Winter-Eichberg-Latour machine. In addition, a slight phase displacement exists between the effective field and current, so that the output of the motor is slightly less than that of either of the other two motors. The diagram of this motor (Fig. 7) does not profess to have the same exactitude as those of the other two motors, as the theory of the repulsion motor is by no means complete at present. This motor also sets up a rotating field at synchronism, though it is not so regular as in the Winter-Eichberg motor, as the distribution of the exciting field ampere-turns is very different from that of the compensating field ampere-turns.

The reversed Thompson repulsion motor need not be considered in detail, but it will be seen that with this combination (No. IV., C—A E) the compensating short-circuit is situated on the stator, so that this motor behaves similarly to the compensated series motor.

The four principal types of motor mentioned in the table may be divided into two groups, the first consisting of the C E—A and C—A E combinations, which have the compensation on the stator, and consequently cannot set up a rotating field, since the stationary short-circuit prevents the production of a cross field. In the motors of this group, the short-circuit compensation might be replaced by a compensating winding fed from the supply without materially affecting the action of the machine. The motors of the second group, consisting of the combinations A—C E and A E—C, on the other hand, are real rotary field machines, as distinguished from the first group, which work with an oscillating field. The fact that combinations II. and III. can be worked direct from a high-tension supply, while this is impossible in the case of I. and IV., is of practical importance.

The results of the above rapid comparison may be shortly stated as follows: (1) For the same excitation and the same armature strength all three types of motor give approximately the same torque, since there is practically no phase displacement between the working field and current, and the power components of the current are the same in all three cases. The cross field produces practically no torque, at least at synchronism. (2) The power factor is best at synchronism in the A—C E (Winter-Eichberg-Latour) motor. At starting it is equally bad in all three motors, and approximates to the value ·1, neglecting the losses. (3) The series motor improves its power factor considerably as the speed increases, so that it is suitable for running at speeds well over synchronism—*i.e.*, it may be built with very many poles. (4) With the Winter-Eichberg motor and the repulson motor it is not possible to run above synchronous speed with the higher excitations, as the cross field, which is practically proportional to the power component of the voltage, cannot be increased beyond the saturation value. This means that only the smaller numbers of poles (corresponding to approximately synchronous speed) can be employed with these motors.

From the diagrams it will be seen that all three motors require the same voltage at starting, and this voltage is about 50 per cent. of the voltage required for running at synchronism with the same torque, so that the speeds of all the motors can be very conveniently varied by altering the applied voltage. In this way, for instance, the accelerating torque on a train could be kept constant from start to full speed by gradually increasing the primary voltage, and then reducing this voltage again for steady running at full speed. In the Winter-Eichberg motor an adjustment is also provided in the transformation ratio of the transformer, which determines the ratio between armature ampere-turns and exciting ampere-turns, and by this means a large speed variation can also be attained, though it would not seem to do away with the necessity for primary voltage regulation as well.

The question of commutation in these motors has still to be considered. It is well known that this is the point in which alternate-current commutator motors give most trouble, and though it is constantly stated that these troubles have been overcome, it is certain that only a partial solution of the difficulty has been attained as yet. In the case of an alternating motor, a so-called reactance voltage is set up in the short-circuited coil just as in the direct-current machine. In Fig. 8 the curve of the alternating current is shown. Suppose commutation commences at time x, when the alternating current has the value y. At the end of the commutation period the value of the current is $-y_1$. The time interval between y and $-y_1$—*i.e.*, the time of short-circuit, T—is usually quite small as compared with the alternate-current period, and is smaller the higher the speed of rotation.

In order to calculate the reactance voltage, it is sufficiently accurate to use the average value of y and $-y$—*i.e.*, y_m. The average E.M.F. of self-induction in the short-circuited coil is, therefore, proportional to the instantaneous value of the current to be commutated, and is, therefore, in phase with this current. The maximum value of this commutation voltage will be 1·4 times as great as with continuous current, and this is one cause of the greater tendency to spark observable in alternate-current motors. A further cause of sparking is the induced voltage set up in the short-circuited coil by the transformer action of the alternating flux. This voltage depends on the number of turns per section of the armature, on the number of magnetic lines looped with the section, and on the frequency of the alternating supply. Its value is

$$E_t = 4\ 44\ \omega\ B\ Q\ n\ 10^{-8},$$

where ω is the frequency, B the average induction in the section of the winding, Q the area of the space enclosed by the winding. In order to keep this voltage down, the turns per section, n, must be reduced to the minimum, a single turn being generally found too much even. Keeping B down simply leads to a motor of large size, so that the only available method is the reduction of the frequency. In the series motor dealt with above the value of this transformer voltage comes out at about 7·8 volts, which is too high to permit the motor to work at all. It would, therefore, be necessary to build the machine with eight instead of four poles, and so reduce the transformer voltage to about four, though even this would hardly give satisfactory working.

With those motors which work with a rotating field, this transformer voltage is to a great extent counteracted, at least at synchronous speed. If the rotating field were sinusoidal in form and perfectly uniform in speed, this counter-action would be complete, for at synchronism no cutting of lines could then occur. The field is, however, not quite uniform, so that this cancelling out is never quite perfect. The transformer voltage, which in the motors with oscillating field lags practically 90deg. behind the primary current, combines with the reactance voltage, which is in phase with the rotor current, to form a resultant voltage which it is extremely difficult to reduce below five or six volts, whilst machines with a reactance voltage of only about two volts are already found difficult to operate. The reactance voltage alone of all three types of motor will usually be higher than for a direct-current motor, especially if both stator and rotor have continuous iron faces, so that the short-circuited coils cannot work in an interpolar air-gap. The transformer voltage is least in motors in which the short-circuited coils enclose the smallest area—*i.e.*, in motors of small output or motors with many poles. In the rotating field type of motor the number of poles is

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more or less fixed by the periodicity, and the transformer voltage is, therefore, large at starting, though as the speed increases this voltage is gradually counteracted. The difficulty of keeping the transformer voltage down increases with the size of motor. Lamme employs high-resistance commutator connections to reduce the short-circuit currents, and numerous other arrangements have been suggested, but without much success up to the present—at least for the larger sizes of motor.

The question of relative output of these alternating motors as compared with direct-current motors must next be considered. The effective (torque-producing) field in all three types of motors is that set up by the exciting circuit. This field varies from a maximum to zero, and produces a periodic torque with the effective current with which it is practically in phase. Calling the maximum obtainable value of the flux in either alternating or direct current machine 1, and the effective value of the armature current in either case $\frac{1}{\sqrt{2}} = \cdot 707$, the torque in the case of the direct-current motor is $1 \times \frac{1}{\sqrt{2}} = \cdot 707$. In the alternating motor the torque follows a $(\text{sine})^2$ curve with a maximum value of 1 and an average value of $\frac{1}{2}$, so that the average torque of the same motor used on alternating current is only ·5, and the ratio of maximum torque attainable as a direct-current motor to that attainable as an alternating motor is about 7 : 5. This difference cannot be avoided, and naturally it forms a drag on the alternating motor in its competition with the direct-current motor. Another difficulty encountered with alternating motors of all these types is the fact that they can only be built for comparatively low voltages. This is due to the fact that, at least in the larger sizes, only one turn per section is permissible, instead of two or three, as with direct currents. Low-voltage armatures involve large commutators. The ordinary compensated or uncompensated series motor is perhaps worst off in this respect, owing to the large number of poles which can and must be used on them. The permissible armature voltage with lap armatures varies inversely as the number of poles. Some improvement can, however, be obtained by employing series or series-parallel armature windings. It would appear as if the motors of the rotating-field class would be better in this respect than the motors with oscillating field, as with the latter the whole energy of the motor is conveyed through the commutator. This is, however, by no means the case, for, though it is true that the energy conveyed through the commutator of the rotating-field motors at synchronism is only a small percentage of the whole energy supplied to the motor, the size of commutator required is much the same as for the oscillating-field machines.

It is entirely incorrect to suppose that the energy transmitted by a commutator is a measure of its size. All three types of motor must have as many armature conductors as possible, so as to obtain the maximum possible armature voltage. All three types—at least, above a certain size—can only have one turn per section. The minimum size of commutator segment is a fixed quantity, and alike for all the motors. Further, the necessary commutator surface is in all cases decided by the commutator losses, and these, allowing for railway work with frequent starting, are about alike in all three motors, so that all require about the same commutator size. The Winter-Eichberg motor has, it is true, very small short-circuit losses on the commutator and in the armature at synchronism, but then it has the extra sets of brushes for the exciting current.

With regard to efficiency at full load, the ordinary series motor is perhaps worst off, as it runs above synchronism, and so has more iron losses and also more short-circuit losses, which may reduce its efficiency several per cent. below that of the other types. Of the practical value of all these types of motors in heavy railway work nothing is known at present. It is possible that, in their gradual development, the undoubted advantages of the single-phase motor may be found to outweigh all their disadvantages, and even that some method of overcoming the commutating troubles either by a fresh electrical arrangement or by the employment of different materials for commutator and brushes may be discovered. On the other hand, it is possible that a return may be made to direct-current motors, which are still capable of considerable improvement. In any case, the attempt to introduce the single-phase system will have a good effect on the electrical railway industry, and may lead to the perfecting of a system suitable for universal application for light and heavy traction, for single motor carriages, for long trains and for locomotives, and for short and long distance work.

NORWICH ELECTRICITY ACCOUNTS.

From the accounts of the Norwich Corporation electricity department up to Dec. 31, 1903 (one year and three months' working), it appears that the total expenditure on capital account to that date amounted to £261,547. Abstracts of the revenue account, etc., are appended.

Dr.	Revenue Account.	£	s.	d.
Generation of electricity		10,734	13	0
Distribution of electricity		1,291	7	7
Rents, rates, and taxes		1,935	11	8
Management expenses		2,980	16	4
Insurances, etc.		488	12	9
		17,431	1	4
Amount carried to net revenue account		20,141	6	1
Balance to provide for bad debts		150	0	0
		£37,722	7	5

Cr.	£	s.	d.
Sale of current per meter	34,990	14	4
Rental of meters and other apparatus	1,356	15	8
Rents receivable	57	8	6
Other items	275	9	3
Installation work	540	8	0
Wiring revenue	502	11	8
	£37,722	7	5

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	255,908	0	0
Sundry creditors	6,265	1	4
Balance at credit of net revenue account	4,585	5	4
Sinking fund account	4,115	0	0
Suspense account	500	14	6
Balance for bad and doubtful debts	150	0	0
	£281,524	1	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	261,547	16	4
Stores on hand	4,626	2	2
Sundry debtors for current supplied	9,948	12	10
Other debtors	1,407	2	9
Cash in hand	3,994	7	1
	£281,524	1	2

APPOINTMENTS VACANT.

Tramways Manager and Engineer, Huddersfield Corporation. Salary, £350 per annum. Applications by noon on Aug. 8. See advertisement.

Electrical Engineer, Heston and Isleworth Urban District Council. Salary, £250 per annum. Applications to Mr. H. J. Baker, clerk, Town Hall, Hounslow, by Aug. 6.

Chief Assistant Electrical Engineer, Weymouth. Salary, £120 Applications by Aug. 10.

Cable Companies and Wireless Telegraphy.—Sir J. Wolfe Barry, when presiding over the meeting of the Eastern Telegraph Company last week, said that the directors intended to make use of wireless telegraphy. While holding the view that wireless telegraphy would not compete with long-distance submarine telegraphy, they thought there were places where wireless telegraphy could be usefully employed. A case in point was the Azores, where the cables of the associated companies touched. It was desired by Portugal that some of the outlying islands should be placed in telegraphic communication. Owing to the nature of the bottom and the landing place of these islands, it was not considered a suitable place to make the connection by cable, neither would the traffic warrant an expenditure on this account. They therefore intended to connect the points by a system of wireless telegraphy, to be worked in connection with their cable system.

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TO CORRESPONDENTS.

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GOVERNMENT BY MAJORITY.

The clauses of the 1904 Supply of Electricity Bill have the commendation of electrical engineers as a whole, and the few exceptions, which are electric lighting company engineers, seem likely to be converted before the measure becomes law. We are not surprised, however, to find that the Bill is not so favourably received by the gas interests. Thus, our contemporary, the *Journal of Gaslighting and Water Supply, etc.*, has this week as a heading to an article about this Bill, "A Serious Menace to Gas Companies' Interests." Our contemporary invariably takes extreme views of the competition between gas and electricity for lighting purposes, and on this topic we do not now propose to touch. Neither do we propose again to enquire into the *bonâ fides* of the defunct Bermondsey clause, which was nominally introduced to protect the ratepayers of a community against the acts of their elected representatives. What we do propose to criticise is a statement in the article headed as above, which reads as follows: "But what voice have the ratepayers under the provisional order system? Absolutely none." Our contemporary then details the protection which it considers ratepayers have when powers similar to those now proposed to be granted by provisional order are sought by way of a Bill. These are well known to our readers. Our contemporary contrasts with them the procedure in connection with a provisional order. It says that "in this case no borough fund proceedings are applicable, the ratepayers and the Local Government Board are not consulted, and the Board of Trade ask no questions—in short, the orders are handed over almost as a matter of course where there is no opposition. The only opportunity a ratepayer has of expressing his views at all is when the Local Government Board hold an enquiry respecting their sanction for a loan. But then—mark the distinction!—the enquiry is not for the purpose of determining whether the money should be raised, or of determining whether the powers of the order should be carried into force, but solely for the object of settling how much money is to be spent. If a ratepayer goes into the room, and protests that the works in question are not wanted, he will be told that this is not the concern of the Local Government Board, and that (the provisional order having been granted) the only duty of the Board is to say how much money they should authorise for the objects in view." We quite agree with the truth of what our contemporary states as far as the interference from a small body of ratepayers is concerned. We deny emphatically, however, the truth of the preliminary statement that ratepayers have absolutely no voice in what shall be done under the provisional order system. In the first place, the ratepayers elect the members of a corporation, and as a rule the projects to be brought before the corporation in any one year are vigorously discussed at the November elections. Having thus elected their representatives, it is absurd to say that they have no voice in the control of the undertakings of the corporation. If the party in power obtain a provisional order and decide to spend a certain amount of money on the same, this question has also to be voted on by the elected members of the corporation before application is made to the Local Government Board. To show the point of the view which Cabinet Ministers take of this matter, we remember the reply which Mr. Austen Chamberlain, when Postmaster-General, gave to a deputation from the Tunbridge Wells Ratepayers' Association with respect to the telephone question. At the time the Corporation of Tunbridge Wells had, through the instrumentality of the town clerk, agreed to sell its municipal telephone undertaking to the National Telephone Company,

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there was strong opposition from a large body of the ratepayers, but the Corporation had voted in favour of the scheme. These ratepayers then asked the Postmaster-General to refuse to give his consent to the agreement on the ground that it did not meet the views of the majority of the ratepayers. The reply was to the effect that Mr. Austen Chamberlain could not entertain the view that the elected members of the Corporation of Tunbridge Wells did not represent the wishes of that town. Our contemporary would be equally correct if it said that Sir George Livesey, as managing director of the South Metropolitan Gas Company, did not represent the shareholders in that company, and hence it was a great injustice that he should make them responsible for a possible loss on expenditure in which they have had no voice. We are quite sure that neither Sir George Livesey nor the members of any electric light committee will continue to control their respective undertakings unless they do so in such a way as to command the confidence of the shareholders or ratepayers respectively. The reasoning in the new Electric Lighting Act which upsets our contemporary is that under it local authorities will be more able to conduct electric lighting undertakings on business lines, which was quite impossible with the Bermondsey clause in force.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BELT CALCULATIONS.

SIR,—In the *Electrical Engineer* for July 15 there appears an interesting article on "Belt Calculations," which, undoubtedly, is from the pen of an engineer, and has also come at a most appropriate time. But I do not quite understand why he should dispute the advantages gained in a long drive even if both pulleys are of the same diameters. Personally, I have always thought and most engineers will tell you that it is an advantage. However, he admits that it is in the case of the pulleys being of different diameters, but he neglects to say what would be a reasonable length, one that would give the best results without an unnecessary waste of leather, say, in the case of the ratio of the two diameters being, say, 3 to 1 and 5 to 1. If Mr. Yrreb could help me in determining these I should feel great obliged.—Yours, etc.,

M. WOLVERHAMPTON.

SIR,—Respecting the article on "Belt Calculations" which appeared in your issue of the 15th ult., the article, on the whole, is certainly a very good one, and one that will be found useful to general engineers and millowners. But I notice that Mr. Yerreb entirely omits a constant, or factor, for determining the proper thickness of leather he would use, which is a most important item when running at high speeds and large ratios. Surely he would not use the same thickness in every case.—Yours, etc., N. L. G.

LIGHTING, HEATING, AND VENTILATING AT THE NEW HALL OF THE ROYAL HORTICULTURAL SOCIETY.

This new hall was opened by the King on July 22, and its construction was most favourably commented on at the opening ceremony. Owing to the peculiar nature of the building, the question of lighting, and more particularly of heating, required special consideration, as the effects of cold draughts from the roofs would be disastrous to orchids and other valuable plants which will so frequently be exhibited in the hall. When a room is warmed from below the heated air naturally rises, and if the roof is of glass at a much lower temperature than the room, the air is rapidly cooled down and falls again, giving a cold draught, producing exactly the same effect as if cold air were actually finding its way in through openings in the roof. To avoid this in the new hall of the Royal Horticultural Society, the consulting engineers have adopted the novel plan of running on each side of each of the main girders of the roof two 2in. iron pipes, to which steam at a pressure of 15lb. per square inch is admitted. These pipes have a total radiating surface of over 1,000 square feet, and serve to keep the roof at such a temperature that the warm air from above is not cooled down, but passes away through the ventilating fan in the roof.

In the basement below the hall are four chambers, each containing steam radiators. Air is drawn in through four inlets, carried to the top of the building, passed through canvas screens and through a water spray to cleanse it and add the necessary moisture, and then by means of four powerful electric fans forced over the heater coils and delivered through four openings, two at each end of the hall, about 10ft. above the floor line. The speed of the fans, and therefore the amount of heat delivered to the hall, can be varied as desired, and in summer-time the fans will deliver cold washed air. In addition, there is a 36in. exhausting fan in the roof which can be worked as required.

The library, board-room, staircases, offices, and other portions of the building are heated by means of low-pressure steam radiators, of such a size that with an outside temperature of 32deg. F. the rooms can be easily kept at a temperature of not less than 60deg. F. Steam is supplied by means of a 9ft. by 5ft. 6in. "Economic" boiler fixed in boiler-house in basement, the steam, when condensed, being returned through traps to the hot-well, from which it is again pumped into the boiler by means of a Worthington pump. In addition, there is in the boiler-house a small auxiliary boiler to supply hot water to the lavatories, and for cleaning purposes in the summer, when the main boiler will not be worked.

The building is lit by means of 26 arc lamps and 200 incandescent lamps. The wiring has been arranged throughout to comply with the requirements of the London County Council for public buildings, the lights being divided approximately equally on two distinct services from the mains of the Westminster Electric Supply Corporation. It is also again sub-divided, so that the current consumed in the hall, annexes, lecture-room, cloakrooms, and other rooms, which may be let for entertainments, can be metered separately from the library, offices, and other rooms peculiar to the society. The installation has been carried out on a system devised by the consulting engineers, Messrs. Handcock and Dykes, the wires being drawn into drawn brass tubes, with cast-brass joint and switch boxes. The brass tubes are concealed throughout in the plaster of walls and cement floating of floors, the small size of the brass tubes enabling them to be covered by the plaster without having to chase the walls. All joints between tubes and between tubes and boxes are soldered so as to make an air and watertight junction, thus preventing condensation in the pipes, which frequently leads to failure of the wires. The sub-circuits are grouped to distribution fuse boards on the various floors, the circuits to these various boards being all controlled from the office in the entrance hall.

The main hall is lit by means of 20 arc lamps suspended about 20ft. above the floor-level, so arranged that they can be quickly lowered to the floor for cleaning purposes. In addition, there are a number of three-light brackets round the walls for incandescent lighting, the fittings for these, together with the various electroliers and pendants, being made by the Art Fitting Company, Limited, in "Pewtal," a white non-tarnishable metal. Sockets are also provided in the floor of the hall to allow of temporary lighting when required for decorating stalls or benches down the hall. The lecture-room is provided with sockets at each end from which current can be obtained for working an electric lantern for showing slides, etc., arrangements being made that the lecturer can turn off or on the rest of the lights in the lecture-room at will from either end.

The contractors for the heating and ventilating were Messrs. Kinnell and Co., 65, Southwark-street, S.E., and for the lighting the National Electric Wiring Company, 34, Victoria-street.

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LETTERS FROM AN OLD HAND TO A YOUNG ONE.

I.—On the Choice of Engineering.

My Dear Young 'Un,—Your letter of yesterday's date to hand, announcing that you "have decided to become an Electrical Engineer." Why use capitals? There is nowadays no more common noun than "engineer"; anyone from a bellhanger to a wireless telegraphist is electrical. Thanks for giving me early notice of competition. It is the age of young men, and we, products of effete training systems, have only our experience to rely on. Or is your letter a gentle hint that you want me to find you a job?

I am going to take the privilege of a friend—to make myself disliked—by offering that which the clergy call "a word in season." Have you *decided on*, or only *fancied*, engineering? Most fellows between the ages of 15 and 19 are attacked by "calf-love." They pick up some girl to whom they write verses, waft kisses, and swear evermore to be faithful. And between the ages of 24 and 42 they usually marry—some other girl! Are you sure that engineering is not your calf-love among the professions? Let me assure you that picking a wife and choosing a profession are the two most appalling jobs a man has to go through. Generally speaking, the biggest fool chooses in the biggest hurry. Of the two choices, that of a profession is perhaps the more serious. When you marry, there is always the off-chance of a separation; but if you give your profession the go-bye, you must start life again. Unless you care enough for Engineering to say that for the love of Her you will be satisfied if She gives you, in return for hard days of work and long evenings of study, just enough to live on decently, you had better go Bank-clerking or butter-slapping.

Look at it this way: In an average engineering firm the number of men who get enough to pay income tax will not exceed 5 per cent. of the whole crowd; if it did, the firm would be all head and no tail. The bulk of the 95 per cent. are probably keeping wives and families, and wishing they had never been born. Or look at it another way: The technical colleges are every year turning out crowds of energetic youngsters, chock-full of theory, willing to work for experience and 5s a week in an already overcrowded labour market. In addition to these are the shoals of youths who start as apprentices, pupils, improvers, or anything else in the cub stage you like to call them. Or, take a look at the "Gazette"—it is healthy reading occasionally—and tot up the number of small engineers who go to pot every year. Of course, I know you are a smart boy, and have honest intentions of becoming President of the Institution of Civil Engineers. But suppose you don't?

A friend of mine once had a craze for railway engineering. He had family influence with the Chief Engineer of one of the lines, and so he felt sure of a soft berth. One of the first questions fired at him by the great man was, "Have you ever built yourself a wheelbarrow?" To which he had to answer "No!" "Or a model yacht?" "No!" Whereupon the Chief intimated that the applicant would be of no condemned service to any Railway Company, and requested the honour of his absence. Only the manner of speaking was more abrupt. My friend took the hint, became an estate agent, and can now buy himself a fancy waistcoat without docking his laundry bill.

That is the test! If you *can't help* using your hands—if you as a kid tied all the chairs together with string and sewing-cotton spools to make the wheels go round, and cut yourself with the carving knife making a boat—then you are an engineer. If you didn't, you aren't. If you aren't, don't try to be; there are plenty who are. You have only one life to live, and you might as well live it according to your instincts.

Another point: If you have any recollection of past mercies, you will remember that last winter I took you to the theatre. There was a fearful crowd round the door when we got there, but we edged round, and by paying a little extra we went in at the early door and got a front seat. I lay this before you as a parable. Assuming that you *are* an engineer, why should you be electrical? I trust you don't bet—bad habit for tender years—but if you meet an engineer, you can lay 6 to 1 that he is electrical. Why?

It has apparently slipped the notice of many young fellows that they can become hydraulic engineers, shipbuilders, bridge and roof constructors, motorcar makers, quite as easily as electricians. If you are wise, and have no overpowering aptitude (I don't say inclination) for electrical affairs, you will keep out of the crush and get your position by the early doors. The only extra expense is a little more thought in making the first choice. Believe me, present-day electrical engineering is by no means Tom Tiddler's ground, whatever it may have been.

If, after all, you decide to be an electrical engineer, put your back into it. Don't hesitate to soil your lily-white hands, and don't be happy till they've grown corns where the blisters were. And—if you will take a word in confidence—you had better throw up that girl who is making a fool of you and buy "Dynamo-Electric Machinery." You haven't time for both.

You might as well write and let me know what you are going to do, for there is no need for you to break your shins on exactly the same rocks that I met.—Yours,

The Old 'Un.

THE WORKING OUT OF INDICATOR DIAGRAMS.

BY H. E. HODGSON.

(*Concluded from page 131.*)

5. *Ordinate Method.*—This method consists of dividing the diagram into a number of equal vertical strips, and arithmetically finding the mean height of these strips. This height, measured by means of a scale corresponding to the spring used, will give the mean effective pressure.

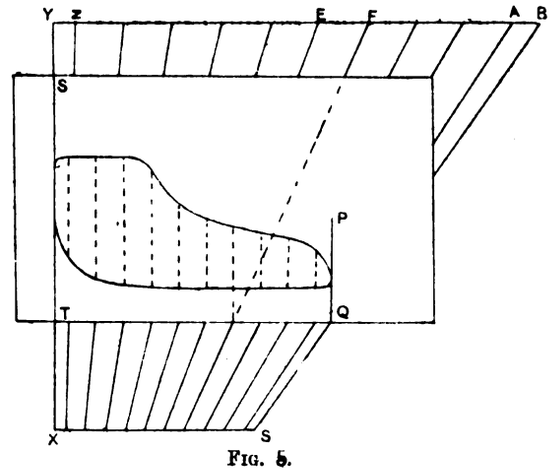

Fig. 5.

It is usual to use 10 strips for diagrams up to 3in. in length, and 12 to 15 strips for diagrams longer than this. There are numerous methods of dividing the diagram into the required number of strips, some of which are as follows:

1. *Dividers.*—This method consists of obtaining by trial the correct length, stepping off 10 equal distances along the atmospheric line, and setting up lines at right angles to this line at points midway between those already found. The sum of the portions of these lines intercepted by the curve, divided by 10 will give the mean height.

2 *Radial Diagram.*—Another and much quicker method is by the use of a radial diagram similar to that shown in Fig. 5. The line X Y is made vertical, and all the other lines radiate from some point in X Y produced. In order that the middle heights only may be drawn without the corresponding boundary lines, the distance between the last and the last but one lines from each end are only half a strip apart, so that 2 Y Z = 2 A B = E F. To use the radial diagram, take the indicator card and draw lines S T and P Q perpendicular to the atmospheric line touching each end of the diagram. Now move the indicator card up or down with the line S T coinciding with the line X Y in the radial diagram until the point Q in the line P Q comes on to the right-hand inclined line, B C. Then mark the bottom of the card where the radial lines cut the edge, draw verticals through these points, and find the mean as before.

3. *Parallel Rule.*—The parallel rule shown in Fig. 6 enables the divisions into 10 parts to be readily accom-

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plished. The rule is extended over the diagram until the front edges of the first and last strips or bars touch the two ends of the diagrams, as shown in Fig. 6. The bars must be perpendicular to the length of the diagram, but usually this can be done with sufficient accuracy by the eye alone. While the rule is thus set draw a pencil along the front edge of each of the bars and measure the mid-heights as before.

4. *Ordinary Scale.*—A fourth method of doing the same thing is shown in Fig. 7. Draw vertical lines, A B and C D, touching the ends of the diagram. Take an ordinary scale and place it diagonally across the diagram with the zero on A B and the tenth division on C D. Mark with a

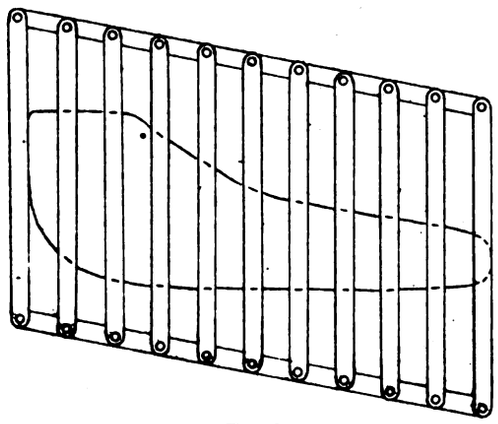

FIG. 6

pencil the middle point of each of these scale divisions, and through these points draw lines parallel to A B or C D. These lines are mid-ordinates, and their mean can be found as before.

5 *Slide Rule with Pointed Cursor.*—Slide rules provided with a pointed cursor have usually an improved scale on the bevelled edge—viz, inches and fiftieths of an inch. To divide up a diagram, the slide rule is used in the same way as an ordinary scale. In the ordinary way 10 separate heights have to be measured, but with the pointed cursor the successive ordinates are added continuously. The method employed is shown in Fig. 8. Place the zero of the scale at the top of the first ordinate and the pointer at

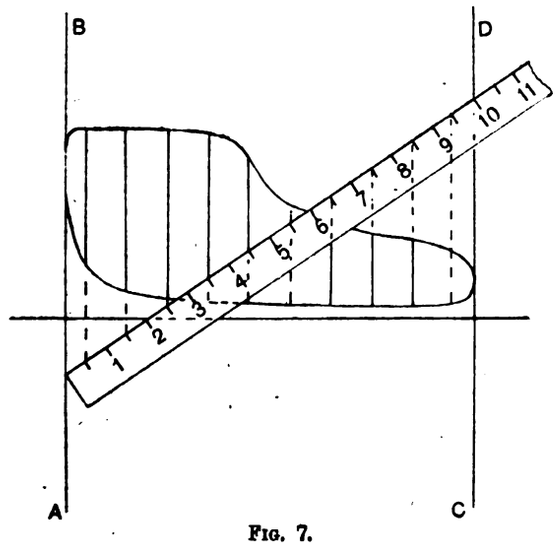

FIG. 7.

the lower end; then shift the rule so that the pointer is at the top of the second ordinate and the rule along its length; run the pointer along until it is opposite the lower end of the second ordinate, and so on. Only the final reading need be noted. This figure, multiplied by the number of the spring divided by 10, will give the mean effective pressure. It will be seen that by this method there are fewer processes, and, therefore, less possibility of error. A further advantage is that the complete process can be performed without writing down a single figure, resulting in a great saving of time. Sometimes during an engine trial the mean effective pressure is required as quickly as possible. In such a case the following method gives a good approximation: Draw the end and middle ordinates, as in Fig. 9; then draw the straight line A B so that as near as possible the sum of the areas X, Y, and Z equals the sum of the areas S and T. Next draw the line C D so that the sum of the areas E and F equals the area G. The intercept of P Q, the mid-ordinate between these two lines, equals the mean height required.

DETERMINATION OF THE STEAM CONSUMPTION FROM THE INDICATOR DIAGRAM

The determination of the weight of steam entering the cylinder per stroke cannot be estimated from the indicator

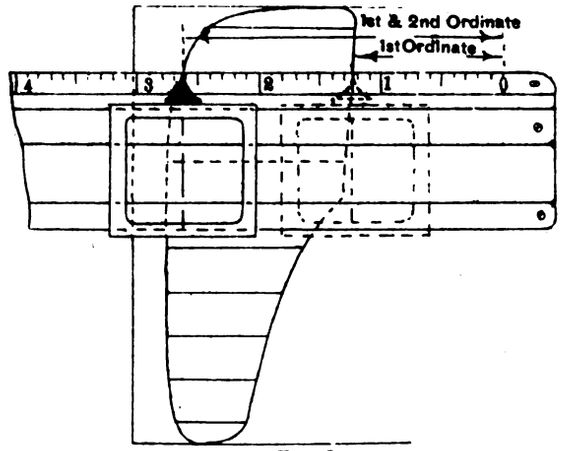

FIG. 8.

card as accurately as the indicated horse-power. If we measure the pressure and volume of the steam in the cylinder at any point between the points of cut-off and release, we can by reference to the steam tables find the weight of steam present. To do this on the indicator card, we must find the lines of zero pressure and zero volume. The zero pressure line can easily be found by setting off a distance equal to the atmospheric pressure to the scale of the spring below the atmospheric line, and drawing a line parallel to it through that point. To find the zero volume line, we must know the clearance volume of the engine; if this is known, proceed thus. Set out a distance E F (Fig. 10) such that E F is the same fraction of F G that the clearance space is of the working volume. At the point E erect a perpendicular to the zero pressure line; this line is the zero volume line.

ESTIMATION OF THE CLEARANCE VOLUME FROM THE INDICATOR DIAGRAM.

The clearance volume is best found by filling the cylinder with water or by calculation from the working drawings.

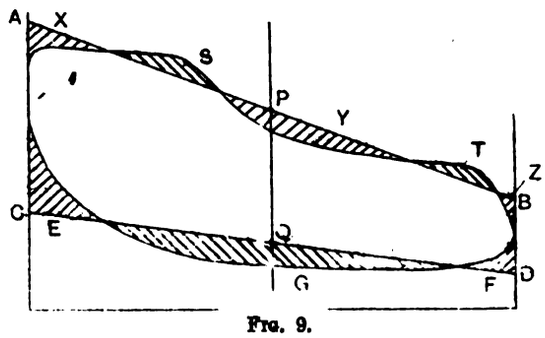

FIG. 9.

But it may be found approximately from the indicator card if there is no leakage; to do this, the expansion curve is assumed to be a rectangular hyperbola. It is found that the expansion curves on cards taken from well-designed engines of not too small a size and in good running order do not differ much from this curve.

Method.—Take any two points, A B (Fig. 10), on either the expansion or compression curve, and draw horizontals and verticals through each of these points intersecting at C and D. Join C D and produce it to cut the zero pressure line in E A vertical through E will give the zero volume line, and $\frac{E F}{F G} \times \frac{100}{1}$ equals the percentage

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clearance. This should be done for a number of points both on the compression and expansion curves. The produced lines should all intersect in the one point E; actually they will not, so a mean should be taken. Having obtained our zero lines, we may now proceed to measure off corresponding values of pressure and volume for different points on the expansion curve. Look up the volume of 1lb. of steam at each pressure and find the actual weights of steam present. For instance, if the pressure at X = 45lb. per square inch, and the volume = 1·8 cubic feet, the steam tables tell us that 1lb. of steam at 45lb. per square inch pressure occupies 9·2 cubic feet. Hence at the point X we have $\frac{1}{9{\cdot}2} \times \frac{1{\cdot}8}{1} = {\cdot}196$lb. of *steam* present. But it will be seen that at the point K there is a certain amount of cushion steam already trapped in the cylinder, hence the weight entering will be the volume indicated less this amount. It will also be found that the weight of steam indicated as in the cylinder will be least just after cut-off and greatest just before release. But the amount of water stuff in the cylinder after cut-off is constant, and is usually some 1 or 2 per cent. greater than the weight of *steam* indicated at release. At cut-off the weight of steam may be only 75 to 80 per cent. of the total water stuff; the remainder is water formed by initial condensation. This

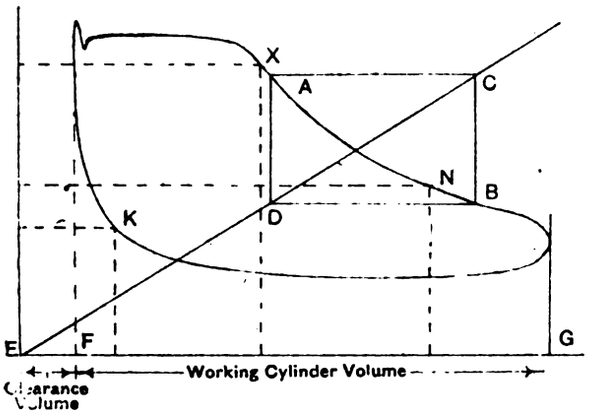

FIG. 10.

water is partially re-evaporated by heat taken from the cylinder walls during expansion.

COMBINATION OF DIAGRAMS FROM COMPOUND ENGINES.

It is often useful to reconstruct a set of indicator diagrams, so that they appear in the new figure as if the steam had acted all the time in the low-pressure cylinder only. The diagrams as received from the indicator have for convenience in working different scales of pressure, and also the lengths of the diagrams are made to suit convenience in taking. Now, as the base line of the indicator diagram is volumetric, when representing these diagrams to the same scale the bases must be altered to suit the volumes of the respective cylinders, and one pressure scale must be employed throughout. The strokes are in most cases equal, and hence the respective volumes are proportional to the square of the diameters. In the compound diagram at A set up a scale of absolute pressures, and horizontally any convenient scale of volumes. Set up vertical lines at A_1 A_2, B_1 B_2 (Fig. 11), such that O A_1 is proportional to the high-pressure clearance volume, and O A_2 to the low-pressure clearance volume; also A_1 B_1 to high-pressure cylinder volume, and A_2 B_2 to low-pressure cylinder volume. Divide the lines A_1 B_1 and A_2 B_2 into 10 equal parts and set up verticals. Divide the diagrams in a similar manner, measure the ordinates of each diagram to an absolute scale, and set them up at corresponding points in the combined diagram. The curves thus obtained show at a glance the comparative amount of work which is being performed in each cylinder, and, further, how nearly the total area corresponds to that which would theoretically be obtained in a single cylinder.

THE QUALITY OF THE STEAM.

The quality of the steam during its passage through the engine can be very conveniently represented on the indicator diagram by means of a simple construction. It is first necessary to construct the combined diagram in the manner previously described. If the compression curves do not exist throughout the range required, a rectangular hyperbola should be drawn, so as to form a continuation of the compression curve, as shown at C and D in Fig. 11. An easy graphical method

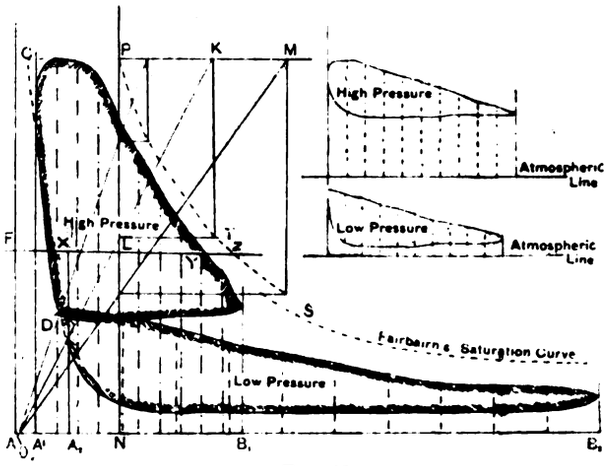

FIG. 11.

of describing a rectangular hyperbola through a given point, P, with a given centre, O, is shown in Fig. 11. Through P draw a horizontal, P M, and a vertical, P N. From O draw radial lines, such as O L K, cutting P N in L and P M in K. Through L draw a horizontal cutting the vertical through K in T, then T is a point on the required curve. Repeat this process to obtain other points. From a knowledge of the steam consumption of the engine the weight of steam used per stroke can be found, and by reference to the steam tables the volumes corresponding to this weight of steam at pressures somewhere near the initial pressures in each cylinder may be found. Then from C set off C P equal to the volume of the given weight of steam at a pressure A C, and from D set off D S equal to the volume of the same weight of steam at a pressure A D. Through each of these points a saturation curve must be drawn, which for rough purposes may be a rectangular hyperbola centre, O. But for greater accuracy the curves

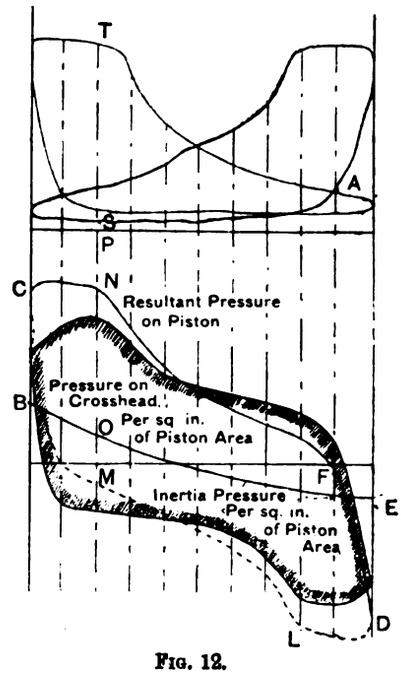

FIG. 12.

should be plotted to Fairbairn's equation—viz., $(p + {\cdot}35)(V - {\cdot}41) = 389$. To do this the origin is merely shifted ·35lb. below the old origin and ·41 cubic feet to the right, and a hyperbola drawn in the usual way. It will be noticed that there is a separate saturation curve for each cylinder of a compound engine. This is due to the fact that the ratio of the clearance volume to the volume swept out by the piston is in general different for the two cylinders. Draw any line, F X Y Z, cutting both the compression and expansion curves, then F × equals the

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volume of cushion steam, X Y the volume of steam in the cylinder, and if P T Z is a saturation curve, Y Z must represent the volume of water stuff existing as water. Hence, assuming the cushion steam is dry, which is very nearly the case, the dryness fraction F Y/F Z. This quantity may be ascertained for other points in the stroke by measuring similar intercepts.

CURVE OF RESULTANT PRESSURE ON THE PISTON.

The actual indicator diagram does very little more than show the varying change in the pressure and volume of the steam on either side of the piston. The actual pressures tending to move the piston are not shown, at least not without a small alteration, and, further, what is more important, the actual forces on the cross-head are considerably different. The difference arises from the additions and deductions which are required to stop and start the reciprocating parts at the end and beginning of the stroke. At any point P in the stroke the forward pressure is represented by P T (ordinate of one diagram) (Fig. 12), and the back pressure by P S (ordinate of the other diagram). Hence the effective pressure on the piston is the difference between these two and equals P T − P S = T S. At the point A the back pressure is equal to the forward pressure, hence the effective pressure is zero. Therefore, if we plot values of T S as M N (Fig. 12), the outline of this curve will cut the base line at F, and for the remainder of the stroke the resultant pressure will be negative. If the return stroke is treated in the same way, the dotted outline will be obtained; the area included between these two curves represents the net work done on the cross-head during two strokes.

CORRECTION OF THE INDICATOR DIAGRAM FOR INERTIA.

To correct for the inertia of the reciprocating parts, we must first find a curve showing the acceleration of these

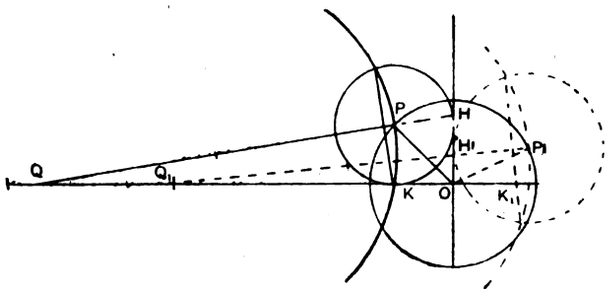

FIG. 13.

parts at different points of the stroke. This is easily performed by the graphical method shown in Fig. 13. PP_1 is the crank pin circle to some scale, preferably the same scale as the base of the indicator diagram; O P is one position of the crank and P Q the corresponding position of the connecting rod. Produce the connecting rod to cut the vertical centre line in H, with P as centre and P H as radius, describe a circle. On P Q as diameter describe a circle and join the points of intersection of these circles, and produce the line to cut the horizontal centre line in K. Then the acceleration, a, at the point, P, $= K O \times a^2$, where a = the angular velocity of the crank $= \frac{2\pi}{60} \times$ revolutions per minute. But the inertia force is proportional to the acceleration, and hence the total inertia pressure $= \frac{W \times a}{g}$, where W = weight of reciprocating parts $= \frac{W \times K O \times a^2}{g}$ lbs., and the pressure per square inch of piston area $= \frac{W \times K O \times a^2}{g \times A} =$ constant $\times$ K O. Find the value of K O for several crank positions, and plot the quantity (constant $\times$ K O) at corresponding points in the resultant pressure diagram, as at M O (Fig. 12). If the engine is a vertical one, the inertia curve must be shifted vertically an amount equal to the weight of the reciprocating parts divided by the area of the piston; then ordinates of the curve B C N D E give the forward pressure, and ordinates of the curve B E D L C the backward pull on the cross-head. These ordinates have been replotted and the shaded curve obtained.

MECHANICAL DRAUGHT FOR BOILERS.*

BY WALTER YATES, M.I.MECH.E, SWINTON.

Perhaps by way of introduction to the subject of producing boiler draught by mechanical means, a few remarks on the combustion of fuel may not be out of place. Carbon is, of course, the principal ingredient in any fuel we desire to use for steam-raising purposes, and it is because carbon is such a large constituent of coal that this material is used almost exclusively for this purpose. Without going in detail into the chemical processes of combustion, it is perhaps sufficient to say that the three elements it is desired to combine are carbon, hydrogen, and oxygen. An evidence that combustion is complete is when it is found that the carbon leaves the hydrogen with which it has been associated, and unites with the oxygen to form carbonic acid. The liberated hydrogen also unites with the oxygen, and forms water; this is usually maintained in its gaseous condition. If upon dissociation a portion of the carbon which is liberated in incandescent particles does not immediately meet with its complement of oxygen, it is liable to become cooled to such an extent by the surrounding gases, that when it reaches an abundance of oxygen its temperature will be too low to permit of chemical union It will therefore pass off as unconsumed and visible carbon in the form of smoke.

For the complete combustion of 1lb. of carbon there are required 2⅔lb. of oxygen. Air consists by weight of 0·236 parts oxygen, therefore the amount of air required for the combustion of 1lb. of carbon must be 11·3lb. It is, however, unnecessary for practical purposes to estimate to a nicety the weight of air necessary for the combustion of fuel, for the variableness in the combustion renders all ordinary calculations approximate only. It is, therefore, the common practice to estimate the amount chemically required for coal at 12lb., or, say, 150 cubic feet per pound of fuel. It is found, however, in practice that the chemical requirement is very much below that actually needed for complete combustion, due to causes which it is unnecessary to enter into here, and it is customary to provide for double this quantity, or 24lb. of air per pound of fuel where natural draught is to be used with hand firing. With mechanical draught, however, this excess of air over the chemical requirement is much reduced, becoming about 18lb. of air per pound of coal. An insufficient supply of air causes imperfect combustion of the fuel, indicated by the production of smoke. An excess of air causes waste of heat. The maximum efficiency is, therefore, to be secured between these two extremes.

Before proceeding to the consideration of mechanical draught, it may also be desirable to refer to a few points in natural draught. Natural draught is that produced by a chimney. The only openings to a chimney should be at either end of it, the top allowing the hot gases to escape, and the bottom, represented by the boiler, allowing the cold atmosphere to flow in. Under these conditions the inflow would continue till the internal walls of the chimney fell to the temperature of the external, when the flow would cease, and commence flowing upwards or downwards as the temperature rose or fell. This explains the bad effect on draught of a leaky chimney. This leakage of air through a chimney or boiler setting has a very serious influence on the draught, and is often accountable for a very greatly decreased efficiency; not only is this the case with faulty brickwork, but it takes place where the mortar joints are apparently sound. The effect is, of course, to increase the volume of air to be handled and decrease the temperature, resulting in a reduction of the draught in the chimney. Chemical analysis of the gases taken from the back of a boiler, and again at the base of the chimney, have frequently shown a great increase of free oxygen in the latter position over that found in the former.

If the temperature of the chimney falls below that of the atmosphere there is a down draught, a good example of which is a fire being lighted in a damp or cold room in a house. Draught, then, is caused by the superior weight of a column of cold air over the weight of a similar column of equal height of the hot air enclosed in the chimney. Thus

*Paper read at Liverpool before the Institution of Heating and Ventilating Engineers.

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the inflowing air is heated and the chimney kept warm by arranging that all inflowing air must pass through the furnace, and so cause the combustion of coal or other fuel, producing enough heat to use most of it to raise steam, and leaving enough to produce the requisite draught. A chimney with natural draught will have a draught dependent upon its height, the power of which will not vary except upon the rise or fall of the internal temperature. It has, therefore, no sucking power—in fact, the term suction in this connection is a fallacy. The chimney acts because the external air is heavier than the internal, and thus presses into the chimney by the only available opening—viz., that at the bottom—the furnace front. The pressure or intensity of the draught fixes the amount of fuel it is possible to burn on a given area of grate. It, therefore, becomes necessary, when it is desired to increase the steaming capacity of a boiler by increasing its coal consumption, to increase the intensity of the draught, and the only way in chimney draught is to increase the temperature of the gases passing up it, or increase the height of the chimney. The first method, of course, means a large amount of waste, and is a very uneconomical arrangement; the second is expensive and unusual. A chimney stack 150ft. high will burn from 15lb. to 20lb. of coal per square foot of grate area per hour under normal conditions, but in wet or foggy weather it will be very much less than this, as the wet air is lighter than the dry, and thus produces less pressure at the furnace (the weight of water vapour is about half that of air).

A fair average of temperature in the furnace is 2,400deg. F., and that of the escaping gases at the chimney without economisers, 600deg. F. This means that one quarter of the total heat generated is sent up the chimney to waste. Thus, on a 2,000-h.p plant, almost 500 h.p. is going up the chimney per hour, and the coal bill necessary to sustain this will come to a big figure in the year. Suppose we could reduce the amount of air accompanying each pound of coal from, say, 24lb. to 12lb. (the chemical requirement), and the temperature kept the same, then we would only send one-eighth of the total power up the chimney, and save one-eighth of the coal bill at the same time. The temperature in the furnace would then be greater, the heat generated greater, and, of course, the temperature of the gases at chimney less. The effect of the draught and the air supply to boilers having been demonstrated to be of such importance, we are brought now to the consideration of the best means of producing the requisite draught, and it is not only the author's contention, but it has become a well-ascertained fact that it is cheaper and better in every way to provide the necessary supply of air for burning fuel in steam-boilers by mechanical means, and to take as much heat out of the hot gases after they have ceased to be in contact with the boiler itself before they are turned out into the atmosphere, than to do it in the older way by utilising a portion of the heat generated to create the necessary supply of air. This is the primary reason for using a mechanical means of moving the air. The heat previously necessary to create the draught by means of a chimney, may now be employed usefully in other directions.

There are several forms of mechanical draught, and perhaps the first step in that direction is the use of steam-jets. These are certainly the most expensive means on an ordinary land installation of Lancashire, Cornish, or water-tube boilers. They may be applied at the fire or in the chimney, as in the case of a locomotive boiler. In the latter case the exhaust steam from the engine is used, and excellent results are obtained. But it is with fan draught that this paper is intended more particularly to deal. Fan draught may be divided into two distinct classes—viz., forced and induced. Forced draught may again be subdivided into two methods—viz., first, closed stokehold; and, second, closed ashpit. The first, or closed, stokehold method is almost exclusively used for shipwork. Here it is possible to entirely close up the stokehold and drive air by means of a fan into it, raising the pressure as shown on an ordinary U-tube water-gauge to about 2in. The only outlet for the air is through the furnaces, and where this method can be adopted it is undoubtedly the best, as a minimum of fan power is required, due to cold air only having to be handled. (It must be remembered that the hot gases leaving a boiler are practically double the volume of the air entering the furnaces, due to expansion from rise of temperature.) The air passes both through the fire from the ashpit and over the fire through the fire-door, the latter assisting largely in preventing smoke.

For land work or stationary boilers, however, this method can scarcely ever be adopted, and if a forced-draught system is desired, the closed ashpit must be resorted to. Here, again, a minimum fan power is required, as cold air is being handled, but there are several disadvantages which, in the author's opinion, far outweigh any saving which might be effected by using the smaller fan, as, for instance: (1) Initial cost of furnace fronts is very high, say £16 per

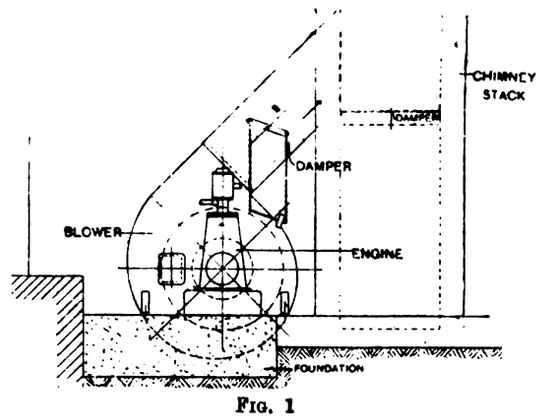

FIG. 1

furnace, and these are frequently needing repair. (2) Fires do not burn so evenly. (3) The air supply must be shut off before the fire-door is opened, or the stoker would run grave risk of being burned through the pressure forcing the heat and flames outwards. (Automatic appliances have been tried, but are not always a success.) (4) The pipes conveying the air to the furnaces are very much in the way, and are usually very unsightly.

In the author's opinion, by far the best method of obtaining draught by mechanical means is the induced-draught system, wherein the fan is placed between the boilers and chimney, or point of discharge of waste products into atmosphere. By such an arrangement the coal consumption may be increased from the 15lb. to 20lb. per square foot of grate in chimney draught to 30lb. to 40lb. per foot

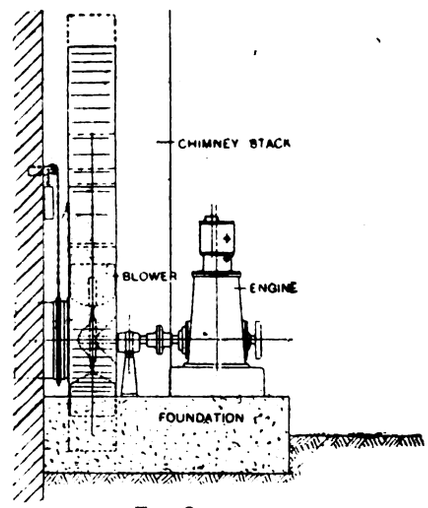

FIG. 2.

under ordinary conditions, and beyond this amount under special circumstances. This results not only in a proportionate increase of steaming capacity in the boilers, but in greater efficiency of combustion, and consequent economy. Most steam-boiler plants nowadays are provided with economisers of the Green's, Lowcock's, or similar type. Where such is the case, an opening is made in the flue between the economisers and chimney, and the fan inlet connected thereto by a short brick or metal flue. Another opening is made in the main flue at a point nearer the chimney, or into the chimney itself, and this opening is connected to the fan outlet in the same way as to the inlet.

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Between the openings and inside the main flue is placed a damper, so that all gases, after leaving the boilers, must of necessity pass through the fan on their way to the chimney, so long as the aforementioned damper is closed. It is also customary to place dampers both at the inlet and outlet of the fan, so that, by manipulating these two and the one in the main flue, the fan may be cut out, and natural draught resorted to in case of necessity. The same arrangement applies where no economisers are installed, and in such cases the fan handles the gases at the high temperature at which they leave the boilers. Of course, in either case special arrangements must be made in order to keep the bearings cool, either by water-jacketed bearings or an arrangement of air cooling.

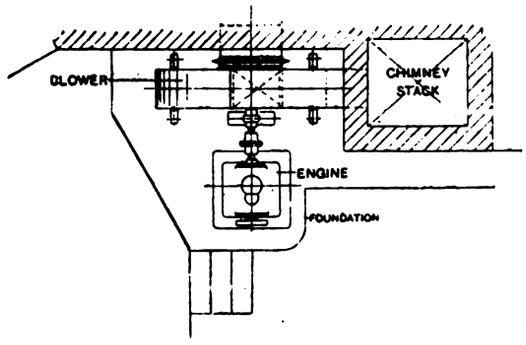

FIG. 3.

Fig. 1, 2, and 3 show respectively front and side elevations, plan, and general arrangement of a cyclone induced-draught plant, such as described and installed by the author's firm in the Manchester district. This is a small installation for two boilers only, as will be seen from the general arrangement (Fig. 4). In this arrangement the main flue was tapped and a connection made to the fan inlet, the fan outlet being connected direct to the chimney as shown clearly in Fig. 1. Instead, however, of putting a damper in the main flue, it was more convenient to place it in the chimney, as shown in Fig. 1, the effect, of course, being the same. The fan in this case is driven by a direct-connected enclosed-type steam-engine, the combination running at about 600 revolutions per minute. The plant was put in for two reasons. In the first place, great difficulty was experienced in keeping steam, and in the second place, the hard firing necessary in the effort to do this naturally resulted in volumes of dense smoke being emitted from the

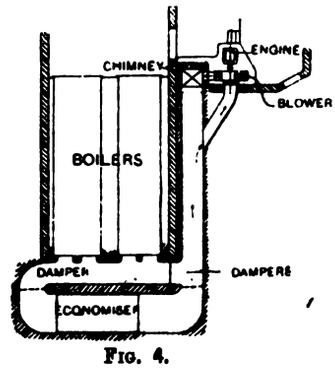

FIG. 4.

chimney stack, for which the firm were prosecuted more than once. The fan enables steam to be kept with ease and has entirely cured the smoke nuisance; only a light smoke can be seen being emitted from the chimney.

Another installation is illustrated by Figs. 5 and 6, which show elevation and plan respectively. In this instance the fan inlet is placed close against the main flue, and again the outlet or delivery is through a connection into the chimney. It will be noticed that the fan shaft goes right through the flue to a bearing on the opposite side. This was necessary as the fan is a large one, and an overhung wheel was not desirable. It is interesting to note the results accruing from this installation. One boiler after another had been added to those put down when the works and chimney were built. As a natural consequence the draught had become totally inadequate, resulting in insufficient steam, and smoke trouble. A new chimney was contemplated, but the proprietors were persuaded to try a fan first. The net results after 12 months' trial were: (1) an ample supply of steam under all atmospheric conditions; (2) a discontinuance of the smoke nuisance; (3) retention of the old chimney, thus saving the cost of a new one; and (4) a saving of exactly 25 per cent. of the year's coal bill, through being enabled to burn an inferior quality of coal. It is, perhaps, worth while to note this saving more than paid for the induced-draught plant in the first year's run.

Still another arrangement is shown by Figs. 7 and 8. This is very similar to the last, the principal difference being in the method of driving. Being a town electric lighting station, the authorities preferred to drive by motor and belt. The very satisfactory results secured by a system

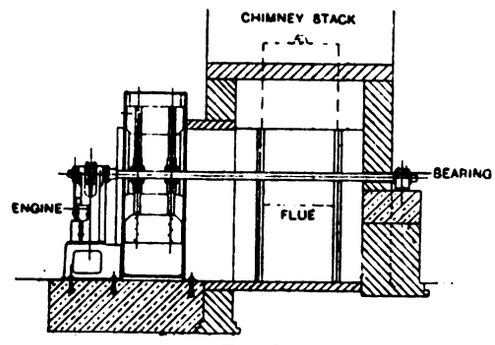

FIG. 5.

of induced draught are due to a less volume of air being required, though at a higher pressure than with chimney draught. A chimney easily works at a vacuum of ½in. to ¾in., while an induced fan is generally arranged to give 1½in. to 2in. In consequence of this, thicker fires can be carried and higher temperatures maintained, resulting in more rapid conduction of heat through the heating surface, and, therefore, a greater economy of heat than with chimney draught. This higher temperature of combustion, and consequent increase of evaporating power of the boilers, is such that usually three boilers with induced draught will do the work of four with chimney or natural draught. Occasionally better results even than these have been secured. One advantage of induced over forced draught is that a better and more even distribution of air is obtained.

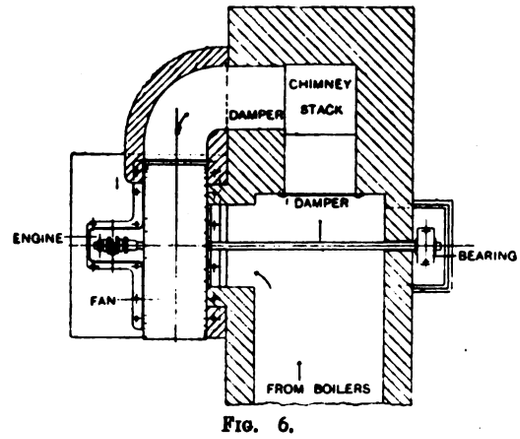

FIG. 6.

One of the best arguments in favour of induced draught is that by it the pressure may be kept practically constant, and consequently the temperature, so that the boiler shell and furnaces do not contract and expand to the same extent, thus saving large sums of money in repair bills for leaky joints and rivets. It is not always possible to keep boilers idle when an induced-draught system is introduced to an existing plant as where one or two boilers may be installed. In such a case an alternative is to reduce the length of the firebars, and by keeping thicker fires to secure the beneficial results already described. One of the most valuable features of an induced-draught apparatus is that it enables the high temperature upon which a chimney depends for its results to be dispensed with. In fact, the more heat abstracted from the gases by economisers and such like apparatus for heating water, air, etc., the better it is for the fan.

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These are days when profits are made—or, at all events, augmented—by economies at all points, and insufficient attention has been paid in many installations to the possibilities in this direction. Not only may the boiler feed water be heated by economisers, but in works where quantities of hot water are required for manufacturing purposes, such may also be obtained in the same way. And again, in manufacturing establishments, laundries, etc., where hot air is required for drying or similar purposes, this also may be obtained by economiser pipes, just as hot water is. An induced-draught fan renders the plant it is working with quite independent of climatic conditions. A chimney that will just do its work on a clear

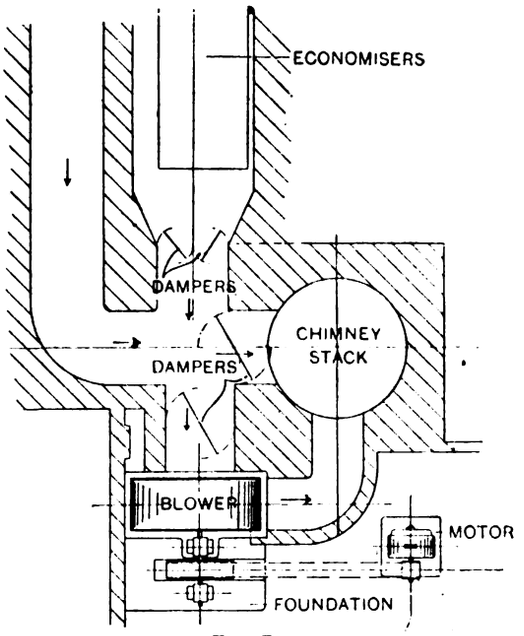

FIG. 7.

cold day may give considerable trouble in damp or foggy weather, but a fan is always positive and alike. It is also more flexible and under control, rendering it capable of answering to sudden calls. In the case of an electric light station, for instance, if a heavy fog comes on there is a big rush for current, and consequent heavy demand on the boilers. If chimney draught has to be depended upon, it will be at its worst under such conditions, but a fan would not be affected by the fog, and would answer at once to the demand made upon it. Again, in consequence of the intensity of fan draught, it is possible where such sudden demands for steam are likely to be made to keep fires banked up and dampered down, and then, when required, to have them in full blast in a few seconds. Another minor

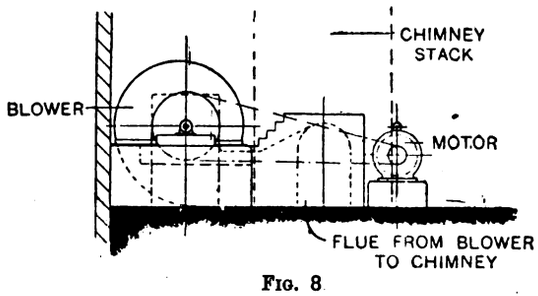

FIG. 8.

advantage in an induced-draught apparatus, especially where a steam-engine is the motive power, is that of automatic control. A very simple device can be arranged so that as steam falls below a given fixed pressure, the speed of the fan is automatically increased and *vice versâ*. Fan draught is a great aid to mechanical stokers—in fact, some forms of stoker cannot be worked without, but depend on the fan for their usefulness.

Reference has already been made to the economy secured by burning cheaper fuel. It is not fully recognised that the calorific value of coal is not at all in proportion to its cost. The lower grades of coal have a calorific valve not a great deal less than the higher-priced qualities. The difficulty with chimney draught is to burn them and thus extract their value. But with fan draught this difficulty is overcome, as, by its aid what has hitherto been termed absolute rubbish and useless can be burned and made to yield its heat units for a useful purpose. Mention has also been made of the value of an induced-draught fan as a smoke preventer. Public authorities are daily increasing their vigilance, and woe betide the firm that belches its black smoke into the atmosphere, polluting all the surroundings. But this is not all. This black smoke, as pointed out earlier in the paper, is unconsumed carbon, and, therefore, waste. So on all accounts it is desirable to stop it. A properly designed and arranged induced-draught plant will accomplish this, as already stated, by increasing the temperature of combustion, and thus make the boiler consume its own smoke, or, to put it another way, by enabling the proper chemical changes to take place in the furnace to obtain immunity from smoke trouble.

A very important point not yet touched upon, and particularly applicable to buildings projected, is the question of the chimney in relation to induced draught. A stack higher than that necessary to carry the gases above the surrounding property, say about 50ft. high, is useless when an induced-draught fan is at work. It, therefore, pays to consider the question of fan *versus* chimney in the matter of first cost, and also as to economy of space. To take a recent installation as an illustration. There are five boilers, with a combined grate area of 190 square feet, and working at a steam pressure of 160lb. The chimney is 120ft. high. It was desired to burn 170 tons of coal per week of 56 working hours, say 31lb. coal per square foot of grate, besides night consumption. One boiler was always idle for cleaning purposes, reducing active grate area to 152 square feet. It was found quite impossible by natural draught to consume the quantity desired, and in making the effort dense volumes of smoke were turned into the atmosphere. For this plant a No. 11 cyclone induced-draught fan was installed, running at 400 revolutions per minute, and capable of handling all the gases from the five boilers, if necessary, at a water pressure of 1·7in, and absorbing 20 b.h.p. The results far exceeded the proprietor's expectations. Instead of volumes of dense black smoke previously turned into the atmosphere, nothing but a thin grey vapour now issues from the chimney top. Two boilers now stand idle, although the 170 tons is easily being burned at the rate of 42lb. per square foot of grate, and more water is evaporated with the three at work than previously obtained with the four. The quality of the coal used has been reduced to one at about 25 per cent. less cost. Suppose this firm had decided to adopt mechanical draught instead of chimney draught in the first instance, the cost would have been about 20 per cent. of that paid for the plant with natural draught. Seeing that the power required to drive an induced-draught fan is only about 1 per cent. of the power of the plant it operates, the cost is of little consequence.

In addition, then, to the many advantages other than financial to be derived from an induced-draught apparatus over chimney draught, there are two outstanding economical features—viz., much reduced first cost, and reduced cost of fuel. In conclusion, I desire to acknowledge my indebtedness to Mr. Snow for some extracts culled from his treatise on "Mechanical Draught," and to the members of our engineering staff for their assistance in the preparation of this paper, which, I trust, may be of some assistance to the members of the institution.

Appended are the results obtained in regard to Lancashire boilers 30ft. × 8ft × 160lb. working pressure under test at Messrs. W. and J. Whitehead's, Laisterdyke, Yorkshire, with induced and natural draught. The boilers were fitted with Proctor's mechanical stokers.

These tests were conducted on behalf of Messrs. Matthews and Yates, Limited. It will be seen that the firms concerned have cause for congratulation on the results of the induced-draught plant, as two boilers are now doing the work that formerly took three, evaporating more water per hour per pound of coal fired and, of course, per square foot of fire grate per hour. The temperature of the feed water was raised 184·4deg. in the economiser as against 137deg. by natural draught, and the temperature of the waste gases was lowered by 172·6deg. as against

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115deg. by natural draught, thus utilising more of the available heat. The nuisance resulting from dense volumes of smoke being emitted from the chimney, in the forcing of the boilers, and hard firing necessary under natural draught, was entirely cured, only a light smoke being visible at the chimney top. It may be noted that the test was made with coal of exactly the same quality, although the coal formerly used was 3s. per ton dearer than that tested, the saving in the coal bill on a weekly consumption of 170 tons being about £25. 10s., or about 25 per cent. on an average, easily. The difference in the weight of ash and clinker is worthy of notice, and it should be mentioned that in the induced-draught test the fan was working three boilers, although only two were being tested. This was owing to the fact that the third boiler was being used for heating purposes, and working at 80lb., and was not fed with the same water as the boilers for running the main engines.

	Induced draught.	Natural draught.
Duration of trial	3½ hours	3½ hours
Size of boilers	30ft. × 8ft. × 160lb. W.P.	
Number of boilers	2	3
Total grate area	72·4 sq. ft.	110 sq. ft.
Mean working pressure	159lb.	157lb.
Kind of fuel used	Rough slack at 7s. 6d. per ton	same
Total weight of fuel used	9,387lb.	9,204lb.
Fuel used per hour	2,682lb.	2,629lb.
,, ,, ,, square foot of grate per hour	37lb.	23·9lb.
Total weight of ash and clinker	560lb.	708lb.
Percentage of ash and clinker	5·96 %	7·6 %
Dry fuel used	8,799lb.	8,629lb.
,, ,, per hour	2,514lb.	2,465lb.
,, ,, per square foot of grate per hour	34·7lb.	22·4lb.
Percentage of ash and clinker per pound of dry fuel	6·3 %	8·2%
Av. temp. of feed water entering economisers	104deg. F.	110deg. F.
,, ,, leaving ,,	288·4deg. F.	247deg. F.
,, gases entering ,,	559·3deg. F.	467deg. F.
,, ,, leaving ,,	383·1deg. F.	352deg. F.
,, ,, entering fan	378deg. F.	—
,, superheated steam	540deg. F.	530deg. F.
Total amount of feed water supplied	76,320lb.	71,546lb.
,, ,, evap. per hour	21,805lb.	20,441lb.
,, ,, ,, per lb. fuel fired	8·11b.	7·7lb.
Equivalent evaporation from and at 212deg. F.	9·11b.	8 6lb.
Water evaporated per hour per lb. dry fuel	8·6lb.	8·2lb.
Average output of fan in cub. ft. per minute	30,000	—
Horse-power required to drive fan	15	—
Average revolutions of fan	347	—
Class and number of fan, cyclone induced draught, No. 11.		
Note.—This fan was working three boilers, although only two were tested for evaporation, etc. See previous note.		
Average draught of fan suction	1½in.	—
,, pressure of air in furnaces	½in.	½in.
I.H.P. of Corliss engine driven by boilers	1,420	1,420
Fuel used per I.H.P. per hour	1·8lb.	1·8lb.

LEGAL INTELLIGENCE.

PROMOTION OF THE GENEVA TRAMWAYS.

The action brought by Chaplin, Milne, Grenfell, and Co., Limited, against L. Hirsch and Co., Limited, in which the plaintiffs, pleading misrepresentation, claimed rescission of an underwriting contract in connection with the promotion of La Compagnie Genevoise des Tramways Electriques, and also the repayment with interest of £250,000 subscribed by the plaintiffs, occupied Mr. Justice Warrington some days. The defendants denied misrepresentation.

Mr. Levett, K.C., Mr. Astbury, K.C., and Mr. D. Pollock (instructed by Messrs. Bompas, Bischoff, and Co., of 4, Great Winchester-street, E.C.) appeared for the plaintiffs; and Mr. Rufus Isaacs, K.C., Mr. Ralph Neville, K.C., Mr. Martelli, and Mr. H. Goldberg (instructed by Messrs. Goldberg, Barrett, and Newall, of 2, West-street, Finsbury, E.C.) represented the defendants.

On behalf of the plaintiffs it was stated that they were induced to enter into the contract on the strength of a circular letter they received from the defendants in November, 1900, which, they alleged, misrepresented the earnings of the old company. It was also alleged that statements made by Mr. Neumann, a member of the defendant firm, as to the position of the tramways company were misrepresentations.

Evidence was given on behalf of the plaintiffs by Mr. A. M. Grenfell, Mr. G. D. Milne, Mr. Ernest Chaplin (directors of the plaintiff company), and other witnesses. In the course of his evidence **Mr. A. M. Grenfell** denied that it was a subject of common conversation that the earnings were insufficient to pay the debenture interest in July, 1901.

For the defence, **Mr. Ludwig Neumann** denied all misrepresentation, and stated that the basis of the contract was a favourable report on the undertaking by Mr. Field, a tramway expert.

His Lordship, delivering judgment on Tuesday, observed that though the plaintiffs' claim was based on alleged misrepresentations, they stated emphatically that those misrepresentations were not fraudulent, that they were innocently made, but that, though innocently made, were sufficient ground for the rescission of the contract said to have been induced by them. In the first instance, when the action was started on May 12, 1903, and the statement of claim delivered in June, 1903, the only representations complained of were contained in the letter of Nov. 16, 1900, and it was not until a year later, in May, 1904, that the statement of claim was amended. In that amended claim there were inserted allegations that the defendants, by one of their partners, Mr. Ludwig Neumann, had made certain parole misrepresentations as to the earnings of certain tramways, and plaintiffs then, for the first time, added that claim founded on parole misrepresentation to the case previously made. The case was more remarkable from the fact that as it developed it turned out that that representation was in reality that on which plaintiffs' claim was based, and the only real question that he had to determine was whether the parole representation was in fact made. It was obvious that at the time of the interviews between Mr. Neumann and the plaintiffs it was well known that the earnings of the tramways were wholly insufficient to pay the £38,500 required for debenture interest. It was said that at these interviews Mr. Neumann told the gentlemen there assembled that the net earnings of the three undertakings then in operation (two other lines having been amalgamated with the original concession) were sufficient to provide the £38,500, and plaintiffs said that statement was the determining factor in their minds, and that, unless they had been assured that the existing undertakings were earning enough to pay interest on the debentures, leaving the profits expected to be realised by the electrification of the system to go to paying dividends on the shares, they would not have gone into it at all. Nothing was settled at the first meeting, and at the second meeting Mr. Bousquet, who had been in Geneva, attended with Mr. Neumann. It was said that Bousquet repeated the statements as to the debenture interest; but the plaintiffs' witnesses all seemed to have a different impression as to what Bousquet said. At the third meeting Mr. Burns (of J. S. Morgan and Co.) attended, and he also said that Mr. Neumann stated to him that the earnings were sufficient to pay interest on the debentures. His evidence was confirmed by other witnesses. As a consequence of that interview, plaintiffs determined to go into the transaction, and on Dec. 18 Messrs. Hirsch wrote a letter which purported to record the effect of the negotiations and the contract into which plaintiffs desired to enter. The tramways were worked, but suffered from various untowards circumstances, with the result that the debenture interest was not earned, and no issue was made to the public, the underwriters taking up the debentures. During 1901 the weekly returns of the tramways were sent to plaintiffs, and in the middle of 1901 a balance-sheet for 1900 was sent to them. Mr. Arthur Grenfell admitted seeing these, and also tabular statements comparing the weekly receipts for 1900 and 1901. If he had examined the returns, even in the most cursory manner, he must have seen that the net earnings for 1900 could not have been anything like £38,500. He said he trusted to Mr. Neumann's word, and did not look at the returns to see if Neumann's statement was true. It was very difficult to understand that. The statement that had been made was, according to him, the very basis of the transaction. On March 23, 1903, the plaintiffs wrote to the defendants complaining that the representations made to them were untrue; but it was not until April, 1904, that plaintiffs gave notice that they intended to rely on the alleged statement of Mr. Neumann as to the earnings in 1900 being sufficient to pay interest on £850,000 debentures. That was the most serious matter of all, because if it were true that the statement was made, it was not disputed that it was untrue. More than that, it would be absurdly untrue. He had seen Mr. Neumann in the witness-box and watched him carefully, and he had not the least hesitation in saying that not only he, but every person in court, must have been convinced that he was telling the truth, and not only telling the truth, but that he was a man who would be incapable of making a fraudulent statement such as that which, in reality, although not in terms, he was accused of making. He therefore found as a fact, on the consideration of the evidence that had been adduced, that Mr. Neumann did not make the statement which he was alleged to have made. The witnesses for the plaintiffs must have given their evidence under some misapprehension.

Judgment for the defendants, with costs.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The petition of the company was heard by Justice Buckley for the reduction of its capital by writing off £58,910.

Mr. Macnaghten, K.C., explained that the company was formed in 1885, and since 1901 no dividends had been paid, and large sums had had to be written off the capital in consequence of losses. The business was that of manufacturers of lamps and appliances for the purposes of electric lighting, and in regard to which three valuable master patents had now expired.

His Lordship sanctioned the reduction, and directed its advertisement for three months.

COMPANIES' MEETINGS AND REPORTS

DIRECT UNITED STATES CABLE.

The ordinary general meeting of the Direct United States Cable Company was held at Winchester House on Tuesday under the presidency of Mr. E. M. Underdown, K.C.

The **Chairman** stated that the revenue for the six months to June 30,

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after deducting disbursements, amounted to £43,121, while the working and other expenses, including income tax, but exclusive of the cost of cable repairs, absorbed £21,185, leaving a balance of £21,936 as net profit, making, with the amount brought forward from the previous half-year, £2,479, and, with £1,966 compensation received on surrender of the lease of premises at New York, a total of £26,381. The whole result of the financial year's working was as follows: receipts, £92,902, less expenses and other ordinary payments, £43,002; £36,426 had been paid in dividends and £14,000 had been placed to reserve. The cables were in very good condition and working entirely satisfactorily. He concluded by proposing the adoption of the report and accounts and the payment of a final dividend of 3s. a share, free of income tax, making, with the interim dividends already paid, a total distribution of 3 per cent. for the year ended the 30th ult.

Sir James Pender, Bart., seconded the resolution, which was carried unanimously.

NATIONAL TELEPHONE.

The general meeting of the National Telephone Company, Limited, was held last Friday, Sir Henry Fowler, M.P., the chairman, presiding. Particulars of the report were published in our issue of the 15th inst.

The **Chairman** remarked that the half-year under review—*i.e.*, to June 30—had been a record one. There had been an increase of revenue of £90,016, and the working expenses had increased by £57,000. The net result, after taking off the Post Office royalties, amounting to £90,702, was a balance of £326,825 as compared with £303,000 in the corresponding half of last year, being an increase of net income of £23,668. About 9,200 new customers were added during the period, and 9,700 were now waiting to be put on, representing a new income of £53,000 a year. The messages sent last year were 938,000,000, a large increase, the average receipts for each message being less than ½d. He expressed the belief that the Postmaster-General would credit the directors with a desire to meet him in a fair spirit, and he hoped the negotiations for the taking over of the business would result in a satisfactory arrangement being arrived at.

The report was adopted.

EDMUNDSON'S ELECTRICITY.

The seventh ordinary general meeting of Edmundson's Electricity Corporation, Limited, was held on the 21st inst. at the Westminster Palace Hotel, Mr. Francis E. Gripper, M.I.E.E., chairman and managing director, presiding. Particulars of the report were given in our issue of the 15th inst.

The **Chairman** remarked that he was glad to be able to report continued satisfactory progress. Established seven years ago for the purpose of working a considerable number of electric lighting undertakings, the Company was now reaching the end of what might be termed the construction stage. Since the last meeting the Company had completed electric lighting works at Caterham, Glossop, Berwick, Ryde, Surbiton, Frome, and Dorking, and had completed and opened electric tramways at Glossop and Scarborough. At Newbury the lighting works were almost completed, and would be opened in a few weeks. Good progress had been made in connection with the Lancashire electric power station, which would probably be opened early next year. With the exception of two towns, the Company would then have the whole of their works opened and running. The two exceptions were Ramsgate and Inverness, for which, after many attempts, the Company had recently obtained the necessary parliamentary powers. It was not the intention of the directors to seek for further powers, except such as might be necessary for the Company's existing undertakings, as the Company would have ample scope in the development of the undertakings it was now interested in. The rapid expansion of the various undertakings is shown by the lamp connections, which during the year increased from 335,000 to 568,000, and have since increased by another 65,000 connected or applied for during the past three months. During the past year the issue of new capital had been necessarily heavy to meet the expenditure on the new works and the extensions required in the older works, and 20,000 preference shares, 20,000 ordinary shares, and £92,000 of debenture stock had been issued. The necessity for raising so much new capital at a time when market conditions were unfavourable for all issues had given the directors much cause for careful consideration, but the requisite capital had been obtained on reasonable terms. The Company's capital requirements for the future would be on a less extensive scale The chairman concluded by moving the adoption of the report and accounts.

Mr. W. R. Davies seconded the motion.

The resolution was carried unanimously.

On the motion of **Mr. Davies**, Mr. H. Wolfenden's election to a seat on the Board, through the resignation of Mr. J. R. Wigham on account of failing health, was confirmed.

Mr. W. R. Davies was re-elected a director of the Company, and a vote of thanks to the chairman and directors terminated the proceedings.

EASTERN TELEGRAPH.

The half-yearly meeting of this Company was held last week at River Plate House, London, Sir J. Wolfe Barry presiding. Particulars of the report appeared in our last issue.

The **Chairman** announced in the course of his address that the directors intended to utilise wireless telegraphy. Though they considered that wireless telegraphy would not compete with long-distance submarine telegraphy, the directors were of opinion that there were places where wireless telegraphy could be usefully employed. An example was afforded by the Azores, where the cables of some of the associated companies touched. It was desired by Portugal that some of the outlying islands should be placed in telegraphic communication. Owing to the nature of the bottom, and the landing place of these islands, it was not considered a suitable place to make the connection by cable, neither would the traffic warrant an expenditure on this account. They, therefore, intended to connect the points by a system of wireless telegraphy, to be worked in connection with their cable system.

The report and accounts were adopted.

CHILI TELEPHONE.

The fifteenth ordinary general meeting was held at Winchester House, Mr. George Keith presiding. Particulars of the report appeared in our issue of the 15th inst.

In the course of his remarks, the **Chairman** stated that during the year an additional circuit had been put up between Santiago and Valparaiso, and several provincial offices had been opened.

The report was adopted.

ANGLO-AMERICAN TELEGRAPH.

The report for the half-year ended June 30 last, to be presented at to-day's meeting, states that the total receipts, including the £1,128 brought forward, amounted to £165,614. The traffic receipts show a decrease of £13,280 compared with the half-year ended June, 1903. The total expenses, including the repair of cables, etc., amounted to £63,578, being a decrease of £2,314. The directors have, before declaring the net profits, set apart £12,000 to the renewal fund, leaving a balance of £90,035. Quarterly interim dividends of 12s. 6d. per cent. on the ordinary stock and of £1. 5s. per cent. on the preferred stock were paid on April 30, 1904, absorbing £43,750, and second quarterly interim dividends of 12s. 6d. per cent. on the ordinary stock and £1. 5s. per cent. on the preferred stock, amounting to £43,750, will be paid on July 30. The balance of £2,535 will be carried forward. A scheme of pensions for employés of the Company, in lieu of the present system of endowment assurance, has been prepared by the directors, and will be submitted to the stockholders for approval.

METROPOLITAN RAILWAY.

The report for the half-year ended June 30 states that the works required for the electrification of the line have proceeded rapidly during the past six months, and that in the course of a short time the testing of the machinery and plant under normal conditions of working will take place. Thirteen trains of new corridor cars have already been constructed and are being electrically equipped at Neasden. The rest of the rolling-stock necessary for the new system of working is in course of construction at Manchester and Birmingham. The Harrow and Uxbridge Railway was opened for public traffic on July 4, and is being worked by the Company under the statutory agreement. The directors recommend a dividend upon the ordinary stock at the rate of 3 per cent. per annum. A resolution will be submitted to a special meeting providing for the creation of the capital authorised by the Metropolitan Railway Act, 1904.

NEW COMPANIES REGISTERED.

Haste Pump Company, Limited.—Capital, £100,000. Objects: to adopt an agreement with F. C. Haste and C. W. Milne for, *inter alia*, the carrying on of the business of mechanical and electrical engineers, electroplaters, galvanisers, etc.

Public Undertakings, Limited.—Capital, £10,007. Objects: to acquire, *inter alia*, the benefits of and rights of the promoters under the Bishop Auckland, Shildon, and Spennymoor Tramways Order, 1904, to adopt an agreement with the United Kingdom Tramway, Light Railway, and Electric Syndicate, Limited, and to carry on the business of steam, electric, or horse tramway and railway proprietors and lessees, etc. Registered office: 28, Victoria-street, Westminster.

Davies, Kent, and Stewart, Limited.—Capital, £3,500. Objects: to acquire the business carried on as Davies, Kent, and Stewart, and to carry on the business of manufacturers of electrical accessories, flexible wire makers, electricians, suppliers of electricity, etc. No inital public issue. Registered without articles of association.

Electrical Bleaching Company (1904), Limited. — Capital, £75,000. Objects: to adopt five agreements, one with the Electrical Bleaching Company, Limited, three with C. E. W. Gaddum, and one with J. J. Graham, and to carry on the business of bleachers, dyers, electricians, electrical engineers, suppliers of electricity, etc. Registered office: 196, Deansgate, Manchester.

Liens Registered.

Blackheath and Greenwich District Electric Light Company, Limited.—Trust deed, dated June 3, 1904, to secure debenture stock to an amount not exceeding the paid-up share capital from time to time, and being supplemental to a deed of Aug. 3, 1900, securing £120,000 debenture stock, has been registered. The present deed is stamped to cover £30,000 (making a total of £150,000 covered by stamped duty). Property charged: the company's undertaking and property, present and future, including uncalled capital, and the undertaking of the Crystal Palace District Electric Supply Company Limited, which the company undertake to complete the purchase of. Trustees: H. R. Beeton, 18, Austin-friars, E.C., and W. R. Davies, 10, Moorgate-street, E.C.

Bath Electric Tramways, Limited.—A charge for a sum not exceeding £10,000 has been registered in favour of the Union of

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London and Smith's Bank, Limited, secured on certain undertakings authorised by various orders, land in Bath, and the property, assets, and effects, including the purchase money which may be realised by the sale of the undertakings and certain debenture stock.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Newcastle-upon-Tyne.—The Guardians invite tenders for the installation of the electric light in the hospital block at the workhouse. Specifications may be seen at the offices of Messrs. Newcombe and Newcombe, 89, Pilgrim-street, Newcastle-upon-Tyne. Tenders by 12 noon on Aug. 4.

Plymouth.—The Corporation invite tenders for (25) steam alternator, etc.; (26) Lancashire boilers, with mechanical stokers; steam, exhaust, and other piping; ejector, condenser, valves, etc. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by Aug. 15.

London, S.E.—The Bermondsey Borough Council invite tenders for the wiring of the staircases and courtyards of the Fulford-street dwellings. Specifications, etc., may be obtained from Mr. Fredk. Ryall, town clerk, Town Hall, Spa-road, S.E. Tenders to be delivered at the Town Clerk's Office by Aug. 8.

Hapton (Lancs.).—Tenders are invited for the street-lighting of the parish of Hapton for eight months, commencing Sept. 1 and ending April 30, 1905; also tenders for same period during years 1905, 1906, and 1907. Tenders to Mr. Ed. O'Shaughnessy, clerk to the Hapton Parish Council, 16, Hammond-terrace, Padiham, by July 30.

Leeds.—The Corporation invite tenders for the supply of two 1,000-kw. turbo-alternators, with condensers, exciters, and high and low tension switchgear for same. Forms of tender, etc., can be obtained from Mr. J. B. Hamilton, general manager, Standard-buildings, City-square, Leeds. Tenders to the Town Clerk by 10 a.m. on Aug. 15.

Dover.—The Corporation invite tenders for the supply and erection of one surface-condenser air-pump, two centrifugal pumps, and pipework, to heat 10,000lb. of steam per hour and to give a vacuum of not less than 28in. Specifications, etc., may be obtained on application to Mr. L. W. Woodman, borough electrical engineer, Park-street, Dover. Tenders by July 30.

Beverley.—The Visiting Committee invite tenders for various work in connection with the provision of new fire appliances at the asylum, including internal electric fire-alarm communications. Specifications, etc., may be obtained on and after 25th inst. at the office of Messrs. Maxted, Knott, and Coles, engineers, Burnett-avenue, High-street, Hull. Tenders by 12 noon on Aug. 10.

Penang.—The Municipal Council of George Town, Penang, invite tenders for the supply and delivery of tramcars, complete with motors, controllers, trolleys, etc. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by 12 noon on Aug. 24.

Perth.—The Corporation invite tenders for the construction and equipment of about 4¾ miles of route length of tramways, constructed as single line with passing places—viz.: (1) permanent way and paving, including copper bonding; (2) overhead equipment; (3) cables, ducts, etc.; (4) cars and equipments; (5) car depôt building. Specifications, etc., can be obtained from the Town Clerk. Tenders before noon on Aug. 16.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Manchester.—The Directors of the Manchester Dock and Warehouse Extension Company, Limited, invite tenders for the wiring (for power and light) and electric lighting of five transit sheds (now in course of erection) on the southerly side of dock No. 9, in the county borough of Salford. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Aug. 30.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

Reichenberg (Austria Hungary).—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

RESULTS OF TENDERS.

Exeter.—The Corporation have accepted the tender of Bruce Peebles and Co., Edinburgh, at £1,050, for the tramway generating plant.

London.—We learn that the order for the electric lighting of the new War Office has been awarded to F. A. Glover and Co., Limited.

Thorne (Yorks.).—The Parish Council have accepted the tender of the Thorne Gas Company, Thorne, at £112. 11s. 6d., for lighting the town.

Rochdale.—The Corporation have accepted the tender of W. A. Peter and Sons for the erection of increased building accommodation at the electricity works.

Radcliffe.—The Urban District Council have accepted the tender of Messrs. Etheridge and Clark, 10, Norfolk-street, Manchester, for the construction of the permanent way.

Radcliffe.—The District Council have accepted the tender of Etheridge and Clark, at £7,930. 6s. 11d., for the construction of the tramway track. The lowest tender was £7,910. 1s. 6d., and the highest £12,660. 0s. 5d.

Whitby.—The Urban District Council have received the following tenders for distributor and street-lighting cables:

Simplified Underground Conductor Company	£971
British Insulated and Helsby Cables	717
St. Helens Cable Company	702
Union Cable Company	689
Glover and Co.	689
Henley and Co.	678
Siemens Bros. and Co.	669
Western Electric Company	658
Callender's Cable Company (accepted)	648

For network and service boxes the tender of the Cable Accessories Company, amounting to £97 (the lowest received), was accepted.

London.—The Metropolitan Asylums Board have received the following tenders for an installation of fire-alarms at the Darenth Asylum:

P. Dewhirst, 24, Birley-street, Blackpool (accepted)	£320	5	0
Donnison, Sillem, and Co., 116, Great Portland-street, W.	400	0	0
Jackson Bros., The Broadway, Plaistow, E.	403	10	0
Electrical Engineering and Maintenance Company, 5, Eastcheap, E.C.	420	0	0
National Telephone Company, Limited, Salisbury House, London-wall, E.C.	440	10	0
Baxter and Impey, 54, Dudley-street, Birmingham	459	0	0
Lea, Son, and Co., Pengwerne Works, Shrewsbury	497	0	0
H. G. Rider and Co., 27, Chancery-lane, W.C.	500	0	0
Lever Bros. and Co., 101, Dawes-road, Fulham, S.W.	600	0	0
Mason, Cash, and Co., Woodville Electrical Works, Burton-on-Trent	672	0	0
Private Wire and Telephone Installation Company, Limited, 5, Palmer-street, Westminster, S.W.	797	10	0
Lawrences, Limited, 6, Spur-street, Leicester-square, W.C.	1,650	0	0

Engineer-in-chief's estimate, £380.

Greenwich.—The London County Council have received the following tenders for the supply, delivery, and erection of electric jib cranes and locomotives, and overhead travelling cranes and lifting apparatus required for the Greenwich electricity generating station:

Electric jib cranes and locomotives.

A. Barclay, Sons, and Co., Limited, Kilmarnock (incomplete)	£1,178	0	0
H. J. Coles, Derby (incomplete)	3,652	0	0
C. and A. Musker (1901), Limited, Liverpool	4,073	6	6
Ditto (alternative)	4,108	6	6
J. Hitchen and Son, Halifax	4,380	0	0
J. Booth and Bros., Limited, Rodley (incomplete)	4,924	5	0
T. Smith and Sons, Rodley, Leeds (incomplete)	5,173	0	0
Wimshurst, Hollick, and Co., Limited, Rochford, Essex	5,248	0	0
Cowans, Sheldon, and Co., Limited, Carlisle	5,264	17	0
J. Carrick and Sons, Limited, Edinburgh	5,334	0	0
Ransomes and Rapier, Limited, London	5,878	0	0
G. Russell and Co., Limited, Motherwell	5,619	7	0
Jessop and Appleby Bros., Leicester and London	6,628	0	0
Rushworth Bros., Colne, Lancs.	7,185	0	0

Overhead travelling cranes and lifting apparatus.

H. Morris and Bastert, Limited, Loughborough (incomplete)	£937	0	0
C. and A. Musker (1901), Limited	1,192	0	0
Cowans, Sheldon, and Co., Limited	1,541	2	0
J. Carrick and Sons, Limited	1,557	0	0
Carrick and Ritchie, Edinburgh	1,712	15	0
J. Booth and Bros., Limited	1,740	0	0
Jessop and Appleby Bros. (not to specification)	1,766	0	0
J. M. Henderson and Co., Aberdeen	2,025	0	0
Holt and Willetts, Cradley Heath (incomplete)	2,352	0	0
Wimshurst, Hollick, and Co., Limited	2,651	15	0

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London.—The Metropolitan Asylums Board have received the following tenders for the provision of internal telephones at the Eastern and Western Hospitals:

P. Dewhirst (accepted)	£359	10	0
Baxter and Impey	437	0	0
R. Weston, 100, Mortimer-road, Kingsland, N.	440	0	0
Donnison, Sillem, and Co.	450	0	0
British Home and Office Telephone Company, 49, Finsbury-pavement, E.C.	459	18	9
Electrical Engineering and Maintenance Company	494	0	0
National Telephone Company, Limited	506	0	0
Lea, Son, and Co.	521	0	0
Private Telephone Company, 27, Chancery-lane, W.C.	529	10	0
E. Probert and Co., 5, Bond-court, Walbrook, E.C.	579	15	0
Private Wire and Telephone Installation Company, Limited	609	19	6
Lawrences, Limited	655	10	0
Ward Bros., Bevois House, 28A, Basinghall-street, E.C.	740	0	0
G. and H. Turner, 11, High-street, Harlesden, N.W.	795	18	0
Jackson Bros	876	5	0
Mason, Cash, and Co.	996	0	0
C. Barrington, 51, High-street, Stoke Newington, N.	1,182	10	0
Lever Bros. and Co.	1,200	0	0

Engineer-in-chief's estimate, £580.

London, E.—The Stepney Borough Council have received the following tenders for an electric light installation at the public baths, Goulston-street:

Electric Motor Supply Company, Houndsgate, Nottingham (accepted)	£237	8	0
G. Weston and Sons, 153, Fenchurch-street, E.C.	305	0	0
A. H. Marshall and Co., 270, High-road, Leytonstone	324	0	0
E. Probert and Co., Walbrook, S.E.	337	11	0
Donnison, Sillem, and Co., 116, Great Portland-street, W.	350	0	0
Jackson Bros., Broadway, Plaistow	359	0	0
W. J. Fryer and Co., Sloane-square, S.W.	364	0	0
Eastlakes, Limited, 1, Carteret-street, Westminster	365	10	0
W. Holmes and Co., 8, Norfolk-terrace, Horsham	372	15	0
A. Sweet, 100, Hampstead-road, N.W.	375	0	0
Smeeton and Page, 63, Queen Victoria-street, E.C.	383	19	9
E. D. Pearcey, 10, Roscoe-street, Golden-lane, E.C.	386	0	0
T. Potter and Sons, 44, South Molton-street, Oxford-street, W.	393	0	0
Willey and Co., Exeter	395	15	0
Tamplin and Makovski, Limited, 15, James-street, Haymarket	399	0	0
J. Richmond and Co., Hatton-garden, W.C.	402	10	0
F. E. Emerson and Sons, 60, Burdett-road, E.	405	0	0
Russell and Co., 42, Berwick-street, W.	410	0	0
Lawrences, Limited, 6, Spur-street, Leicester-square, W.C.	420	0	0
Geipel and Lange, 72A, St. Thomas-street, S.E.	428	8	0
M. Wildhofft, 42, Upper-street, N.	441	10	0
Ward Bros., 28A, Basinghall-street, S.E.	447	3	0
Glover and Co., 10-12, Garrick-street, W.C.	470	0	0
C. Ross, Bridge-street, Walsall	475	10	0
Barlow Bros., 237, Shaftesbury-avenue, W.C.	493	0	0
J. Defries and Co., 1-6, Gravel-lane, E.C.	520	0	0
Waring and Withers, 10A, Soho-square, W.	556	16	0
J. T. Halsey, 24, Great Eastern-road, Stratford, E.	572	13	9
G. Cohen and Co., 522, Mile End-road, E.	606	7	6
Electrical Engineering and Maintenance Company, 5, Eastcheap, E.C.	669	0	0

BUSINESS NOTES.

LIGHTING AND GENERAL.

York.—The extensions of the electric lighting plant on Foss Island were formally opened on July 18.

Ravensthorpe—The District Council have decided to apply for a provisional order for electric lighting.

Leicestershire and Warwickshire Electric Power Bill.—This measure has received the Royal assent.

Metropolitan Electric Supply Co.—An interim dividend of 9s. is declared on the ordinary shares, being at the rate of 9 per cent. per annum.

Dunstable.—The Council have received notice from a supply company of their intention to apply for a provisional order for lighting within the area.

Westminster Electric Supply Co.—The directors have declared an interim dividend for the half-year ending June 30 at the rate of 13 per cent. per annum.

Wrexham.—The Local Government Board have sanctioned the borrowing of £5,600 for the purpose of extending the electric light works and cables of the Corporation.

Deptford.—The Borough Council have decided that no further action be taken with reference to the electric lighting and maintenance, at the public expense, of clocks in the borough.

Radstock.—The Western Electric Distributing Corporation have notified the Urban District Council of their intention of applying for a provisional order for lighting Radstock.

Nantwich.—The Urban Council have received notice from Mr. G. Vaughan Fowler announcing his intention to apply for a provisional order for the electric lighting of Nantwich.

Shardlow.—The Rural District Council have received notice of the application by T. Hooley, Limited, of Sandiacre, for a provisional order to set up electric lighting works in Sandiacre.

Cleethorpes.—The Urban District Council have resolved to apply to the Board of Trade for a further extension of one year in connection with the Council's electric lighting provisional order.

Southampton - Portsmouth.—The Postmaster-General hopes shortly to be able to proceed with the construction of an additional telephonic circuit between Southampton and Portsmouth.

Hampstead.—The Borough Council have approved the decision of the London County Council to apply to Parliament for powers to enable local authorities to wire and fit consumers' premises for lighting.

Iceland.—According to reports in the daily Press, the long-dismissed telegraphic communication between Denmark and Iceland is about to be realised, the initiative being taken by the Great Northern Telegraph Company.

Aylesbury.—The Rural District Council have received notice from the Aylesbury Electric Supply Company of their intention to apply for a provisional order to supply electricity within the rural district of Aylesbury.

Newcastle Electric Light Co.—The directors have declared an interim dividend of 7 per cent. per annum for the half-year ending June 30, which is the same rate as that paid by the company for the last six years.

Hexham.—The Examiners of Standing Orders in the Commons have passed the Electric Lighting Confirmatory Bill, which has been ordered for second reading. The measure has already passed through the Upper Chamber.

Houghton-le-Spring.—The Examiners of Standing Orders in the Commons have passed the Electric Lighting Confirmatory Bill, which has been ordered for second reading. The measure has already passed through the Upper Chamber.

Bombay.—It is reported that there will shortly be a great demand for electric ventilators and other electrical apparatus in Bombay, as a generating station is being erected by the Municipality for the distribution of electric light and motive power.

Haywards Heath.—The Urban District Council have decided "in principle" to take the necessary steps to obtain powers to generate and supply electricity for lighting, traction, and other purposes within the area of their district and in the neighbourhood.

Cork.—The Cork Gas Company and the Cork Electric Tramways and Lighting Company are displaying some rivalry in regard to the illumination of the Carnegie free library. The electric company offers, in the public interest, to carry out the installation free.

Mirfield.—In regard to the electric lighting scheme, the District Council have decided to apply for sanction to borrow £5,000 for the laying of the cables in the district, plans for which have been prepared. The Council will not necessarily spend the whole amount in the first instance.

St Pancras.—A recommendation was submitted at Wednesday's meeting of the Borough Council that application be made to the London County Council for sanction to a loan of £10,000 for electric lighting purposes. Twenty-five fresh applications for the supply of light or power have been received.

Boiler Feed Purifiers.—We are informed by the Paterson Engineering Company, Limited, that they have recently received orders from Messrs. Babcock and Wilcox, Limited, Messrs. Edwin Danks and Co., Limited, Messrs. Belliss and Morcom, Limited, and the borough of Ealing electricity works for their boiler feed purifiers.

County of London Electric Supply Co.—The directors have declared an interim dividend on the ordinary shares for the past half year at the rate of 4 per cent. per annum. The amount of electricity sold in the company's London districts during the half year is estimated to realise £59,338, which compares with £49,854 for the corresponding period last year.

Fulham.—In reference to the note published in our issue of the 15th inst. a recommendation was submitted at the last meeting of the Borough Council that the first section of the scheme prepared by Mr. A. J. Fuller, the engineer, for the extension of the electric lighting undertaking, be authorised. This had been passed by the Finance Committee, the cost being put at £52 000.

Alton.—The Southern District Electricity Corporation, 66, Victoria-street, Westminster, and the Alton and District Electric Supply Company, Limited, have given the Urban District Council notice of their intention to apply for a provisional order in respect of the urban district of Alton. The Council have instructed the clerk to submit a number of questions to the parties before taking any further action.

Norwich.—The Corporation have agreed to amend the agreement with the National Telephone Company with reference to placing telephone wires underground. Originally it contained a clause for the purchase of the exchange system from the company, but the latter now took exception to it and wanted the clause to be limited to the conduits and manholes in the streets, to which the Corporation have now consented.

Leek.—The Urban District Council have resolved that the extension of the cable for lighting Ball Haye Hall and the Derby-street extension be carried out by three single cables laid solid, to be ordered from Callender and Co. It has also been decided to communicate to the Local Government Board, in reply to their letter as to the proposed extension of cables, for which a loan is required, particulars of the work contemplated.

Trowbridge.—The Bill containing the electric lighting provisional order promoted by the Western Electric Distributing Corporation, which has already passed through the House of Lords, came before the examiners of the House of Commons last week for proof of compliance with Standing Orders. Formal proof having been given, the examiners

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decided that the Standing Orders had been complied with, and the Bill was allowed to proceed.

Ilford.—The annual report to March 31 states that 2,105,788 units were generated. 421,568 were used for public lighting, private consumers took 655,802 and the trams 563,464. The quantity used on the works amounted to 214,170, leaving 250,784 units unaccounted for. The number of public lamps totalled: arc, 57 (10 and 13 amperes); incandescent, 892 (25 c.p.). The total maximum supply demanded was: lighting, 832 kw.; traction, 250 kw.

Blackheath and Greenwich District Electric Light Co.—Letters of allotment for a further £30 000 4½ per cent. first mortgage debenture stock and a further 30,000 7 per cent. cumulative preference shares of the Blackheath and Greenwich District Electric Light Company, Limited, have been posted. Both issues were over-subscribed by the company's shareholders and debenture stockholders, the preference shares being very largely over-subscribed.

Insurance.—The Associated Fire Offices have issued a set of revised rules for electromotors used in textile and corn mills and other buildings where motors are exposed to dust. The essential difference between these rules and those which they supersede is that the new rules allow unprotected ventilating openings in the metal covers of induction motors, provided the superficial area of each such opening does not exceed ¼in. and provided the openings are ⅛in. apart.

St. Marylebone.—At yesterday's meeting of the Borough Council the Finance Committee reported the receipt of a letter from the London County Council in reference to the terms of the advance of £1,415,000 for the electric lighting undertaking. The Finance Committee express the opinion that the terms offered by the County Council are very generous, and intimate that they have been formally accepted by the town clerk in accordance with previous instructions.

Huddersfield.—The engineer's report shows that the number of consumers to date is 1,931, and that 50 lamps had been connected since June. During June, 94,292 units were metered as compared with 91,640 in the corresponding period last year. The report also shows that compared with the month of January, July showed an increase of 44 consumers, 1,354 connected lamps, and 42,815 metered units. On July 1 the total length of mains was 85,551 yards primary and 61,452 yards secondary.

Keighley.—The sale of electricity for June increased by 3,829 units as compared with June, 1903, the actual amount sold being 10,646 units as compared with 6,817 units. From July 1, 1903, to June 30 of this year, 184,307 units were sold as compared with 137,721 in the corresponding period of twelve months ago—an increase of 46,586 units, equal to 33·8 per cent. The Electricity Committee propose to lay 80 yards of cable in Parker-street for the supply of electricity for power purposes to Messrs. Smith and Paget's works.

Chester-le-Street.—The Rural District Council have received a letter from the County of Durham Electrical Power Distribution Company, Limited, stating that they intend making application for a provisional order authorising them to supply electrical energy within the district. It was resolved to oppose the application on the ground that the County Council are expected to undertake a scheme for lighting the whole shire. The Rural District Council have not, apparently, taken any steps in connection with the electric lighting order granted to them.

Ripon.—At the monthly meeting of the City Council it was reported that notices had been received from three companies of their intention to apply for electric lighting orders for the city; while the Power and Traction Company, Limited, having got their Tramway Bill through Parliament, were applying to have the electric lighting order of the Ripon Corporation cancelled. A councillor expressed the opinion that electric lighting would not pay in Ripon unless there was a large increase in population. The matter was deferred for further consideration.

Bath.—In order to meet several applications for a reduction in the charge for current used during the hours of daylight, the Town Council have decided that current be supplied for lighting purposes from Sept. 1 to March 31 between the hours of 9 a.m. and 4 p.m., and between April 1 and Aug. 31 between the hours of 6 a.m. and 6 p.m., at 2½d. per unit, and that special two-rate meters be issued to consumers upon application at the following rentals: 15 lights, 10s. per quarter; 30 lights, 12s. 6d. per quarter; 60 lights, 15s. per quarter; 120 lights, 20s. per quarter.

Melbourne.—The materials for the electric lighting of the Melbourne express have arrived, and it is expected that the cars will be equipped shortly. The commissioners recently had their own inspection car and another fitted with the Maxim-Vickers electric lighting system for trial purposes, and the results gave satisfaction. The system adopted for the express cars is that made by Messrs. Stone and Co., of England, which is at present in use on thousands of cars in Great Britain, and which has met with the approval of the railway companies.—*N.S.W. Railway Budget.*

Tenbridge.—The following is a statement of electricity generated and sold during the year to March 31: current generated, 128,679 units; public lamps, 36,810; private consumers, 47,389; quantity used on battery, 14,260; used on mains, 4,139; used on works, 26,081; total units sold, 84 199; total used at works, 44,480; works cost per unit, 2·766d.; total cost per unit (omitting capital charges), 3·711d.; average price obtained, 3·9d. per unit; price charged for motive power, 2 0). per unit; deficit chargeable to general district rate, less gross profit of £156. 9s. 1½d., £1,280. 9s. 2d.

Camberwell.—The Borough Council have granted an application from the Postmaster-General for consent to the placing of an underground telegraph line along the south side of Chadwick-road, and another from the fire station in Peckham-road to the corner of Rye-lane, thence along the west side of Rye-lane to and under the London, Brighton, and South Coast Railway Company's arch; also from the corner of High-street and Rye-lane along the south side of High-street to opposite the towing path, and from thence across High-street and along the towing path to a point near the Grand Surrey Canal.

Northfleet.—The Urban District Council have three suitors for the privilege of supplying electric current to that town. In addition to the Gravesend Corporation, notices have been received from Messrs. Foote and Milne, Limited, of Victoria-street, London, and the Kent Electric Power Syndicate. The Council themselves have an electric lighting order, and the Board of Trade have enquired what steps are being taken to carry it into effect. An agreement for transferring the order to the Gravesend Corporation is to be drafted, and in the event of its not being ratified, the Council propose to exercise the powers themselves, an extension of time for the purpose being applied for.

Edinburgh.—After considerable discussion the Corporation have adopted the following resolution: "That a sum of £14,175 out of the profits upon the electric lighting accounts for the year now closed, shall be placed to the credit of the electric lighting reserve fund; and that the balance of the said profits shall be placed to the credit of the rates, under the third head of estimate (general improvements), and that the acts of Council be modified and altered accordingly." The opinion was strongly expressed among a section of the Corporation that it would be premature to devote any of the profits to the relief of the rates until the depreciation fund had been made up to the full estimate.

London Gazette.—The partnership between William Frederick Ibbotson and Richard Green, carrying on business as electrical and mechanical engineers, and trading as Ibbotson and Green, has been dissolved by mutual consent. A general meeting of the Electric Magnetic Traction Company, Limited, will be held on Aug. 26 for the purpose of having an account laid before them showing the manner in which the winding up has been conducted and the property of the company disposed of; J. H. Howard has been appointed liquidator. A receiving order has been made out on debtor's petition in the estate of Harold Powell, electrical engineer, lately commission agent, 47, Northumberland-street, Derby, lately carrying on business at the Strand-arcade, Derby. The first meeting in the estate of Herbert Barham, engineer, 28, Bucklesbury, Hitchin, in the county of Hertford, and carrying on business at West-lane, Hitchin, will be held at 11 a.m. on Aug. 4 at the Court House, London.

Battersea.—At the last meeting of the Borough Council the Lighting Committee reported the receipt of a letter from the London County Council, with further reference to the adoption of a general and uniform method of fire-alarm indication throughout the Metropolis, and submitted a recommendation that the County Council be informed that the Borough Council approve of the design and the manner in which it is proposed to fix the indicators to the lamp posts, but are of opinion that the work should be undertaken by the County Council. Further recommendations submitted were that a meter testing room and meter stores be provided by the Works Department at an estimated cost of £153; that electric mains (including arc light leads) be extended from Northcote-road along Bramfield-road to Ashness-road, at an estimated cost of £142. 5s. 7d., applications for the supply of energy in that neighbourhood having been received; that the distributing mains and leads be extended to, and throughout, the Shaftesbury and Beaufoy Estates, and that 170 ½-ampere Nernst lamps be provided and fixed at an estimated cost of £3,653.

Watford.—The Watford and District Tramways Company having enquired whether the Council were prepared to supply energy for the purpose of the tramway, and, if so, at what date and upon what terms, the clerk was instructed to ascertain whether continuous or alternating current will be required, the maximum load demanded, and the date the supply is to commence. The Electricity Committee recommend that as soon as the answers to the queries which have been dispatched to various towns on the Continent where electricity is adopted for water pumping are received, the electrical engineer be authorised to accompany the surveyor to visit certain towns on the Continent, and to make a report on the subject. Sanction has been received to a loan of £26,000 for the extension of the generating station. The number of consumers connected to date is 345. The electrical engineer having reported that, as the majority of the consumers preferred to be charged on the flat rate instead of the demand indicator system, there were a large number of demand indicators in stock, and recommending that these be advertised for sale, the committee directed him, in the first instance, to send circular letters to the various electrical undertakings where demand indicators are used, inviting prices.

Cheltenham.—An analysis of the accounts of the electricity undertaking for the year ending March 31 shows that the capital was increased from £148,027. 11s. 11d. to £151,528. 5s. 7d., but the number of private consumers rose from 676 to 756, and the number of 8 c.p. lamps connected with the mains from 41,442 to 48,052. After payment of capital charges the undertaking shows a loss upon the year's working of £1,756, but this compares favourably with last year, when the loss amounted to £3,740. The number of units sold was 1,534,144 against 1,287,421 last year. For public lighting 607,314 units were used, private supply 474,795 units, and for traction 252,035 units. The average prices obtained were—private supply 5·03d., public lighting 2·17d., and traction 1·7d. The works cost of generation and distribution was 1·048d. per unit, and the total cost 1·459d. per unit against 1·57d. last year, a saving being effected in distribution. While the output of energy has only increased by 5·6 per cent., the revenue from electricity has simultaneously increased by 9 per cent. By the combination of reduced cost of production, increased output, and increased revenue on all energy supplied, except to the tramways company, the gross profit has been increased from £6,778 in 1902-3 to £8,469 in 1903-4. This gross profit is equal to a percentage of 5·65 of the expended capital.

Hammersmith.—The Electricity and Lighting Committee reported at Wednesday's meeting of the Borough Council that 14 additional consumers, representing a maximum of 418 8-c.p. lamps, have been

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connected to the mains; that seven consumers have been disconnected, and that the present number of consumers taking current from the mains is 1 478. The borough surveyor reported that Messrs. Westwood and Wright had completed the laying of the pipes for the extension of the condensing scheme, at a total cost of £1,083. 7s. 8l. The committee recommended that a claim by the contractors for an extra allowance on account of the river being in flood during the progress of the work be not entertained. Tenders are to be invited for supplying pipes in connection with the river-water main extension. An application for supply has been received from No. 33, Digby-mansions, and the committee recommend that the necessary main be laid. A communication having been received from the London County Council with reference to the Bill to be promoted by them to authorise local authorities to execute wiring, the committee recommended that the Council give the measure their fullest support. It was further proposed that the whole of the vacant land at the rear of the electricity works, which belongs to the Council, should be allocated to the extension of the electricity undertaking. The Works Committee recommended the application of the Postmaster-General for permission to lay an underground telegraphic wire along the west side of Shepherd's Bush-road be granted.

Grimsby.—Mr. W. A. Vignoles, the borough electrical engineer, has circulated his third annual report for the year ending March 31 relating to the electric lighting undertaking. The report states that the most satisfactory feature of the year's working has been the increase in the number and horse-power of motors connected to the mains. The new system of charging (1d. per unit), with a time cut-off, has been introduced as an alternative to the ordinary system, and has been largely adopted. For the year ending March 31, 1903, the number of motors connected was 16, with a total of 45 h.p., the units sold for power purposes being 4,770. During the period under review the number of motors connected rose to 41, with a total of 167 h.p., the units sold for power purposes totalling 16,519. Steady progress was made during the year in securing new consumers for lighting. The number of private lamps connected numbered 31,812, against 22,559 in the previous year. The number of units used for private lighting was 255,835, against 185,622 in the previous year. For all purposes 799,602 units were consumed, against 653,438. The electricity department sold 442,628 units to the tramway company during this year, this being an increase of 70,000 units as compared with the previous year, and 90,000 units more than the guaranteed minimum. The total cost of generation and distribution was £4,125, representing 1·24d. per unit. A pamphlet issued by the electricity department give details of the Corporation's system of supplying energy, which can be had at 1d. per unit by consumers who do not require power after about five o'clock in the winter months. Any further particulars can be obtained from Mr. W. A. Vignoles, the borough electrical engineer.

London County Council.—The Finance Committee recommend the Council to grant loans of £10.000 and £9,958 for electric lighting works to the Woolwich and Shoreditch Borough Councils respectively; and that sanction be given to a loan of £433,800 to the St. Marylebone Borough Council for electric lighting purposes. The following notices under the Electric Lighting Acts have been agreed to: the Blackheath and Greenwich District Electric Light Company, high-tension mains along portions of Sydenham-road, West-hill, Charleville-circus, and to build a transformer box at the junction of West-hill and Crystal Palace-park-road, also low-tension mains along Burghill road and a portion of Pond-road; the Charing Cross and Strand Electricity Supply Corporation, mains across High-street, St. Giles, Holborn; the City of London Electric Lighting Company, to lay mains in Southwark; the County of London Electric Supply Company, to lay low-tension mains along Burstock-road and along Tranmere-street, also a transformer box at the junction of Franciscan-road and Lucian-road, Hazelwell-road and Upper Park Fields, and Deepdene-road and Gleneldon-road, also to lay high and low tension mains along Prentis-road, Becmead-road, Kings Court-road, Norfolk House-road, Moorcroft-road, Brancaster-road, and Blakemore-road, and to construct a transformer box at the junction of De Crespigny-park and Grove-lane; the London Electric Supply Corporation, to lay high and low tension mains along portions of Upper Ground-street, Old Barge House-street, Hatfield-street, and Broad-wall; the Metropolitan Electric Supply Company, to lay high-tension mains along portions of York-terrace, Devonshire-place North, Brunswick-place, and across York-gate; the St. James's and Pall Mall Electric Light Company, to lay mains along portions of Masons'-yard, Ormond-yard, York-street, St. James's-square, Charles-street, and Haymarket; the Westminster Electric Supply Corporation, to lay mains along portions of Eccleston-place, Eccleston-street, and Buckingham Palace-road; the St. Pancras Metropolitan Borough Council, to lay mains across Prince of Wales-road and along a portion of Castle-road and along a portion of Camden-road. The Fire Brigade Committee's report contained the following: "We are of opinion that the Eltham sub-station should be lighted by electricity. The Woolwich Metropolitan Borough Council is not yet in a position to supply electric current, but we understand that it will not be long before it is able to do so. Should the electric current not be obtainable when the station is opened in the autumn, temporary arrangements will have to be made for the lighting of the station. It is desirable, however, that the necessary wiring should be put in hand, and we have therefore given instructions for tenders to be invited from selected firms."

TRACTION.

Maidstone.—The first four days' receipts of the new cars amounted to £114.

Colchester.—The electric tramways satisfactorily passed the Board of Trade inspection on Wednesday, and the service was formally opened yesterday.

Derby.—The London-road to Alvaston and the Osmaston-road to Cotton-lane sections were opened to the public on Wednesday.

Lowestoft.—The trams completed their first year's running last Friday. The receipts up to the end of the week reached an aggregate of £10,457.

Droylsden and Audenshaw.—All opposition to the Manchester Corporation Bill, which authorises the promoters to electrically equip the Manchester, Audenshaw, and Droylsden tramways has been withdrawn.

Aberdare.—The Urban District Council have decided to promote a scheme for an electric tramway system from the centre of the town to Aberaman, with a branch to Cwmaman, and also for the erection of a refuse destructor.

Gravesend.—The Northfleet District Council have decided to make representations to the company with a view to obtaining a reduction of fares and the introduction of ½d. fares in Northfleet, the latter having been found to pay well in Gravesend.

South Australia.—The Government has forwarded to the secretary of the Adelaide and Suburban Tramway Company a legal notice stating that the Government propose to exercise its right of purchase, under the general Tramways Act, in October.

Tees-side.—Following on the agreement arrived at between the Imperial Tramways Company and the Middlesbrough Corporation before the House of Lords' Committee, the Thornaby Corporation have lodged a petition against any alteration of the Bill.

North Metropolitan Tramways Co.—The directors recommend a dividend at the rate of 3½ per cent. per annum for the past half year, carrying forward about £200. During the half year the number of miles run were 6,943,973, and passengers carried 64,301,765.

Parliamentary Bills.—On Wednesday the Tramways Orders Confirmation (No. 2) Bill was before a select committee of the House of Commons, Sir Lewis McIver presiding. Included in the Bill were the Sunderland Corporation Tramways Order, and the Bishop Auckland, Shildon, and Spennymoor Order. There was no opposition to the confirmation of these orders, and the Bill was ordered to be reported to the House.

Hanley.—The Town Council have received a letter from the Potteries Electric Traction Company stating that, after careful consideration, the directors regretted their inability to issue contract tickets, and also that they could not see their way to reducing the present fare between Hanley and the park gates, but adding that ½d. fares would be given a trial at an early date. As to the suggested extension of the light railway up High-street to the borough boundary at Birches Head, the chairman would go into the matter carefully when he was next in the Potteries district.

Metropolitan Electric Tramways Co.—A Press inspection of the company's extensive main power station at Brimsdown took place last Friday, the party subsequently visiting the depôt at Edmonton and the sub-station at Wood Green, returning on reserved cars to Finsbury Park, the terminus of the section opened to the public on that day. Several other sections are well advanced, and when these are completed communication will be provided from North London to several districts in Hertfordshire, arrangements for inter-running having been entered into with other existing or projected systems.

Newcastle.—The company's Bill was finally amended at the sitting of the House of Commons Committee last Friday. Clauses 15 and 16 being struck out, a clause was inserted confirming and giving effect to an agreement between the company and the Corporation for the running of cars by the company over the Corporation lines and by the Corporation cars over the company's system; and fixing a scale of charges and other arrangements for through traffic. The agreement itself was inserted in the Bill as a second schedule. A clause was also agreed to providing that in the event of the sale of their undertaking by the company the arbitrator in determining fair market value shall not have regard to any increase of value directly due in his opinion to the exercise by the company of powers conferred by the agreement. The Bill thus amended was reported to the House.

Torquay.—The Tramways Bill was read a third time in the House of Lords on Monday. On the motion that the Bill be passed, Lord Clifford of Chudleigh moved to insert the following new clause: "If at any time it be proved that any injury or damage to any mains, pipes, or apparatus of the Corporation, or the Torquay Gas Company, shall have resulted from the use of electric current on any of the tramways authorised by this Bill, nothing in the Bill shall relieve the company from liability to make compensation for such injury or damage." This clause had been allowed by the committee, but had been subsequently struck out at the instance of Lord Balfour of Burleigh as being contrary to precedent. The committee did not desire to establish a precedent, but considered that the circumstances of the case justified the clause. Lord Wolverton, as representing the Board of Trade, now opposed the motion. Eventually the proposed clause was negatived without a division, and the Bill was then passed.

Ossett.—On Wednesday the Select Committee of the House of Commons presided over by Sir Lewis M'Iver considered a Bill to confirm, *inter alia*, a tramway order granted by the Board of Trade to the Corporation of Ossett. The Great Northern Railway Company opposed. It was announced in the course of the proceedings that a settlement had been arrived at, and under the circumstances the Bill will in due course be considered by the Committee on Unopposed Bills. It is stated that the effect of the arrangement come to by the parties is that the Corporation of Ossett and the Corporation of Dewsbury can carry goods on their tramways within their own boroughs, and in the case of Ossett also into the urban district of Horbury, and in the case of Dewsbury anywhere within a radius of two miles from Dewsbury Town Hall, but subject to these provisions there is to be no carriage of goods on the tramways of either Corporation in competition with the Great Northern Railway Company.

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Wellington (N.Z.).—It is anticipated that the electric trams will start running in a few weeks. The fares have been fixed at 1d. per 96 chains.

Birmingham.—Representations are to be made to the Corporation upon the necessity of providing a tram service to Harborne at as early a date as possible, as many workers are engaged in that district.

Metropolitan District Railway Co.—The directors announce that the accounts will, after paying all prior charges, admit of a payment for the six months ended June 30 of a divinend on the 4 per cent. guaranteed stock at the rate of 2 per cent. per annum.

Brighton.—The Town Council have decided to discontinue the service on the cross route from Seven Dials to Elm-grove. The report of the special committee on the question of revising the fares has been adopted, penny stages to be limited, as far as possible, to 1½ miles.

Proposed Light Railway.—The Ripon Rural District Council last week received a deputation of ratepayers who were in favour of a light railway to Kirkby Malzeard. A fund has been raised towards a preliminary survey, and the District Council will recommend an engineer for the purpose.

North-Eastern Railway.—It is stated that the company contemplate letting a contract for the electrification of the Newcastle and South Shields branch. Experiments have been conducted on this section for some time past. On the south side of the river the railway passes through a very crowded district.

Dewsbury and Ossett.—Petitions have been lodged in the Private Bill Office of the House of Commons on behalf of the Great Northern Railway Company praying to be heard, by counsel, against the Dewsbury Corporation Tramways Order and the Ossett Corporation Tramways Order, when they reach the committee stage.

Liverpool Overhead Railway Co.—The accounts of this company for the past half-year show an available balance of £10,370. 18s. 6d., and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 1½ per cent. per annum on the ordinary shares. Balance carried forward £4,052. 5s. 10d., against £3,747. 5s. 10d. last year.

Tipton.—At Tuesday's meeting of the District Council allusion was made to the recent meeting at Birmingham between the local authorities and the company. The terms required by the Dudley Council for a lease to the company of the lines within their area, which terms the company consider decidedly excessive, appear to be the obstacle in the way of Tipton's requirements. A special meeting of the Council is to be held to-day.

Reading.—The parts of the track in the busy quarters of the town were laid with basic lava, bonded on a mixture of pitch and oil, to prevent noise. The new method proved a success in this respect, but, as anticipated by the borough engineer, it lacked durability. Last week one of the streets originally constructed on this principle—Duke-street—was relaid, the material used consisting of creosoted wood blocks, with edgings of jarrah wood.

Whickham.—The committees of the Whickham and Blaydon Councils met the representatives of the Gateshead and District Tramways Company, when the question of having the trams extended from Dunston to Blaydon was fully discussed. Ultimately the company's representative intimated that until the Local Government Board had passed its Bill to amend the Light Railways Act he was afraid his company could not deal with the matter.

Cardiff.—Owing to inconsistencies in the fare stages, Mr. Arthur Ellis, the engineer and manager, recommends the Corporation to raise the fares all round by charging ½d. stages, with a minimum of two stages for 1d. He works it out on the basis of 1,100 yards for ½d. and 2,200 yards for 1d. The minimum of 1d. is introduced because ½d. fares for one stage would fill the trams for short distances to the exclusion of the more profitable through passenger.

Leith.—In view of the advanced stage now reached by the tramways provisional order, under which the Town Council propose to acquire and reconstruct the present horse tramway system, the Tramways Committee have appointed a sub-committee to make enquiries regarding all systems of traction. It is expected that the sub committee will report to the Tramways Committee early in September. A visit has been paid to Perth to inspect the new petrol tramway car of the Corporation.

Victoria.—At a recent meeting of the Executive Council, states the *N.S.W. Railway Budget*, the necessary Order in Council giving permission to instal an electric system of tramways for Essendon and Flemington was issued. Apparently the undertaking is to be conducted by private enterprise, as a *plébiscite* of the ratepayers is to be taken, the Electric Light and Power Act, 1901, providing that no municipality shall transfer any such powers until a poll shall have been taken in order to ascertain whether or not the ratepayers desire to forbid the proposed transfer.

Taunton.—The borough surveyor having reported that the foundation of the tramway company's track was in a bad condition, the company, though not prepared to lay wood blocks, offered (*a*) to lay, as an experiment, 50 yards with granite setts in the centre and margins of the track; or (*b*) they would consider the question of laying wood blocks if the Council would pay the difference between the cost of wood blocks and granite setts, and give the directors a price for the annual upkeep of the track. Eventually the Council decided to ask the company to try granite blocks in Station-road.

Road Widening.—The Metropolitan Borough Councils' Association have passed the following resolution, which has been forwarded to the various councils: "That when a widening becomes necessary solely by reason of the construction or reconstruction of the tramways, the expense should be entirely borne by the London County Council out of the tramway account. When an improvement is urgently required, irrespective of tramways, the contribution of the local authority should vary according to the importance of the improvement to the borough, apart from the tramway traffic." The circular has been accorded a somewhat mixed reception.

Huddersfield.—The Town Council have approved an agreement with the London and North-Western and the Lancashire and Yorkshire Railway Companies with reference to the laying of a tramway in the goods yard at Hillhouse. The accounts for the three months ending June 30 showed the receipts to be £17,417. 3s. 8d., giving a surplus (without allowing anything for depreciation) of £2,406. 10s. 2d. The receipts were equal to 9·93d. per car mile, as compared with 9·81d. last year. For the month of June the traffic receipts totalled £5,509, with average receipts of 9¼d. per mile, showing a slight decrease over the corresponding period of last year, when, however, the Whitsun holidays were included.

Garstang and Blackpool Light Railway Co.—The Light Railway Commissioners held an enquiry at Preston on Monday into the application of the company for an extension of the order authorising the construction of a light railway from Blackpool to Catterall. It was stated on behalf of the promoters that sufficient capital would now be forthcoming, and it was asked that the name should be changed to the Blackpool and Fylde Light Railway, to distinguish it from the Garstang and Knot End Railway. The order was extended for 18 months. An application by the Blackpool Corporation that the company should cross underneath a new road, on the ground that a level crossing would be dangerous, was dismissed.

New York Underground Railway.—The new underground rapid transit tunnel in New York, connecting the lower part of Manhattan Island with the northern districts of New York City, has been completed, and it is expected that trains will begin running by Sept. 1. The railway is a four-track one, and extends a distance of about 12 miles. Express trains will be run at the rate of 30 miles an hour. Work was begun on the tunnel on March 24, 1900, the price paid by the city for the tunnel being £7,000,000. A special feature of the subway is that each station will be distinguished from the others by a separate combination of colours, thus permitting those who habitually use the system to recognise their station immediately. It is estimated that in the rush-hours of the mornings and evenings the railway will be able to transport 40,000 persons an hour.

Hertfordshire Light Railways.—The Herts County Council have empowered the Highways Committee to open negotiations with the Urban District Council of Watford, assuming the Watford Tramways Company allow their powers to lapse on Aug. 17, 1904, as to the extension of the Bushey Light Railway into the town of Watford. The committee were directed to enter into negotiations with the Urban District Council of Cheshunt for an agreement enabling the County Council to construct the permanent way of the Cheshunt Light Railway with reasonable widenings. The seal was affixed to an agreement with the Metropolitan Electric Tramways, Limited, on the lines of the Cheshunt agreement, for the construction of the Barnet Light Railway, and the committee were empowered to take the necessary steps to acquire the lands required for widening the main road at Barnet, along which the above light railway will pass.

Ilford.—The tramway returns for the period March 14, 1903 to March 31, 1904, the first year of working, give the following particulars: population, 52,000; system and gauge, overhead trolley, 4ft 8½in.; length of single track, 10½ miles; total capital expended, £132,874. 3s. 11d; revenue, traffic revenue £22,587. 17s. 1d., other sources £630. 0s. 8d.; costs, operating £13,566. 1s. 3d., per cent. to revenue 60; interest on loan capital, £3,345. 4s. 4d.; gross profit before providing for interest, depreciation, or sinking fund, £9,649. 16s. 6d.; amount provided for depreciation or sinking fund, £2,291. 0s. 6d.; surplus, £4,570. 17s. 9d. (£557 being refunded by the lighting department for interest and sinking fund on machinery paid for out of the tramways loan); car miles run 577,034, passengers carried 5,274,025, passengers per car mile 9·14, times population carried 101, revenue per car mile 9·38d., revenue per passenger 1·02d., cost per passenger ·61d., units per car mile ·99; units consumed 585,041 (less 10,800 used on water-cart), power costs 1·54d., traffic costs 3·33d., maintenance and renewals ·48d., management expenses ·29d., total operating costs 5·64d.

Halifax.—Some weeks ago a meeting of the representatives of the District Councils of Soyland, Sowerby, Rishworth, and Barkisland was held with the object of inducing the Corporation to extend their tram service. At subsequent meetings a scheme was prepared, and arrangements made for an interview with the Tramways Committee. This took place on Thursday of last week. The needs of the districts and the advisability of providing better access to the locality were laid before the committee. Emphasis was laid on the fact that the Corporation had had the powers for nearly five years, and if not taken advantage of these powers would lapse, and thus would open the possibility of another authority obtaining them. The distance over which they were anxious lines should be laid was about three miles, and extended from a present terminus at Jerry-lane, Sowerby Bridge, to Slitheroe Bridge, Rishworth. Along the line of route there was a population to be served amounting to about 8,000. The deputation considered there was every possibility of it being a paying venture. The omnibuses had paid when run to Halifax, and the district was also an exceedingly picturesque one, and would prove an excellent holiday route. It is understood that the Tramways Committee, prior to giving a definite reply to the deputation, will inspect the proposed route at an early date.

London County Council.—The Highways Committee submitted a proposal that £4,960 be voted for top-covered cars. The Parliamentary Committee submitted a recommendation that £6,500 be paid to the London, Camberwell, and Dulwich Tramway Company for their undertaking, as arranged before the House of Lords' Committee. It was further proposed that £1,000 be expended on the repair of this track. In reply to the invitation from the New York Rapid-Transit Railroad for a representative to attend the opening ceremony in September, it is proposed that Mr. J. Allen Baker, the chairman of

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the Highways Committee, represent the Council. Approval was recommended to the plan submitted by the City and South London Railway Company for a station to be erected at Euston. Sanction was asked to the expenditure of £58,800 for paving works and the construction of a further portion of the tramway in connection with the system under Kingsway and Aldwych. The receipts for the week ending 16th inst. totalled £14,710 against £10,675 last year; and for the period from April 1 they amounted to £185,758 against £152,641.

Burnley.—The Corporation tramway accounts to March 31 show for the Darwen section a gross profit of £2,825. 5s. 3d., but after making provision for interest on loans, repayment of principal, and sinking fund, amounting to £3,638. 17s. 11d., a net loss is shown of £813. 12s. 8d., as compared with a net loss for the previous year of £1,109. 5s. 2d. This is allowing £900 for depreciation, apart from which there would have been a small profit. The traffic receipts for the year on this section have been £10,664, as compared with £10,743 last year, showing a reduction of £79, attributable to the depression in the cotton and other trades. The revenue account for the Hoddlesden section shows, after debiting £150 for depreciation, a gross profit of £82. 7s. 1d., but after making provision for interest on loans and sinking fund instalments, a net loss of £672. This loss is reduced by the sum of £350 due from guarantors, leaving the net loss at £322, as compared with a net loss for the previous year of £441. The total amount now standing to the debit of tramways net revenue account is £2,949. The total number of miles run and the average traffic receipts per car mile are as follows: Darwen section, 221,613 miles; traffic receipts, 11·5884d.; Hoddlesden section, 31,732 miles; traffic receipts, 12·6892d., as compared with year ended March 31, 1903—Darwen section, 222,329 miles; traffic receipts, 11·5973d.; Hoddlesden section, 31,951 miles; traffic receipts, 11·6174d.

Rochdale.—The Board of Trade inspection of the Mellor-street route took place last week, preparatory to its being used for traffic from Norden to the town hall. Major Druitt (the inspector) and a party of councillors and officials, including Mr. C. O. Atchison (borough electrical engineer) and Mr. J. S. D. Moffett (tramways manager) made the journey in a single-decker combination car, which ran through from the Esplanade to Spotland Bridge in quick time and without the slightest mishap, the car running very smoothly. On the return journey a halt was made at the car-shed at Bridgefold to enable Major Druitt to have a look over the premises, with the appearance and arrangement of which he expressed warm satisfaction. The car containing the party returned to the Esplanade at 10.15, exactly 19 minutes after leaving for the outward journey. Major Druitt was well satisfied with the short trip, and gave the Corporation power to run at 12 miles an hour over the new section, and to use it for traffic immediately. A fortnight ago he sanctioned running at the rate of 12 miles an hour along the Esplanade, these being the only lengths on the Corporation lines where that pace is allowed. On the other sections the pace varies from eight to ten miles an hour. The relaying of the lines at the bottom of Drake-street is now practically finished. So far as track is concerned the circular route is now completed. The road on the Butts side of the river covering has to be raised and men were started on that work on Thursday morning of last week. On the Manchester-road single lines have been laid as far as Brimrod-lane, and double track has been put down to a point opposite Cheltenham-street. When the work around the river covering is absolutely completed, men will be concentrated on the reconstruction of the Manchester-road section as far as the Windmill Inn at Sudden.

Spen Valley.—The Yorkshire (Woollen District) Tramways, Limited, on Saturday issued the following notice: "Owing to the impossibility of coming to a satisfactory agreement with the Heckmondwike Urban District Council for the supply of power, the company find it impossible to maintain the present service running through the Heckmondwike district." Before the company commenced operations an agreement had been entered into with the Heckmondwike Council, under which the latter were to supply for use within the township a minimum quantity of current to the company per year at a stipulated price per unit, providing that more current was not required at once than could be produced by a plant of a certain kilowatt capacity. Almost as soon as the cars commenced running it was found that the demand greatly exceeded the capacity of the plant. Under the agreement the Council were to be paid an additional £12. 10s. per annum for each extra kilowatt required to meet the maximum demand of the company. Finding that the latter were unwilling to comply with this arrangement, the Council restricted the supply to very little beyond the quantity they were called upon to provide at any one time. The result was a frequent stoppage of cars and a dislocation of the service. Ultimately the Council agreed that they would accept a smaller sum than £12. 10s. per kilowatt, and a full service was resumed on the understanding that whatever extra payment was agreed upon subsequently had to be retrospective. The company, whose contention is that they are called upon to pay an unreasonably high price per unit, and that the larger plant can be utilised by the Council for other purposes, appealed to the Board of Trade, but the reply was that they could not interfere with the agreement the parties had already come to. The Council express a desire to deal with the company in a conciliatory spirit, and have recently had a further conference with their representatives, but it is stated that the amount offered by the directors in lieu of the £12. 10s. per annum per kilowatt is utterly inadequate.

Bury.—On Tuesday of last week a trial trip was taken on the Manchester-road section, and was highly successful. The car was driven by Mr. Clough, the tramways manager, and the party included the Mayor, members of the Tramways Committee, and other councillors, and Mr. S. J. Watson, the borough electrical engineer. The whole of the section to the borough boundary was traversed, and the journey outward and inward was performed without a hitch, a special feature being the smoothness with which the car ran and took the points. On the following morning Major Druitt, of the Board of Trade, inspected the section. A car, containing the inspector, members of the Corporation, and officials, again proceeded over the whole of the route, the result being very satisfactory. Immediately after the inspection was concluded, a 10 minutes' service was commenced from Limefield to the Unsworth boundary at Whitefield. The fares on the Manchester-road section have been fixed as follows: from the parish church to the Cemetery Hotel, 1d.; Cemetery Hotel to the Unsworth boundary, 1d.; parish church to Blackford Bridge, 1½d.; parish church to Unsworth boundary, 2d. Major Druitt fixed the speeds as follows: Market-place and Market-street, eight miles; Knowsley-street, 12 miles; and Manchester-road, 14 miles an hour; four miles an hour round curves. An effort is being made to get the Bolton-road sections of the trams opened by Bank Holiday. Following on the reception of the referee's award in the arbitration proceedings between the local authorities and the tramway company, a conference of the authorities interested was held. At the same time that Mr. More, the valuer for the authorities, submitted his valuation of the undertaking, he also sent a sealed packet containing an apportionment of the amount which each authority would have to pay if his valuation were accepted by the arbitrator. The apportionments were made on the principle of the car mileage run in each district, and are without regard to the sum which may be obtained for the rails, cars, engines, depôts, etc. When these are sold off, the amount will be deducted *pro rata* to the amount paid by each authority. As Mr. More's valuation was not accepted, the packet was not opened, and it was decided to return it to him in order that he may alter it in accordance with the amount of the award.

PROVISIONAL PATENTS, 1904.

JULY 18.

15932. Improvements in incandescent electric lamps. Max Sommer, 56, Ludgate-hill, London.

15942. Improvements in alternating-current electric meters. Union Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 18, 1903, being date of application in Germany.) (Complete specification.)

15952. An electrode for electrical accumulators. Karl Ludwig Berg, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, July 18, 1903, being date of application in Sweden.) (Complete specification.)

JULY 19.

15981. Improvements in telephone directories. Myron George Brownell, 52, Chancery-lane, London. (Complete specification.)

16026. Improvements in vapour electric apparatus. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

JULY 20.

16038. Improved telephone system. Bertil Brander, 5, Prinz Heinrich-strasse, Karlshorst bei Berlin, Germany.

16059. Improvements in apparatus for the generation of electricity, primarily designed for the electric lighting of trains. Thomas William Stainer Hutchins, 17, St. Ann's-square, Manchester.

16063. Improvements in connection with electric safety fuses. Joseph John Smith, 6, Finkle-street, Stockton-on-Tees.

16088. Improvements in alternating-current electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16109. Improvements in reverse electric current switches or circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16110. Improvements in and relating to electromagnetic mechanism. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16113. An improved method of treating incandescent lamp filaments to increase their density and also the density of the carbon deposited upon them during the flashing process. Louisa Calvert and William Arthur Snape, 173, Fleet-street, London.

JULY 21.

16155. An improved method of economising space over the third or "live rail" on electric railways. Henry Curwen, 32, Sidney-grove, Newcastle-on-Tyne.

16166. Improvements in surface-contact systems for electric tramways and the like. Thomas Meredith Trumble and Joseph Patrick Trumble, 5, Budge-row, Cannon-street, London.

16171. A shield or guard for the prevention of injury to workmen and others by accidental contact with exposed "live" rails or current distributors on electric railroads and the like. John Thomas McCoy, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

16179. Improvements in electrical transformers. John Sedgwick Peck and Charles Le Geyt Fortescue, The Westinghouse Patent Bureau, Westinghouse-buildings, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Aug. 8, 1903, being date of application in United States.) (Complete specification.)

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16161. An improved electric candle nozzle. Frederick Thomas, 189, Drummond-street, Hampstead-road, London.

16205. Improvements relating to electric furnaces and to the extraction of zinc by means of the same. Arthur Edelmann and Nils Wallin, 37, Essex-street, Strand, London. (Date applied for under Patents Act, 1901, July 23, 1903, being date of application in Germany.) (Complete specification.)

16210. Improvements in electrical winding and switching mechanism. Edward Du Bois, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

JULY 22.

16241. Improvements in or connected with electric arc lamps. James Brockie, 33, Chancery-lane, London.

16242. Improvements in electric lights. Heinrich Beck, 216, Friedrichstrasse, Berlin, S.W., Germany.) (Date applied for under Patents Act, 1901, July 24, 1903, being date of application in Germany.) (Complete specification.)

16256. Improvements in systems of electrical distribution. Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 23, 1903, being date of application in United States.) (Complete specification.)

16257. Improvements in systems of electrical distribution. Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 23, 1903, being date of application in United States.) (Complete specification.)

16258. Improvements in transforming the energy of electric currents. Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 23, 1903, being date of application in United States.) (Complete specification.)

16260. Improvements in electrical controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16261. Improvements in apparatus for electrically heating liquids. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16267. Deposition of zinc or other metals by means of electricity. Frederick William Gauntlett, Tower Royal, Cannon-street, London.

JULY 23.

16311. Improvements in electrical signalling apparatus for railways. William Andrews, Frederick Allcock, and William Keyworth, 111, Hatton-garden, London.

16312. Improvements in or relating to the detection of electrical oscillations. Louis Heathcote Walter and James Alfred Ewing, 111, Hatton-garden, London.

16324. Improvements in galvanic elements or batteries. Simon Gerardus Visker and Philip Cohen Kaz, 77, Chancery-lane, London.

16326. Improved apparatus for use in the teaching of electric, telegraphic, and other signalling by means of the Morse or other similar codes. William McDonald, 53, Chancery-lane, London.

16340. Improvements in and relating to electric couplings. William Chater Lea, 323, High Holborn, London.

16340. Improvements in or relating to selective electric switches. Isidore Bernard Birnbaum and Francis George Bell, 322, High Holborn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 11, 1904.

1903.

15979. Electric tramcars. Lycett and Conaty.

16368. Portable electric accumulators. Ramsbottom and Richardson.

17179. Electric railway systems and apparatus for use therein. Lake. (Morgan Electric Machine Company.)

17207. Dynamo-electric machines. Dutton and Sandycroft Foundry Company, Limited.

17063. Reversing mechanism for dynamos. Manley.

18121. Enclosed or open electric arc lamps. Mensing.

19048. Alternating-current induction motors. Hunt and Sandycroft Foundry Company, Limited.

21742. Ships' telegraphs. Watters.

1904.

4063. Means for rupturing electric circuits. Thomas. (Date applied for under International Convention, June 27, 1903.)

4063A. Means for rupturing electric circuits. Thomas. (Date applied for under International Convention, June 27, 1903.) (Date applied for under Patents Rule 9, Feb. 25, 1904.)

5185. Method of receiving electrical vibrations utilising electrolytic cells. Thompson. (Gesellschaft für drahtlose Telegraphie m.-b.-H.)

7586. Electric telegraphy. Kitsee.

8444. Safety devices for electric railways. Gibbs.

12439. Electric fire-alarm and the like signalling apparatus. Hubber and Higgs.

12449. Small meter for alternating electric current. Reiss and Klemm.

13724. Electric drills. Duntley.

13758. Portable electric lamps. Hubbell. (Date applied for under International Convention, July 2, 1903.)

13968. Means for producing electric arcs from alternating currents, also applicable for rectifying alternating currents. Weintraub. (Date applied for under International Convention, June 20, 1903.)

13933. Electric storage battery separators. Boult. (Dodge.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅜-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¾-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	101-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	3¼-3½
—— 4 per cent. Mortgage Debenture Stock	100	..	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1
—— Non. Cum., 6 per cent. Pref.	2	..	¾-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	96-99
—— 4½ per cent. 2nd Debenture Stock	100	..	71-76
Callender's Cable, Debentures	100	..	101-105
—— Ordinary	5	..	9¼-10¼
—— 5 per cent. Pref.	5	..	5-5¼
Crompton and Co.	5	..	1¼-2
—— 5 per cent. Debentures	100	..	94-97
Edison and Swan United, "A" Shares, 1-99,261	5	..	¼-½
—— "A" Shares, 01-017,139	5	..	¼-½
—— 5 per cent. Debentures	100	..	78-82
—— 4 per cent. Deb. Stock, Red.	100	..	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2¼-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	93-98
W. T. Henley's Telegraph Works, Ordinary	5	..	11-12
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-18¾
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	35-39
—— 5 per cent. Bonds	100	..	99-102
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	100-105
Bournemouth and Poole, Ordinary	10	..	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	10¾-11¼
—— 7 per cent. Preference	5	..	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	7-7⅛
—— Nos. 20,001-30,000	5	..	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-108
Charing Cross and Strand, Nos. 1-70,000	5	..	7⅛-8
—— 4½ per cent. Cum. Pref.	5	..	5¼-5½
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	102-104
Chelsea Electricity Supply	5	..	6¼-6⅝
—— 4½ per cent. Debentures	100	..	106-109
City of London, Ordinary	10	..	10¾-11¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London Electric Supply, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	100-103
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6-6¼
—— 6 per cent. Cum. Pref.	5	..	5¾-6
—— 4½ per cent. First Mort. Deb.	100	..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	..	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	12-13
—— per cent. Debenture Stock Red	100	..	102-105
Kensington and Knightsbridge and Notting Hill	100	..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	3	..	1¼-1¾
—— 6 per cent. Pref.	5	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	94-97
Metropolitan Ordinary	10	..	21¼-22¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	103-112
—— 3½ per cent. Mortgage Debenture, Red.	100	..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	..	100-103
Notting Hill Electric Lighting	10	..	13¼-14¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510	5	..	5¼-6
—— 4 per cent. Debenture Stock	100	..	97-100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2¾-3¼
—— 4 per cent. Debenture Stock	100	..	86-90
South London, Ordinary			3¾-4¼
St. James's and Pall Mall, Ordinary, 101-30,060	5	..	14¼-15¼
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4¼-5
Westminster, Ordinary	5	..	12¾-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	5-5¼

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 –	89-91
—— 4 per cent. Pref.	100 –	102-104
—— ,, deferred	100 –	79-81
—— 4 p.c. Deb. Stock (Prov. Scrips Certs., fully paid).	100 –	102-104
City and South London, Consolidated Ordinary	100 –	47-49
—— 4 per cent. Debenture Stock	100 –	106-109
—— 5 per cent. Pref. Stock '91	100 –	123-126
—— ,, ,, ,, '96	100 –	120-123
—— ,, ,, ,, '01	100 –	118-122
Liverpool Overhead, 5 per cent. Pref.	10 –	10-10¼
—— Ordinary, 1-50,000	10 –	3¼-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— –	98-101
Waterloo and City, Ordinary	100 –	89-92
Electric Tramways.—		
Anglo-Argentine, 1-250,007	5 –	5-5¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 –	137-141
Blackpool and Fleetwood Tramroad	10 –	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 –	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 –	3¼-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 –	96-101
British Columbia Electric Railway Co., Ord. Def.	100 –	100-103
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 ..	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 –	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	97-100
British Electric Traction Ord. 1-500,000 & 60,001-80,000	10 –	8¼-9
—— 6 per cent. Cm. Pf., 30,001-60,000	10 –	10⅜-11¼
—— 5 per cent. Perpetual Debenture Stock	100 –	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	2¼-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 –	5⅛-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 –	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 –	105-108
—— Prov. Certs., all paid	100 –	101-104
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅛-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-103

Name.	Amount paid.	Last price
	£	£
Cork Electric Tramways and Lighting Co., Ordinary	10 –	9¼-10
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18-19
—— 6 per cent. Cum. Pref.	all –	14-14¼
—— 4½ per cent. Deb Stock	100 –	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 50,001-60,000	5 –	3¼-4
—— 4 per cent. Debenture Stock	100 –	88-91
Kidderminster and District Lighting and Traction, Pref.	5 –	8 8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10¼-10¾
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	103-106
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 –	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 –	¼-1
New General Traction, Ordinary	5 –	¼
—— 6 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,715 (Regd.)	100 –	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12¼
—— 5 per cent. Cum. Pref.	10 –	9¾-9⅞
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 –	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	9-10
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,152 6 per cent. Preference	1 –	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. –	100 p.c.
Telephones.—		
National Telephone, Preferred	100 –	106-108
—— Deferred Stock	100 –	88-91
—— 6 per cent. Cum. First Pref.	10 –	12-14
—— 6 per cent. Cum. Second Pref.	10 –	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 –	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 –	97-99
—— 4 per cent. Deb. Stock, Red.	100 –	103-105
Oriental Telephone and Electric Company	1 –	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 23	1,876	1,597	+ 279	+ 2,282h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	,, 23	38	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 24	1,333	1,136	+ 200	+ 205	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 23	5,494	5,241	+ 253	+10,290	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 15	1,087	871	+ 216	+ 1,310	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 21	1,950	1,813	+ 137	+ 1,070	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 23	1,470	1,391	+ 79	− 265	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 24	2,014	2,048	− 33	—	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 20	1,166	1,022	+ 144	+ 1,099	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 16	5,211	4,078	+1,133	+12,449	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 24	1,148	960	+ 208	+ 903h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 22	5,430	5,581	− 151	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 16	1,263	935	+ 328	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 24	393	—	—	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 23	2,162	2,136	+ 25	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 23	258	256	+ 2	—	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 23	6,087	6,402	− 315	— h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City & South London Railway	,, 24	2,316	2,545	− 229	— h	6⅜	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 21	555	643	− 88	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 22	255	259	− 4	− 107	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 23	275	271	+ 4	—	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 22	153	125	+ 23	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 22	4,427	7,471	−2,944	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 22	1,324	2,543	−1,219											
Dundee City Tramways	,, 13	814	874	− 20	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 23	811	700	+ 111	+ 1,193	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 23	11,995	11,471	+ 522	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 20	450	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 13	3,495	3,048	+ 447	+ 1,594	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 23	1,378	1,284	+ 90	—	34	34	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 23	2,170	1,911	+ 259	+ 4,229	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 9	528	552	− 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 14	160	207	− 47	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 20	358	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 23	5,971	5,958	+ 13	+ 5,908	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 18	1,466	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 16	11,795	10,700	+1,095	+ 7,499	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 24	1,894	1,710	+ 184	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 2	13,329	11,495	+1,834	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 23	316	—	—	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 23	13,152	12,417	+ 735	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 16	128	97	+ 31	+ 783	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 23	2,659	3,514	+ 145	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 23	539	476	+ 69	+ 1,835	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 23	2,492	2,026	+ 466	+ 3,951	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 21	505	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 25	4,327	4,056	+ 271	+ 5,530	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 23	293	—	—	—	7⅔	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 24	4,860	4,767	+ 93	—	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 21	1,068	1,115	− 46	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 20	512	421	+ 91	+ 534	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 22	680	360	+ 320	+ 4,307	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 24	1,554	1,426	+ 128	+ 890	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	,, 23	1,041	844	+ 196	+ 793	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 21	1,127	—	—	—	1⅔	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 13	843	581	+ 252	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Armour Institute.—We have received the 1904-5 year-book of the above institute at Chicago. The syllabus of the instruction given in the different subjects shows that the institute is well up to date. Electrical engineering is well represented, there being separate courses for electric light and power engineers and for telephone engineers.

Wellington Tramways.—The trial run of electric tramcars in Wellington, N.Z., took place on June 8, and was extremely satisfactory. In consequence, the first routes, we note, have now been opened to the public, and we understand that the contractors, Messrs. Macartney, McElroy, and Co., are completing their work promptly. There is, unfortunately, a certain amount of delay in the construction of one or two tramlines, for which we understand these contractors are by no means responsible.

Underground Telephone Wires in Bombay.—Fortunately for the inhabitants of Bombay, the local telephone company required a new contract with the municipality just before the introduction of electric traction. In consequence, there were clauses inserted in the new contract under which the telephone company have to lay their wires underground wherever necessary. In consequence of this the telephone company have already put a large number of their wires underground, and have pulled down the old overhead construction. As a result, there is not likely to be that interference between telephones and tramways, with the consequent danger to the public, which has been experienced in other towns in different parts of the world.

Standard Sections.—The Engineering Standards Committee have just issued a book entitled "Properties of British Standard Sections." These cover all the steel and iron sections adopted by the then sub-committees dealing respectively with shipbuilding, bridges, and general building construction and railway rolling-stock underframes. The preparation of this work has entailed a vast amount of labour, and no pains and expense have been spared to ensure the accuracy of the results contained therein. "The Properties of British Standard Beams," which was issued in advance, by special request, in the autumn of last year, is contained in the present volume. The general preface gives an idea as to the method adopted in arriving at the list of standard sections. The mathematical preface contains useful information on moments of inertia, ellipse of inertia, moments of resistance, etc. The list of members of the three committees responsible for the compilation of the lists of standard sections is included also in the volume, which must find a place in every engineer's office.

In a Magnetic Cloud.—The following has received the credit of a good evening paper in this country, and it speaks volumes for the knowledge of the sub-editor of the same. Obviously the story has crossed the Atlantic, and we presume that the writer was either approaching or receding from a "bar" at the time he was delivered of the paragraph. We admire the vivid description of the magnetic, electric, and gravity storm cloud quite as much as we do the transparent veracity of the writer. The British ship "Mohican," which has arrived at Philadelphia, reports having passed through a magnetic cloud while approaching the Delaware breakwater. Fire played across the metal ship from stem to stern, the needle of the ship's compass flew around like an electric fan, and everything was magnetised. It was impossible to lift even light chains or bars, which clung tightly to the iron deck. The captain says: "The hair of our heads stuck out like bristles, and it was difficult to move the arms or legs. Suddenly the magnetic cloud lifted, and the phosphorescent glow around the ironwork vanished, and things became as usual."

St. Louis Railway Congress.—In addition to the five papers which are to be presented at the convention of the American Railway, Mechanical, and Electrical Association on Oct. 10 and 11, there will be a question box. It is hoped that this will give rise to very interesting discussions on subjects apart from the topics on which the papers are being prepared. The papers to be read and discussed are as follows: "Inspection and Maintenance of Electrical Equipment," by Messrs. Baker and Lindall, of the Boston Elevated Railway, Boston, Mass.; "Wheels," by J. Millar, of the International Railway Company, Buffalo, N.Y.; "Universal Street Car Body," by W. W. Annable, Grand Rapids Railway Company, Grand Rapids, Mich.; "The Ideal Shop," by W. D. Wright, of the Rhodes Island Company, Providence, R.I. There will also be a joint meeting with the accountants on Oct. 14 to discuss "Shop Records and Accounts." H. H. Adams, of Baltimore, and G. and E. Farrington, of Boston, have this matter in charge for the mechanics, and G. M. Pease, of Buffalo, and W. T. McDole, of Cleveland, are to represent the accountants. The headquarters of the American Railway, Mechanical, and Electrical Association will be at the Inside Inn during the convention period.

Junior Institution of Engineers.—The summer meeting of the institution this year is to be held in Germany, Düsseldorf being the first stopping place. Here, at the town hall on Saturday, Aug. 13, the members are to be welcomed into the Fatherland by the burgomaster and the Society of Architects and Engineers of Düsseldorf. The exhibition will be visited, and on Monday there will be an excursion to Oberhausen for viewing the works of the Gutehoffnungshutte (blast furnaces, steelworks, etc.). The Beurather Crane Works will also be seen. On Tuesday the Elberfeld-Barmen monorail suspended railway is to be inspected in the morning, and in the afternoon the members proceed to Hanover for the purpose of visiting on the following day Messrs. Korting Bros.' works, the Hanover Engine Works, and the works of the Westinghouse Brake Company. Thursday morning will be spent at Hanover, and in the afternoon Berlin will be reached. Here, on Friday, the Overhead and Underground Railway will be seen, including car-sheds, generating station, etc.; also the Charlottenburg electrical engineering works of Messrs. Siemens and Halske. Saturday, Aug. 20, will be spent in visiting the Mariendorf works of the Imperial Continental Gas Association and the Royal Technical High School at Charlottenburg. The members leave Berlin on the Monday for Leipsic, remaining there till Wednesday, when they go on to Frankfurt-on-Main to visit on Thursday and Friday, by invitation of Mr. W. H. Lindley, M.I.C.E., the municipal works, with an excursion to Homburg. On Saturday, Aug. 27, the return journey to England will be made to include the Rhine from Brebrich to Bonn.

Standardisation of Fuses in America.—In order to overcome the difficulties due to the lack of uniformity of sizes and ratings of the various enclosed fuses now upon the market, and to be able to suggest to manufacturers proper details of construction for obtaining the most satisfactory dimensions in securing interchangeability of the fuses for any given capacity, a committee of the Underwriters' National Electric Association, of the United States, has been collecting information regarding the enclosed type of fuse from manufacturers all over the country, and has been conducting a series of tests to determine experimentally the advantages of certain constructive features. Through co-operation with the Edison Illuminating Company, of Boston, and the Boston Elevated Railway Com-

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pany, tests were conducted in the large power stations of these companies to ascertain the operation on short-circuit and otherwise of fuses of very large capacities, at 220 and 550 volts. The tests were so arranged that the fuses were subjected to conditions equivalent in all respects to those which obtain in any large system. As a result of the information obtained from the manufacturers and from the tests, the committee has recommended certain standards which are about to be adopted by the National Board of Fire Underwriters. According to the recommendations, the ferrule type contact clip is to be used for all sizes not exceeding 60 amperes and for all voltages up to 600, while for currents from 61 to 600 amperes the knife-blade contact type is required. The length of a 200-ampere 250-volt fuse is to be 4·5in. between clips, while a 200-ampere 600-volt fuse is to be 7in. The results of such free and friendly co-operation between the underwriters, the manufacturers, and the users of electrical devices should, says our contemporary the *Electrical World*, be greatly beneficial to all electrical interests, and the securing of a standard in fuse dimensions at this time will be a distinct step in advance.

Reliability Trials for Motor Boats.—The following is an abstract of a report to be presented to the committee of the Automobile Club of Great Britain and Ireland on Aug. 8 respecting the recent trials of motor boats. The judges (Major Lindsay Lloyd, Lieutenant Mansfield Cumming, and Captain R. E. T. Dixon) with commendable promptitude have prepared their report, in which, after dealing with the number of competitors and general arrangements of the trials, they express their satisfaction at the results of the trials and at the proved reliability of the boats taking part, only two of the 16 starters failing to complete the 20 hours' run, five boats making complete non-stop runs. The report proceeds with an appreciation of the good performance of the Seal and the Vosper boats using ordinary paraffin, and of the good general condition of all the boats at the termination of the 20 hours. One of the most important recommendations of the report is dealt with at some length—viz, that of the safety of boats fitted with internal-combustion engines—and the effects of this recommendation should be evident in next year's trials. The question of convenience of general arrangement of details is also treated of, the Napier Minor and the Maudslay boat being taken as examples of excellence in this direction. After expressing approval of the general lines of the present trials, suggestions are made as to further points for marking in future trials, with a recommendation that further trials should be held. The report concludes by recommending the following awards: Class II.—Seal Motor Company, 2½-h.p. 18ft. launch, gold medal. Class III.—Vosper and Co., 12-h.p. 22ft. launch, gold medal; Mitcham Motor Company, 6-h.p. 22ft. launch, silver medal. Class IV.—Maudslay Motor Company, 20-h.p. 25ft. launch, gold medal; Woodnutt and Co., 10-h.p. 30ft. launch, silver medal. Class V.—S. F. Edge, Esq., 5-h.p. 35ft. launch, gold medal. Class VI.—J. I. Thornycroft and Co., 20-h.p. 30ft. launch, silver medal. The judges expressed their satisfaction with the admirable fashion in which Mr. Basil Joy, the secretary, had organised the trials.

German Tramway Practice.—The *Street Railway Journal* of New York publishes an interesting article on German axle, wheel, and rail practice which is contributed by a German engineer. In it reference is made to the recent meeting of the Rheinisch-Westfälische Strassenbach-Betriebsleiter-Vereinigung held in Essen, when the members witnessed at the Krupp Works a series of remarkable tests of Martin crucible steel and nickel-steel street railway car axles. An equal number of finished axles, made of the two materials named, all 110mm. (4·33in.) in diameter, were subjected to several cold bending tests under a pressure of 5,000 tons. In the first trial one axle of each material was bent round a core of 120mm. (4 72in.) radius. The nickel-steel axle assumed the shape of the letter U, but failed to show the slightest evidence of rupture, whereas the Martin steel axle showed a break about 1in. deep on its outer surface. Another set of axles was taken for the second trial, but before bending each axle was notched in the centre with a heavy chisel. The nickel-steel axle again took the shape of a U without any apparent increase in the depth of a notch, but the other axle broke in two before one-fourth of the bending process had been completed, despite the fact that it was made of the best Martin steel. It is well known that most axle breakages occur at a sharp edge, as at the corner of the gear seat, and accidents of this kind, it is thought, will be avoided by the use of nickel-steel axles. Although these axles cost 40 per cent. more than those of the ordinary steel, they are largely used in Germany. The author goes on to describe the improvements in wheel-tyre material due to the introduction of nickel steel. Harder rails are being sought for in Germany, with the result that there is a considerable increase in the use of open-hearth steel for such work. As the result of this demand for harder rails, recent railway specifications call for a considerably lower drop test, for the reason that it is very difficult to get the required hardness of the rails if the former tensile strength is maintained, and because in tramway service tensile strength is really of less importance than hardness. For testing the homogeneous condition of the rails the etching test has recently been largely used. As a substitute for breaking tests, certain companies are now beginning to prescribe rolling pressure tests.

Calibrating Integrating Meters.—Mr. Douglas P. Morrison contributes to the columns of the *Electrical World* the following details of a simple method of meter testing he has developed to save labour. The method is applicable to any type of meter, of any size or capacity, but in the writer's present experience has been used only with two wire meters of the induction type. In its use neither the windings nor other electrical features of commercial meters need be altered, the only change made being in the recording mechanism, the gears being adjusted to a ratio of 10 to 1 between the disc shaft and the first indicating hand. There are provided two hands which record and repeat 100 revolutions of the disc. The disc being graduated to 100 parts, from the combination of disc and dial, revolution and fractions thereof from $\frac{1}{100}$ to 100 can be observed. In the shunt circuit of the "standard meter' is introduced an ordinary ball spring switch. The method of use is as follows: The "standard" and the "unknown" are so placed in the circuit that they measure the same load. The switch in the shunt circuit of the "standard" is then opened, and the reading of its disc and dial noted. When the disc of the "unknown" comes to the starting point, the shunt switch is closed, starting the standard, to which no further attention is paid by the observer. The requisite number of revolutions of the "unknown" is noted, and as it comes to the finish the switch of the "standard" is opened and its disc stopped. Disc and dial are again read, the difference between initial and final observations being the "standard revolutions," which, compared with those observed on the "unknown," give the error of the latter, without reference to the actual load on the two meters. Repeated observations under test have given duplication of results to within one-tenth of 1 per cent. on full load and one-half of

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1 per cent. on one-thirtieth load. In practice, the "standard' is compared with a reference standard placed in the position of the unknown, the two operations of calibration and test being identical, and therefore eliminating any error due to sluggishness in the starting and stopping of the working standard. The reference standard is calibrated in the ordinary way by comparison with indicating instruments. The method has been experimented with for some time on a large system, and has given such good results that a number of instruments have been built and are in constant use.

Medical Electricians.—The last issue of the *Lancet* contains the following letter under the heading "Laymen and Electrical Treatment": "Sirs,—It is unfortunately the practice of many members of the profession to send patients whom they may wish to be treated by some form of electricity or the X-rays either to a layman for this purpose or to an institution owned and managed by laymen. In London, and in most of the provincial towns, medical men who practice entirely in electro and radio therapeutics are to be found, and yet these are time after time passed over, while specialists and general practitioners continue to send their cases to laymen for treatment. In some instances, no doubt, the medical man is not aware of the fact that he can procure all he wants for his patient in a legitimate manner, but I am sorry to say that he has not very often even this excuse for his conduct, and considers that by being present himself for the first two or three sessions he has done all that is necessary. The fact is that in sending patients to unqualified persons for treatment the medical men doing so are guilty of covering, and their presence during the sessions cannot, and does not, exculpate them from the onus of the charge. In order intelligibly to supervise any electrical or X-ray application, a vast amount of technical and practical knowledge is necessary, and the mere presence of a medical man, unless he is equipped with this knowledge, does not contribute to the safety of the patent or the success of the treatment. Now, sirs, in the interests of the profession and the public at large, it is very important that this part of medical work is not allowed to get into the hands of lay institutions entirely. One after another such institutions are springing up all over the country, and where the professional man has too often a difficulty in making both ends meet, they are like the green bay tree of Scripture, flourishing. By the encouragement and support given to them by medical men, vested interests are being established which will be extremely difficult to combat in the future. Electrology and radiology have advanced greatly of late; the death-knell of those dainty little boxes of brass and ebonite and mahogany, known to the public by the all-embracing term of 'battery,' and to the medical man as a faradic coil, has sounded; but there is still much to do, and it is a little hard on those who have worked to raise electrology to the dignity of a science in the eyes of the medical profession that they should meet with so little recognition from their professional brethren, and that the quack-loving peculiarities of the lay public should be manifest in the profession itself. At the present time I know of a large firm of chemists in London making several thousands a year by taking radiograms of patients, in most cases sent by medical men; and another firm who started to sell static machines and other electrical instruments, and who are now giving up the sale of these machines because they find it much more profitable to treat patients sent to them by medical men than to sell these goods. Surely this is a crying scandal, and deserves that every effort should be made to stop it." The letter is signed "Fair Play," but we doubt the applicability of the *nom de plume* chosen by its author. The letter shows the spirit of the old trade guilds during the worst period of their existence. Medical men evidently prefer to go to experts for electrical treatment for their patients, and rightly so. That these experts may not have doctor's degrees and knowledge is not a disadvantage, as this skill is supplied by the patient's own doctor.

Electric v. Steam Railways.—The chairmen of the various railways have recently had to explain to their shareholders the results of another half-year's working, and in so doing have referred to electric traction. These chairmen may be classed under three headings—*i.e.*, those who have anticipated competition from electric tramways and met it by electrifying their railway sections affected, those who suffer from competition while sitting on the fence, and, finally, those who still consider the steam locomotive better than its electric brother. In giving extracts from these speeches or reports in the above order, we commence with the North-Eastern Railway Company. This report says: The substitution of electric trains for steam trains for suburban passenger traffic on the Newcastle and Tynemouth and riverside branches has been effected during the half-year. The work has been carried out most efficiently, considering the novelty and difficulty of many of the practical problems which had to be solved in connection with the adoption of the new form of traction. A large increase has been made in the number of trains on the branches equipped for electric traction, and up to the present there is every indication that the results, both as regards revenue and convenience in working, will be satisfactory. Sir Charles Maclaren, M.P., presiding at the general meeting of the Metropolitan Railway Company, said they had completed their generating station, and cables and conductor rails had been laid, and the general equipment of the permanent way completed from Baker-street to Uxbridge. Similar work was being prosecuted each night upon the Inner Circle section and would soon be completed. All points of dispute between the company and the District Railway had now been settled, and the two companies were working together in a most friendly spirit. If the District Company were ready, he anticipated the new system would be in full working order towards the end of the year. Mr. Cosmo Bonsor, at the meeting of the South-Eastern Railway, remarked that this was the first time since the working union that they had shown an absolute decrease in the passengers carried. The amount of money involved was only £4,000 odd, but there was a decrease of 139,000 passengers. The fact was principally attributable to the electrification of the tramways in the metropolitan area. One station in the metropolitan district alone showed a decrease of 60,000 passengers during the half-year, and all the stations which were affected by the newly-electrified trams showed a considerable decrease. The amount of money did not mean much, but it was of sufficient importance to place upon the managing committee the obligation of seeing whether some of those stations which had been continued open for the convenience of the public, rather than for profit to the shareholders, could not now be closed. Lord Claud Hamilton, chairman of the Great Eastern Railway, said that, owing to the uncertainty of electric traction, the directors thought it advisable not to undertake any new schemes in regard to electrical traction before being fully satisfied as to their value. The directors had carefully watched what was being done by other companies, and, if possible, would profit by their example. They had been watching that portion of the Lancashire and Yorkshire Railway between Liverpool and Southport which was worked by electrical traction, and he, with several officers

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of the company, had visited France for the purpose of ascertaining whether they could effect any alterations in the way in which their system was carried out.

British Association.—The Cambridge meeting of the British Association for the Advancement of Science promises to be an exceptionally interesting one. The fact that the Prime Minister (the Right Hon. A. J. Balfour, M.P., F.R.S.) is the president shows the close relationship between Imperial matters and science. The programme of local arrangements has now been issued, and from it one sees that the local committee have spared no pains to make the meetings a thorough success. The social functions are, if anything, more numerous than usual, and the business portion of the meeting is well arranged. It will be opened on Wednesday, Aug. 17, with the presidential address by the Right Hon. A. J. Balfour, which will be delivered in the Corn Exchange. On Friday, Aug. 19, there will be a lecture in the theatre by Prof. Geo. Darwin on "Ripple-Marks and Sand-Dunes." On Monday, Aug. 22, the lecture is to be delivered by Prof. H. F. Osborn, of New York, on "Palæontological Discoveries in the Rocky Mountains." The usual Saturday lecture to the operative classes will be delivered on Aug. 20 by Dr. J. E. Marr, F.R.S., on "The Forms of Mountains." The reception room in the Guildhall will be opened on Monday, Aug. 15. The programme of the various sections, as arranged up to the present, are briefly as follows: In Section A, on the Monday, Dr. R. T. Glazebrook will describe "Recent Work at the National Physical Laboratory." On Tuesday there will be a discussion on the "Radioactivity of Ordinary Matter," to be opened by Prof. J. J. Thomson; Prof. J. Larmer will read a paper on "The Relation between Röntgen Rays and Ordinary Light"; Prof. J. H. Poynting on the "Temperature Coefficient of *g*." In Section F, devoted to economical science, the presidential address will be delivered on Thursday, the 18th, by Prof. W. Smart to be followed by Prof. F. E. Edgeworth on "A Moot Point in the Theory of International Trade"; Prof. A. W. Flux, on "Improvements in Agriculture and their Effects on Economic Rent." The rest of the programme is as follows: Friday, Aug. 19—Mr. L. L. Price, "Economic Theory and Fixed Policy"; M. Yves Guyot, "The Incidence of Protective Duties"; Prof. W. Lotz, "The Effect of Protection on Some German Industries"; Prof. H. Dietzel, "Free Trade and the Labour Market." Monday, Aug. 22—Mrs. Bosanquet, "The Economic Importance of the Family"; Mr. H. McNiel, "Cotton-Growing in the Empire"; Prof. E. Mahaim, "Changes in Nominal and Real Wages in Belgium"; Mr. A. L. Bowley, "Tests of National Progress." Tuesday, Aug. 23—Mr. T. A. Baines, "The Distribution of Rural Population in India"; Mr. T. C. Horsfall, "The Housing Question"; Mrs. Fisher, "The Town Housing Question"; (possibly) Dr. Pierson, "The Housing Question." Wednesday, Aug. 24—Mr. C. T. Hamilton, "Trade Unions in U.S.A." (?); Mr. W. G. Adams, "The Modification of the Income Tax"; Mr. B. Ellinger, "A Proposed Substitute for the Sugar Tax"; Mr. H. A. Roberts, "The Employment of the Undergraduate." Date not settled—Dr. T. de Körösi, "Statistical Researches in the Mental Development of Girls and Boys." In Section L, which is devoted to education, there are to be informal discussions on important points rather than a series of papers by individuals. These subjects are as follows: (1) The school-leaving certificate of the Board of Education, University of London, and other examining bodies; (2) the national and local provision for training of teachers; (3) the methods of imparting manual instruction (in its broadest sense) in the various grades of schools. The above are specially arranged in view of the problems facing the new education authorities. (4) Lieut.-Colonel Mackinlay, "Realistic Arithmetic"; (5) Dr. R. W. Stewart, "The Place of Hemistic Method in Teaching Experimental Physics"; (6) J. H. Leonard, "Specialisation in Science Teaching"; (7) Report on "Influence of Examinations upon Teaching"; (8) Report on "Courses of Practical, Experimental, and Observational Studies in Elementary Schools."

Tramways and Depreciation.—In our issue for last week we referred to the able speech of Alderman J. A. Godwin, the chairman of the Finance Committee of the Corporation of Bradford, which had improved the financial policy of the Corporation. The following extract from the speech is worthy of full repetition in our columns, as it deals with a much debated matter. Speaking of tramway depreciation, Alderman Godwin said: "The question of depreciation had engaged a considerable share of attention in connection with the financial success of tramways and other municipal undertakings, and upon this question there were divergences of opinion and a variation of practice. The evidence put before the recent Royal Commission on Municipal Trading revealed the fact that even among experts there were two schools of thought. These might be broadly distinguished as the advocates of the English and Scotch systems. The distinction, so far as the Scotch method was concerned, is mainly credited to Glasgow, where, to some extent by the force of circumstances, they were practically tied down to the adoption of a method which, whether it received the assent of the judgment or not, had come to be regarded as part of their municipal creed. The very large income—although the stages were only ½d.—and the favourable character of their gradients, with other fortunate local conditions, produced such a surplus as enabled Glasgow not only to provide for repayment of debt within the prescribed period, and to repair and renew the plant, so that it was always kept up to practically its original value, but, in addition, to put aside such a further sum as would purchase a new tramway undertaking at the end of the sinking fund period. That was practically building up a reserve fund out of the pockets of the present generation which would be sufficient to provide for the next generation a system of tramways or other means of locomotion free of cost. That might be broadly described as the Scotch method, and it found certain advocates. Over and against this it was contended that the method adopted by the majority of English municipalities of providing for repayment of debt within the prescribed period, while keeping the undertaking in proper working condition and providing a fund for contingencies, was quite as much as could be demanded from the users of the tramways, either from a legal or a moral point of view. Where the reserve fund was sufficient to renew portions of the plant which periodically wore out, and where the daily wear and tear could be repaired out of revenue, and the statutory provisions as to sinking fund were adhered to, it appeared to him that neither in law nor in equity was a corporation called upon to do more. The Bradford tramway undertaking had been able to accomplish all this during the past year. The income had been £197,438; the working expenses, which included renewals and repairs, were £137,932, leaving a trade profit of £59,506, representing £7. 19s. 10d. per cent. on the productive capital invested, which was £744,431. The interest and sinking fund absorbed £46,106, leaving a net profit of £13,400. This it was proposed to utilise by wiping off the suspense balance of £10,483 in respect of the amount paid to tramway companies as surrender value of unexpired leases, and to carry the remainder, £2,917, to the depreciation of plant account. It was possible that

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objection might be taken to the apparently small sum which had during the last year been set aside for purposes of depreciation—namely, £2,917—as against £7,747 the year before and £10,015 the year before that, but he wanted to show that the Council could scarcely be expected to expend large sums in upkeep, renewals, repairs, and so on, and in addition provide a fund which would do the same thing over again. If the amount for depreciation was limited to a provision for contingencies and wear and tear which could not under any possible circumstances be met day by day out of revenue, that surely was the extent to which it could fairly be expected to apply. And it might fairly be said that if the amounts spent on repairs and renewals showed an increasing percentage upon the capital outlay, then the amount required for depreciation purposes should diminish in a similar ratio. In other words, if the two sums were added together and the percentage of their total upon capital was seen not to be in a diminishing ratio, then an equal provision for renewal and replacement purposes had been made. During the year ended March 31, 1902, the amount expended upon repairs and renewals was £11,900, and £10,015 was set aside for depreciation, the total giving a percentage on working capital of 5·22. In 1903 the expenditure under these two heads was £32,521 and £7,747 respectively, or 6·13 per cent., and in 1904 it was £40,233 and £2,917, or 5·79 per cent.

Wireless Telegraphy Bill.—The following memorandum explanatory of the Wireless Telegraphy Bill, introduced by Lord Stanley, the Postmaster-General, has been issued as a parliamentary paper [271]: "The development of wireless telegraphy during the past few years and the prospect of its further development and extended use in the near future have rendered legislation on the subject essential in the interests of the naval and military requirements of the Empire. In any future war, especially in a naval war, wireless telegraphy will, probably, play a very important part, and it is essential that the control of this method of communication should be in the hands of the Government. At present, the Governments of nearly all the great Powers and most of our self-governing Colonies have control over wireless telegraphy both for inland and foreign messages, but, except in the case of messages between two points in the United Kingdom and in territorial waters within the three-mile limit, the powers of his Majesty's Government are limited and inadequate. In time of war or emergency, the Government can take possession of the telegraph stations of incorporated companies carrying on telegraphic business, but the power does not extend to the installations of private individuals. The Postmaster-General can also impose conditions in connection with the arrangements for the transmission of foreign telegrams over the postal wires; but advantage could only be taken of this power where facilities for transmission were required, and this, obviously, might not be the case in connection with many installations of danger to the State. Otherwise, the only means of control possessed by the Government are furnished indirectly by an arrangement which has already been made in a number of instances with foreign Powers, by which those Powers undertake not to permit the establishment of systems of wireless telegraphy for communication between their own territory and the United Kingdom except after previous consultation with the British Government. An arrangement of this nature is obviously unsatisfactory and insecure, especially from the point of view of defence, and in time of war or strained relations would give rise to difficulties of a grave and far-reaching nature. It would at such times be of vital importance to prevent unauthorised information leaving this country, and, further, to secure uninterrupted communication between his Majesty's fleets and vessels and shore signal stations. Legislation is therefore needed for the following reasons: (1) The extreme importance in time of war or emergency of exercising control and supervision of all means by which information could be conveyed to an enemy, and of preserving such secrecy as to plans and preparations as is essential for successful operations. It is not a matter of great difficulty for a private individual to set up a temporary installation on his own property. This might, for a time, escape observation, but, if situated near the coast, would be a source of great danger in time of war, as it would not only be able to intercept messages from neighbouring stations, but might further be used for communication with unauthorised persons and the disclosure of naval and military arrangements. (2) One of the great difficulties to contend with in wireless telegraphy is interference as between neighbouring stations, and this must be met by limitation of the number of stations and careful selection of sites. If the number of installations were greatly increased and they were set up without regard to strategic requirements, the interference might easily be so great as to minimise the usefulness of wireless telegraphy for communication with his Majesty's ships. This consideration has especial weight in relation to times of war or emergency. (3) In time of war or emergency it is important that the Admiralty should at all times be able to communicate with his Majesty's ships, and with this view the Government should have power of stopping absolutely the use of wireless telegraphy in private hands when its use would interfere with such communication. Thus, from the point of view of strategic requirements, three of the most important points to be considered are: (*a*) control of the transmission of messages; (*b*) prevention of the establishment of unauthorised stations; (*c*) disposition of stations in the most advantageous way so as to obtain the best results in working, free from interference, accidental or intentional. It is only by means of legislation, and, preferably, by the licensing of stations, that these points can be secured. In addition to the above imperative reasons, there are others which render legislation for the control of wireless telegraphy very desirable. Proposals have been made for an international agreement to regulate wireless telegraphy in certain respects. Since international relations are concerned with wireless communication between stations in this country on the one hand, and ships on the high seas or stations in other countries on the other, it is desirable that the Government should be in a position to enter into an agreement on the subject with other countries, if it should be found expedient to do so. In the present state of the law there would be no means of enforcing the conditions laid down by such an agreement. Further, in order that the invention may be developed and applied with the greatest advantage to the public, it is desirable that matters such as the position of stations, and their interference with one another, should be regulated in the general interest. It is proposed in the Bill, for reasons of administrative convenience, that licenses should be granted by the Postmaster-General, since the Post Office is the department which deals with telegraphs in general, and is in relation with foreign telegraph administrations. On the other hand, it is provided that licenses shall not be granted except with the consent of the Admiralty and War Office, thus securing that the strategic considerations, which are of paramount importance, shall be regarded. As the progress of wireless telegraphy also affects the trade and commerce of the country, it is proposed to add the Board of Trade as a consenting party to the grant of a license.

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NORTHAMPTON CORPORATION ELECTRIC TRAMWAYS.

In 1902 the Corporation decided to convert the horse tramways to electric traction, and in May, 1903, instructed the borough engineer, Mr. Alfred Fidler, A.M.I.C.E., to prepare a complete scheme for the reconstruction of the existing permanent way, together with the construction of the authorised extensions; also the erection of a power

ALDERMAN WOODING, CHAIRMAN TRAMWAYS COMMITTEE.

station, generating plant, car depôt, overhead equipment, underground feeders, cables, and tramcars. In September, 1903, tenders were accepted for the various sections of the work, and shortly afterwards the various works were commenced.

Permanent Way.

The route length is about 5½ miles, equal to about nine miles of single track. The work comprised under this section consisted of the reconstruction of the existing tramways and the doubling for the greater part of the

J. GOTTSCHALK, ESQ., GENERAL MANAGER.

length No. 1—from Franklin's-gardens, St. James End, to the Drapery; No. 2—from the Drapery, along Abington-street and Kettering-road, to the terminus opposite St. Matthew's Church; No. 3—commencing at Abington-square, along Wellingborough-road, to the northern entrance to Abington Park; No. 4—commencing at the Drapery to the top of Sheep-street, with double line, thence along Sheep-street, Barrack-road, and Kingsthorpe-road, to the terminus at the junction of Harborough-road and Walford-road, single line with passing places.

The actual commencement of the work was made in January, 1904, and over several portions of the routes the traffic on the existing tramways was continued. At the present time the whole of the sections are completed with the exception of the Kingsthorpe section, which it is expected will be completed before the end of the month. For various reasons it was decided to maintain the existing gauge of 3ft. 6in. Where found to be sound, the existing concrete foundations were used, and for all new foundations cement concrete of the proportions of five parts

A. FIDLER, ESQ., BOROUGH ENGINEER.

of broken stone, one part of sand, one part of Portland cement was used. The rails are of the girder type, 6½in. deep, weighing 90lb. per yard for the straight rails and 96lb. per yard for the curved rails, and the fishplates weigh 50lb. per pair, having six bolt-holes.

The rails and fishplates were supplied by the North-Eastern Steel Company, Middlesbrough. Mild-steel tie-bars were used, and at each rail joint and midway in the length of the rails Anchor soleplates were used to secure the rails to the concrete foundations. The points and crossings were

J. MC'MAHON, ESQ., ELECTRICAL ENGINEER.

manufactured by Messrs. Askham Bros. and Wilson, of Sheffield; they are of cast crucible steel with forged steel tongues. The movable points are of the automatic spring type, and are interchangeable. The points are 12ft. in length and the crossings are of the iron-bound type, the arms being of similar rail section securely embedded in the castings. The rails are drained where necessary by means of drain boxes discharging into adjacent branch drains. The rails are bonded at every joint with protected copper bonds, the cross bonds being of solid copper of the Neptune

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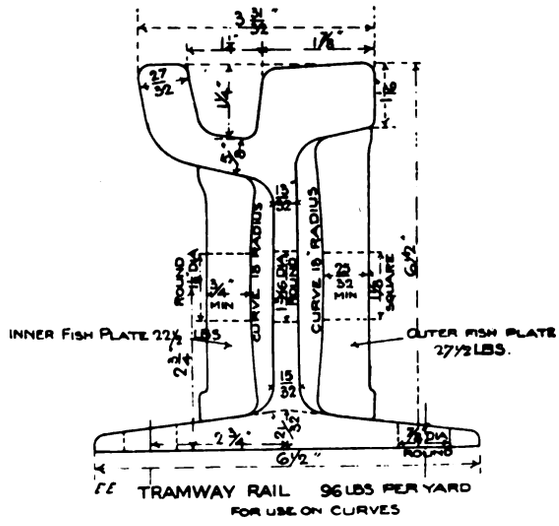
type. The permanent way is paved partly with Norwegian granite setts, and for the remainder with the old setts taken

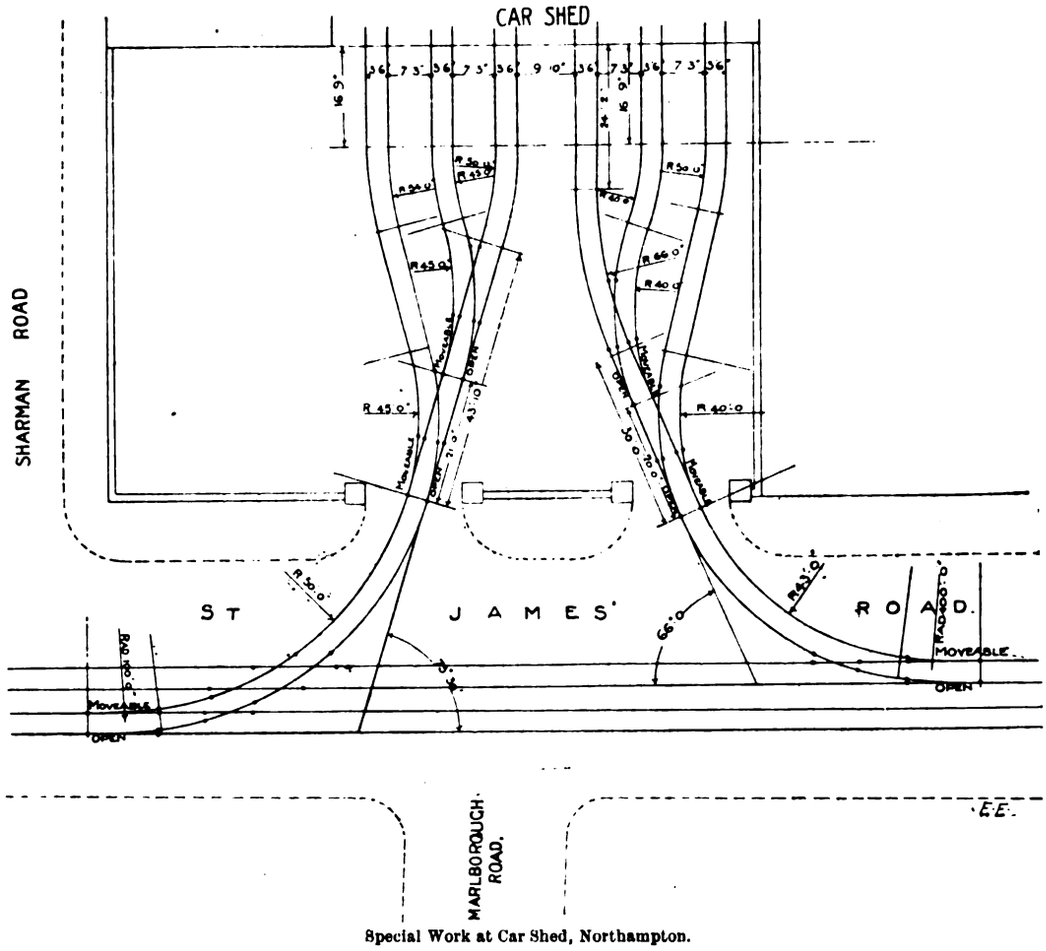
Town Hall, Northampton.

up from the existing tramways and re-dressed, the joints being grouted with Portland cement and sand.

in Castle-street in order to utilise the steam raised by the destruction of the town refuse by the dust destructor, the central position of which enabled a more economical distribution of current throughout the system. The engine-room is 63ft. long, 40ft. wide, and 22ft. 3in. high to the tie-rod of the roof trusses. The boiler-house is 46ft. 3in. long, 38ft. wide, and 14ft. 6in. high. These measurements are over all, and include pump-room, mechanical draught room,



and accommodation for coals. The storeroom is 38ft. long and 18ft. 7½in. wide. A similar space is devoted to the mechanics' shop and engineer-in-charge. Over these rooms is the battery-room, 38ft. long and 38ft. wide and 9ft. high to the tie-beam, with steel and concrete composite floor. The engineer's office, general office, and testing-room are each 12ft. by 12ft. 5in. by 14ft. high. There are two sets of bathroom and lavatory accommodation, 18ft. 6in. by 10ft. 10in. over all. The exterior of the building is of



Special Work at Car Shed, Northampton.

Power Station.

From economical motives it was decided to erect the power station upon ground adjacent to the refuse destructor

selected brickwork, with terra-cotta and stone facings, blue Staffordshire brick dado and plinth. The engine-room floor is laid with red tiles diagonally. The engineer's office floor

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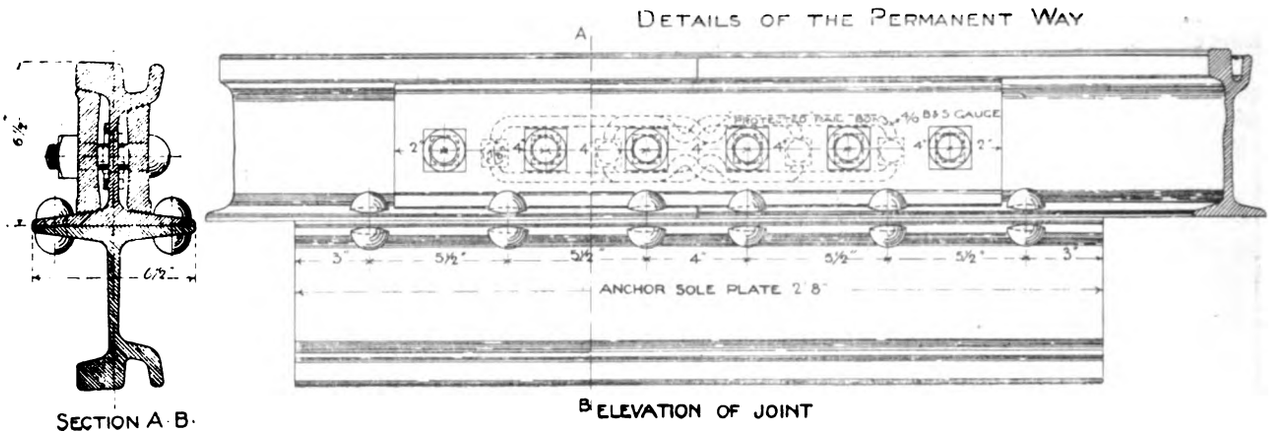
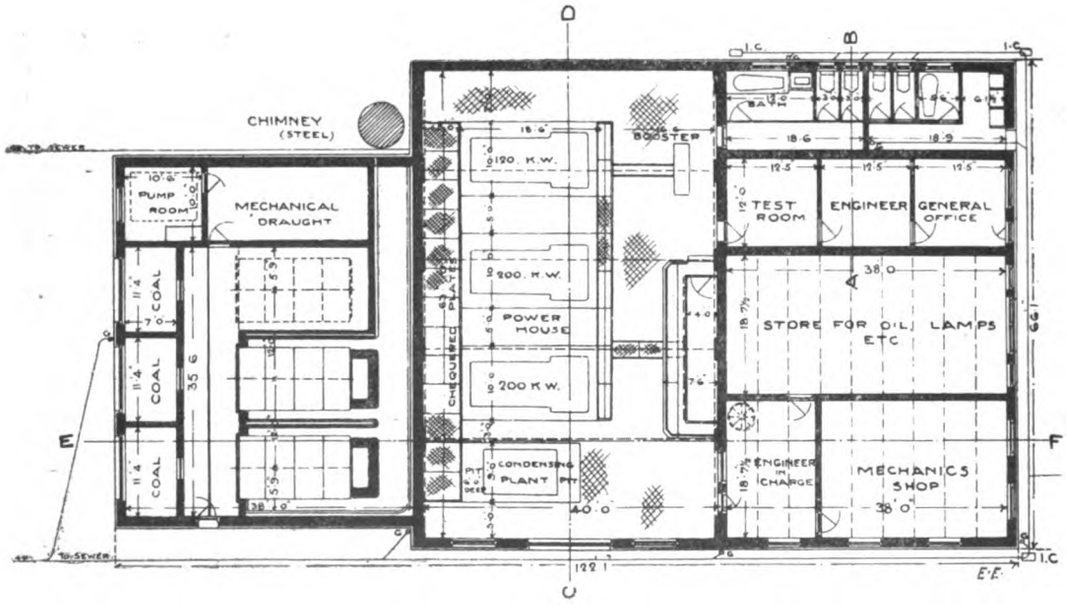


Details of the Northampton Track Work.



PLAN

Plan of the Power Station, Northampton.

is laid with wood blocks. The roof of the building is covered with Mellowes patent glazing, and the portions near the eaves are slated over diagonally-laid boarding.

STEAM-RAISING PLANT, ENGINES, DYNAMOS, ETC.

The existing plant at the refuse destructor consists of two Lancashire steel boilers, 30ft. long and 8ft. diameter, suit-

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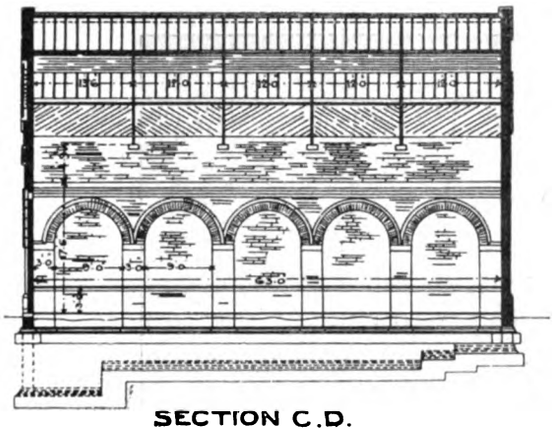
able for working to 160lb. pressure, with a Green's economiser for feed-water heating. The steam-raising plant in the new power station consists of two boilers of the Economic type, each capable of evaporating 8,000lb. of water per hour, and made by Messrs. Davey, Paxman, and Co., of Colchester. The boilers are fitted with mechanical stokers of the Bennis type, and superheaters are placed in the boiler flues capable of superheating the steam to 500deg. F. The boilers are fitted with an induced-draught plant provided by two motor-driven fans and a steel stack. The feed pumps are of the Weir type, and the steam-valves are of Messrs. Templer and Ranoe's make. The steam-piping provides for the coupling of the two Lancashire and the two Economic boilers.

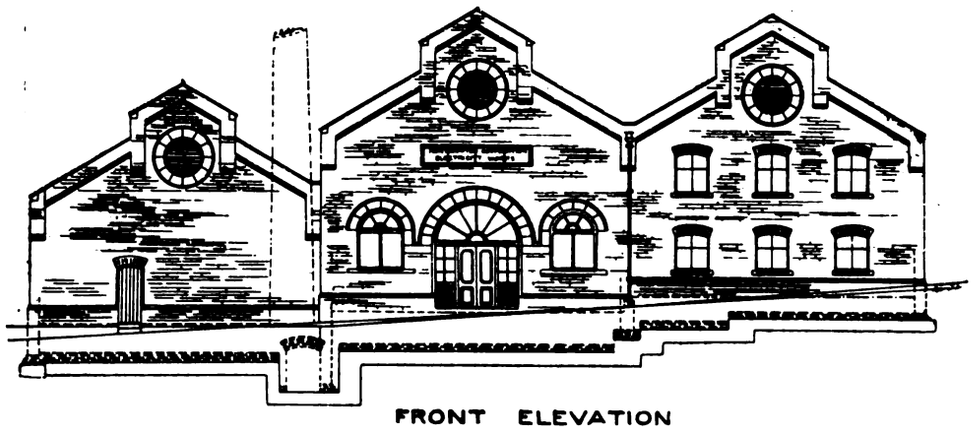
The condensing and cooling plant consists of a Mirrlees-Watson condenser, capable of condensing 12,000lb. of steam per hour. The centrifugal circulating pumps and an Edwards air-pump are motor-driven. The cooling tower is of the Klein type, about 70ft. high. It is of timber, and of the natural-draught type, resting on a brick-faced concrete tank about 22ft. by 32ft. by 7ft. deep. A Paterson water softener and oil separator are provided to deal with the make-up water and the oil after the water leaves the condenser. The water supply will be obtained from the town supply and from a well sunk on the site.

The generating plant consists of two 200-kw. sets, composed of Willans compound three-crank engines running at 300 revolutions per minute, and capable of giving 360 i.h.p, and International Electrical Company's dynamos; also one compound set capable of giving an output of 120 kw., and consisting of a Willans two-crank compound engine running at 350 revolutions per minute, capable of giving 240 i.h.p., and a dynamo of the International Electrical Engineering Company's make. The battery was made by Messrs. Ashmore, Benson, and Pease,

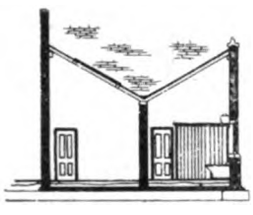


SECTION C.D.

ELEVATION OF OFFICES TO ROAD



FRONT ELEVATION



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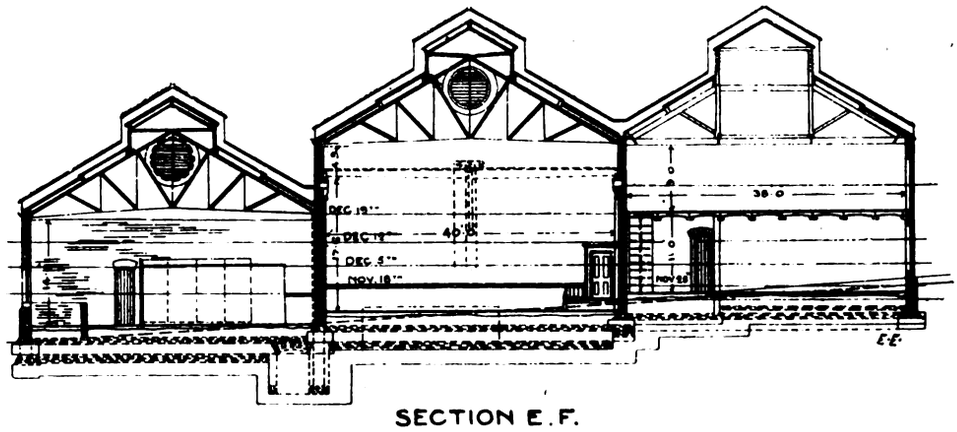
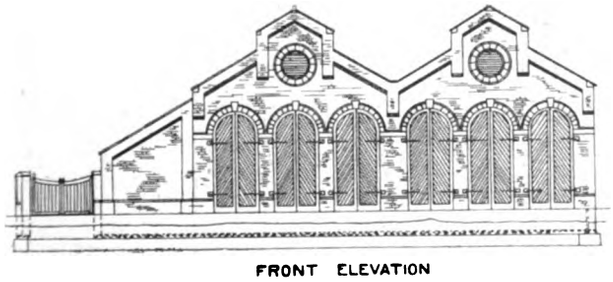


SECTION E.F.



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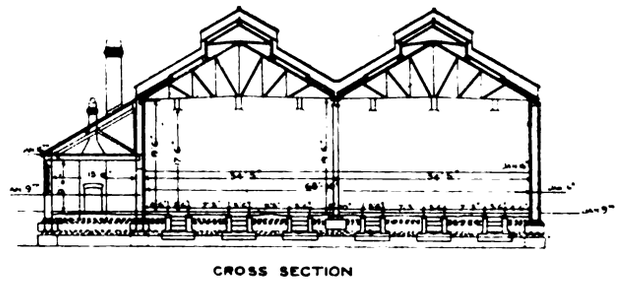

CROSS SECTION

Elevations and Sections of the Power Station, Northampton.

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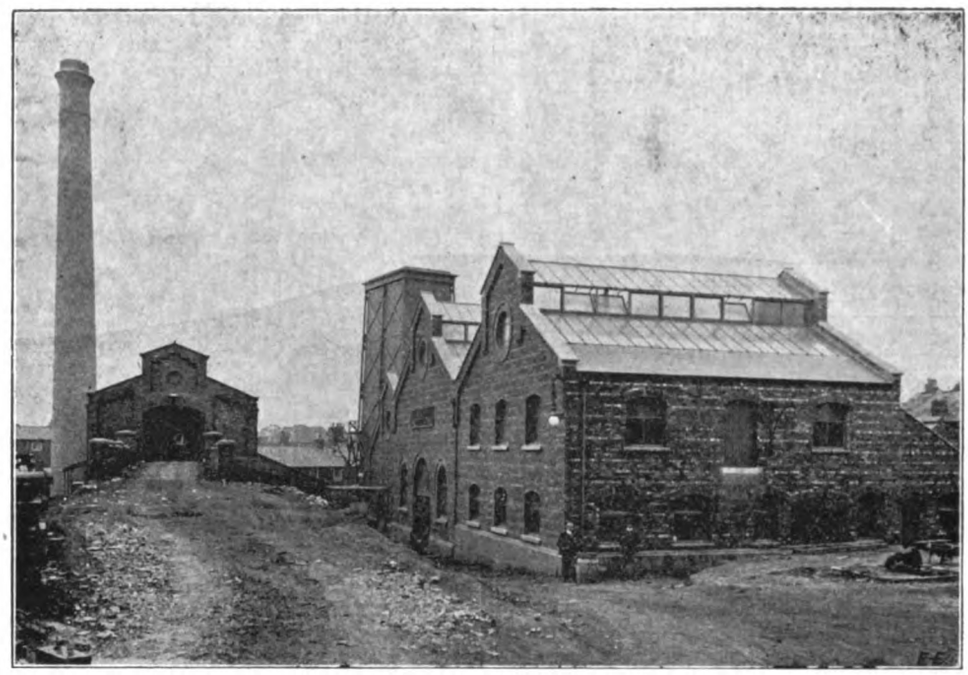
of Stockton-on-Tees. It consists of 250 cells, and is capable of giving out 170 amperes for three hours. There is also provided a reversible booster and milking set, both made by the International Electrical Engineering Company.

The switchboard has eight panels of white marble mounted on a steel framing carried on a wooden platform. The panels carry the necessary circuit breakers, ammeters, lightning arresters, voltmeters, wattmeters for the recording and control of the current generated. In the engine-room there is an overhead travelling crane of 40ft. span, capable of lifting 10 tons, made by Messrs. Jessop and Appleby, of Leicester. The power station is lighted throughout by electric light.

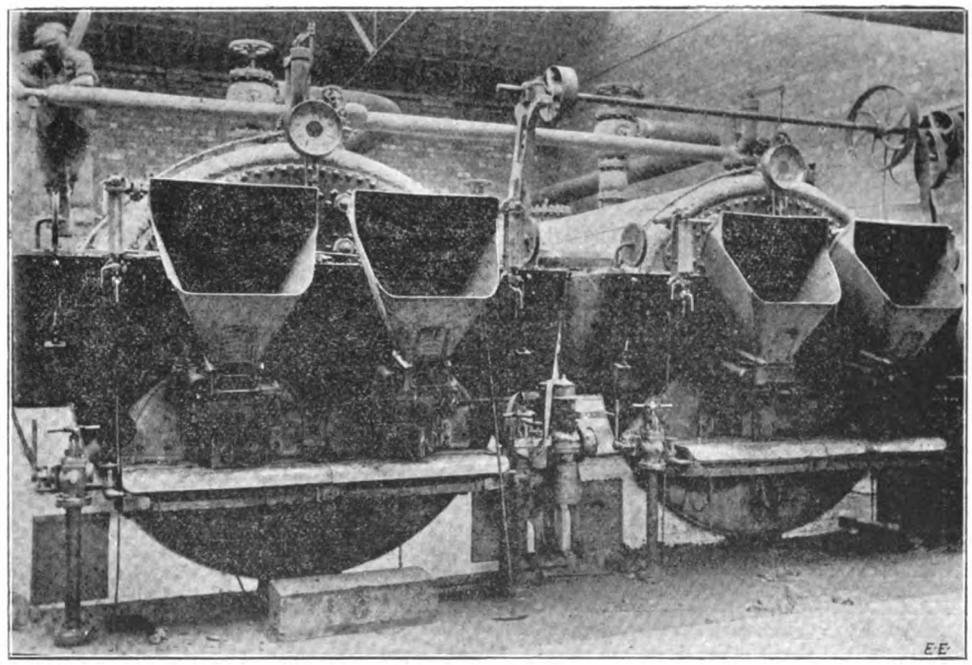


The Generating Station for the Northampton Electric Tramways.

Overhead Equipment.

The overhead equipment is to a great extent on the span-wire principle, with bracket-arm construction in the narrow streets. The poles are of lap-welded steel in five sections, telescoped into each other, and have an ornamental wrought-iron base bearing the borough coat-of-arms. The span-wire poles have curved wrought-iron scrollwork, and the bracket arms have ornamental iron scrollwork supports. Each pole is capped with an ornamental finial. All poles are embedded in the ground to a depth of 6ft. and rest on a concrete base, and are surrounded with concrete up to the underside of the pavement. Double trolley wires are fixed throughout the whole of the system. The wire is hard-drawn copper, No. 000 B. & S. gauge. All frogs and crossings are of gunmetal, and the span and guard wires are of galvanised steel.

The feeder pillars are arranged at half-mile intervals, and consist of cast-iron boxes containing enamelled slate panel, upon which are mounted the necessary switches and lightning arresters, etc., and opposite each feeder pillar on the overhead wires there is a sectional insulator, which divides the overhead line into corresponding half-mile sections, which are fed on either side of the insulator from the feeder pillar. The overhead system is arranged generally for normal central running, excepting the side-arm bracket construction, where it is on the average 4ft. from the centre of the track.



The Northampton Boiler Room—Davey-Paxman Economic Boilers and Bennis Stokers.

The current is conveyed to the various parts of the system by means of lead-sheathed cables laid on the draw-in system in Sykes stoneware multiple conduits. The pilot wires for the return current from each terminus to the

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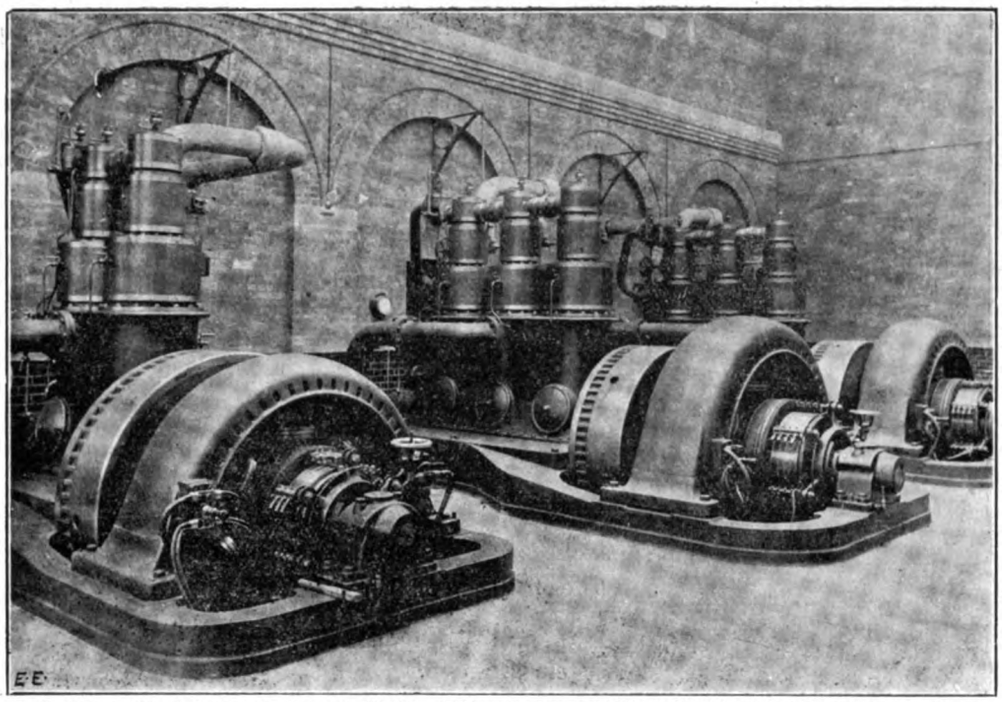
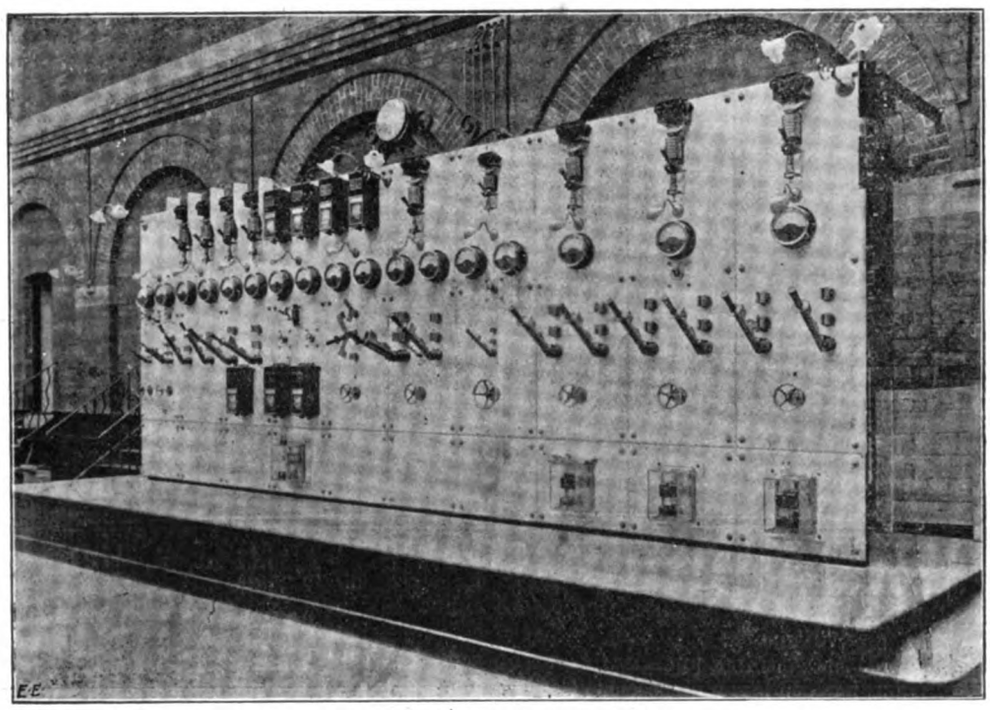
generating station and the telephone wires are carried in three-core lead-sheathed cables in ducts as far as the feeder cables, and laid on the solid system for the remainder of the lengths.

CARS.

There are 20 cars of the following dimensions: length of car body, 16ft.; over-all length, 26ft.; total over all-width, 6ft. 4in. They are all of the single-truck double-deck type. The framing is of oak, the flooring of pine, the dashers of steel plates, the stairway stringers of sheet steel firmly bolted to the car body and platform. The handrails are of brass tubing. The collision fender round the platform is of steel section. The waist panels are of mahogany, and the roof framing is of ash. The ceiling of the cars is of three-ply maple veneer. The upper deck is of pine, and is provided with wearing slats. The railing round the upper deck is formed of polished brass tubes filled in with strong wire screens. The doors are of oak with handsome carved panels. The seats are of perforated veneer, and special provision is made for thoroughly ventilating the cars in the interior. The cars are provided with an effective system of lighting, with head lights, signal lights, and lights for the destination indicators. The cars are handsomely finished in an artistic fashion, the waist being a rich crimson with gold-panelled borders, the remainder of the body being cream. The trucks are of the Brill type; the wheels are of chilled iron, 2ft. 6in. in diameter, and hand-brakes and slipper brakes are provided. At each end of the car an automatic safety guard of the Hudson and Bowring type is fitted. This consists of a hanging gate, which, on meeting an obstacle, flies back and releases a sloping gate in front of the wheels, and drops to the ground, and prevents any body which might be on the track from reaching the wheels. The lifeguard remains down until released by the driver. There are two motors fixed to each car, each of 27 h.p. rating. The gearing between the motor and the axle consists of pinion and spur wheels enclosed in a cast-iron oil-tight gear case, the gear running in an oil bath. A new feature introduced into the cars is the steps. These are made of steel frames,



The Engine Room of the Northampton Tramway Station—Willans Engines and International Electrical Engineering Co. Dynamos.



The Switchboard, Northampton.

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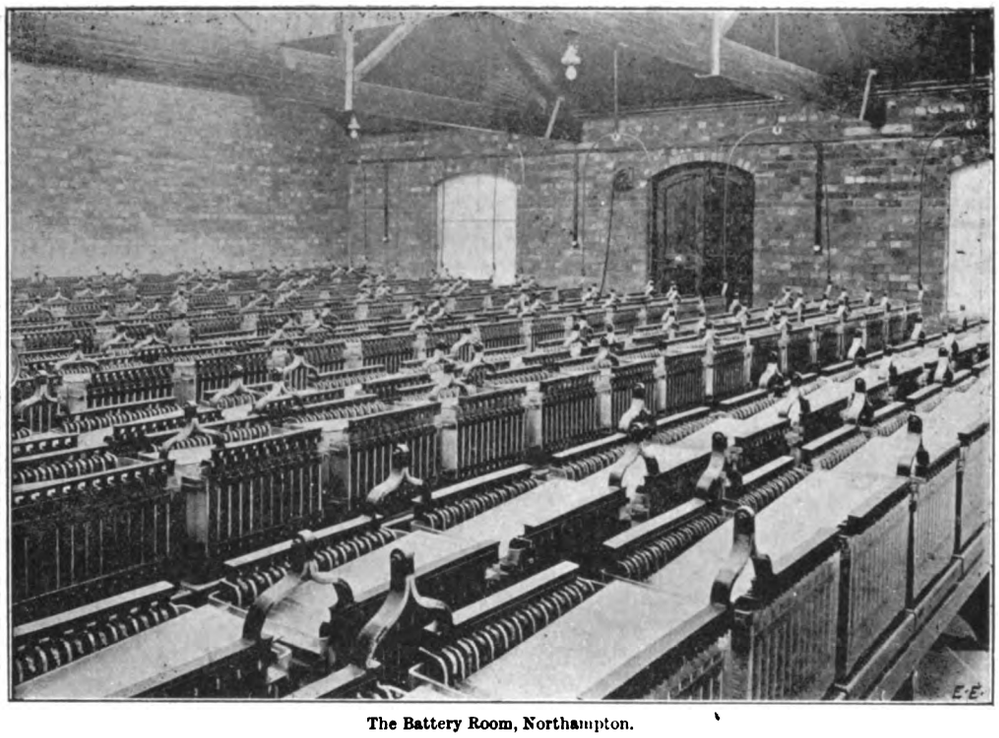
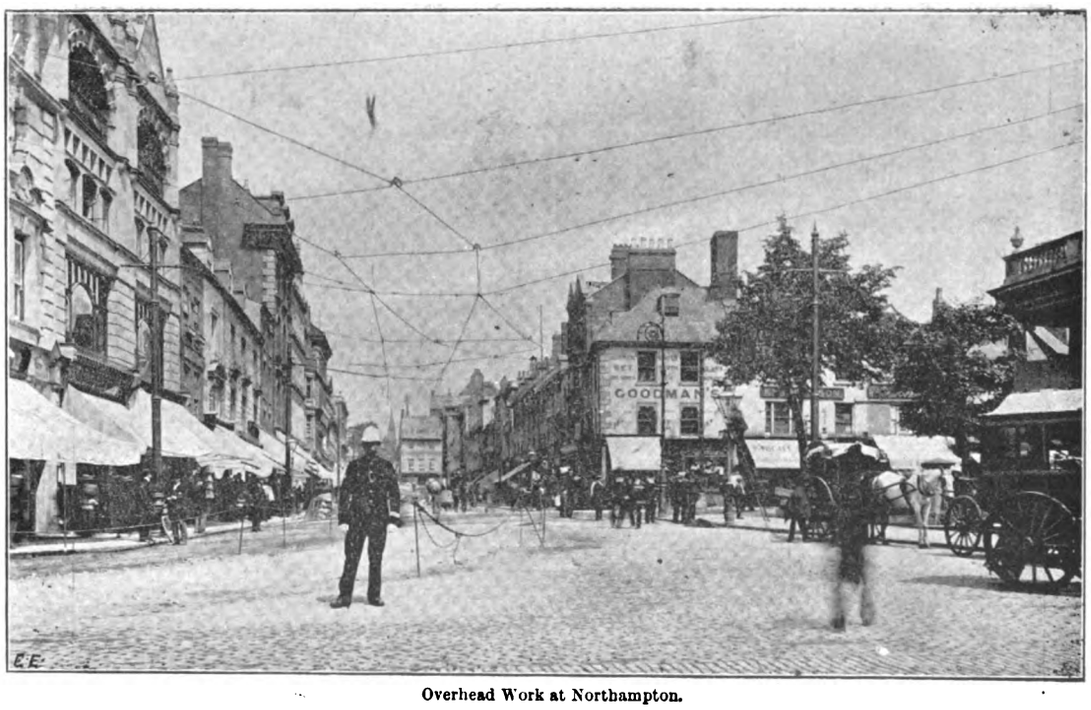
filled in with lattice work. The step can be folded by means of gearing worked by a ratchet, which also secures and locks the platform gate at the same operation. The steps at the driver's end are so arranged as to be always folded. This type of step prevents any projection from the front of the car. A controller is placed on each platform of the series-parallel type, and is arranged so that the main controller can be interlocked with the reversing switch.



The Battery Room, Northampton.

The mast carrying the trolley arm is of the enclosed spring type, the top of the mast being 5ft. 5ft. from the crown of the car. The trolley arm is of steel tube tapering from 2in. at the base to 1in. at the top. The trolley head is of the swivel type, and is insulated from the arm. The arm is also insulated from the mast.



Overhead Work at Northampton.

Car-Shed.

The main building is 150ft. long and 68ft. 10in. wide and 10ft. high to the tierod, and will accommodate 30 cars. The general office, manager's office, stores, carpenters' shop, repair shop, and smithy adjoin the building, and are 15ft. wide and of varying length. Next these shops, etc., is the yard for general stores, and is 140ft. long and 20ft. wide, in which is placed the lavatory accommodation. The shed is divided into six bays, and a pit extends the whole length under each bay except a short length for door opening, etc. Each pit is drained. The steel roof is supported with steel stanchions, 24ft. apart, at each end of which is a rain-water down pipe and a stand-pipe, etc., for car-washing. The yard in front of the building is 75ft. long and 106ft. 2in. wide. The building is treated similar to the power station on the elevation.

The contractors for the various sections were as follows: boilers, condensing plant, etc., the British Westinghouse Electric and Manufacturing Company, Manchester; steam generators, dynamos, battery, etc., the International Electrical Engineering Company, London; the overhead trolley equipment, the Brush Electrical Engineering Company, Limited, London; underground feeder cables and pilot wires, Messrs. Siemens Bros. and Co., Limited, London;

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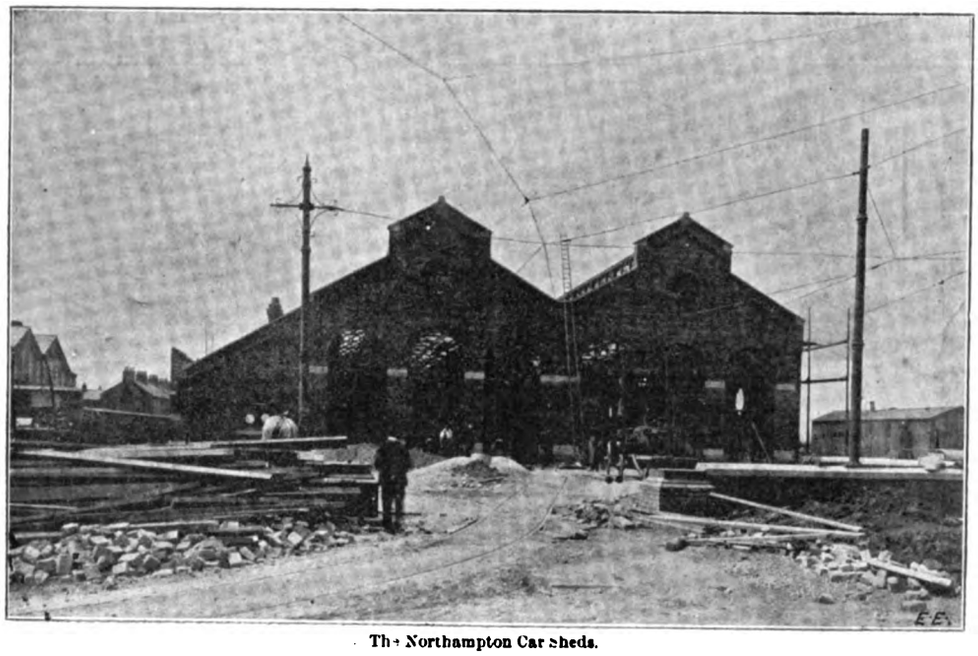
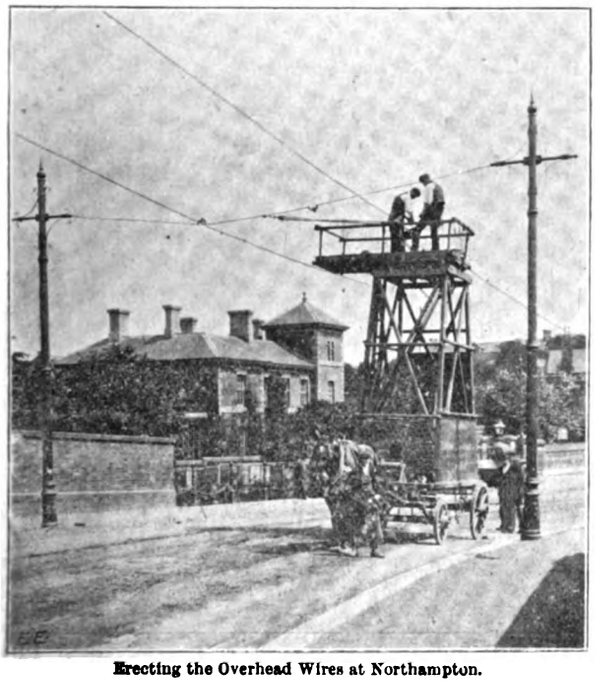


The Northampton Car Sheds.

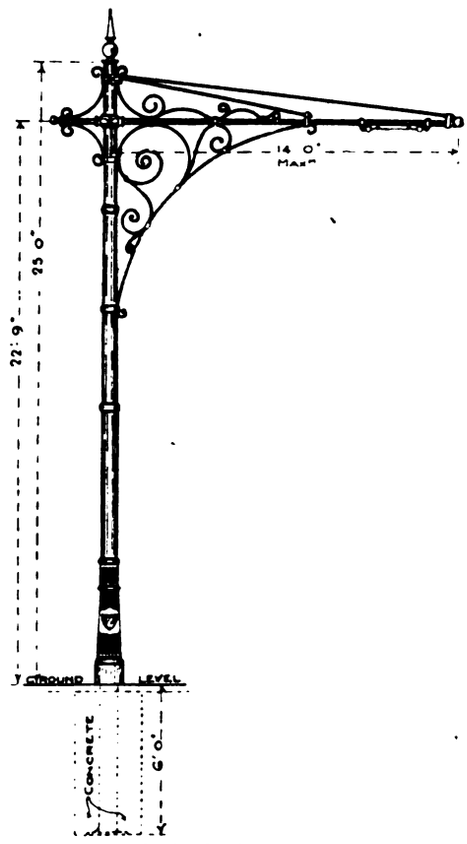
H. HANKINSON, ESQ., TOWN CLERK, NORTHAMPTON.



Erecting the Overhead Wires at Northampton.

cars, Messrs. Dick, Kerr, and Co., Limited, Preston; permanent way, Messrs. J. G. White and Co., Limited, London; power station, W. Beardsmore, Northampton; car-shed, Messrs. Watkin Bros., Northampton.

The scheme has been prepared and carried out by Mr. Alfred Fidler, A.M.I.C.E., borough engineer, and the following members of the borough engineer's staff have assisted in the execution of the scheme: Mr. J. McMahon, A.I.E.E, as resident electrical engineer; Mr. A. W. Ward,



Pole for Overhead Work.

A.M.I.C.E., as superintendent of the permanent way; Mr. S. Wilkinson, as superintendent of the erection of the power station and car-shed. The whole scheme has been carried out without the aid of an outside consulting engineer.

ELECTRIC LIGHTING OF DEVONPORT, TASMANIA.

There are few towns in the United Kingdom of population less than 5,000 that can boast of an electric light supply of their own. An instance of what has been recently

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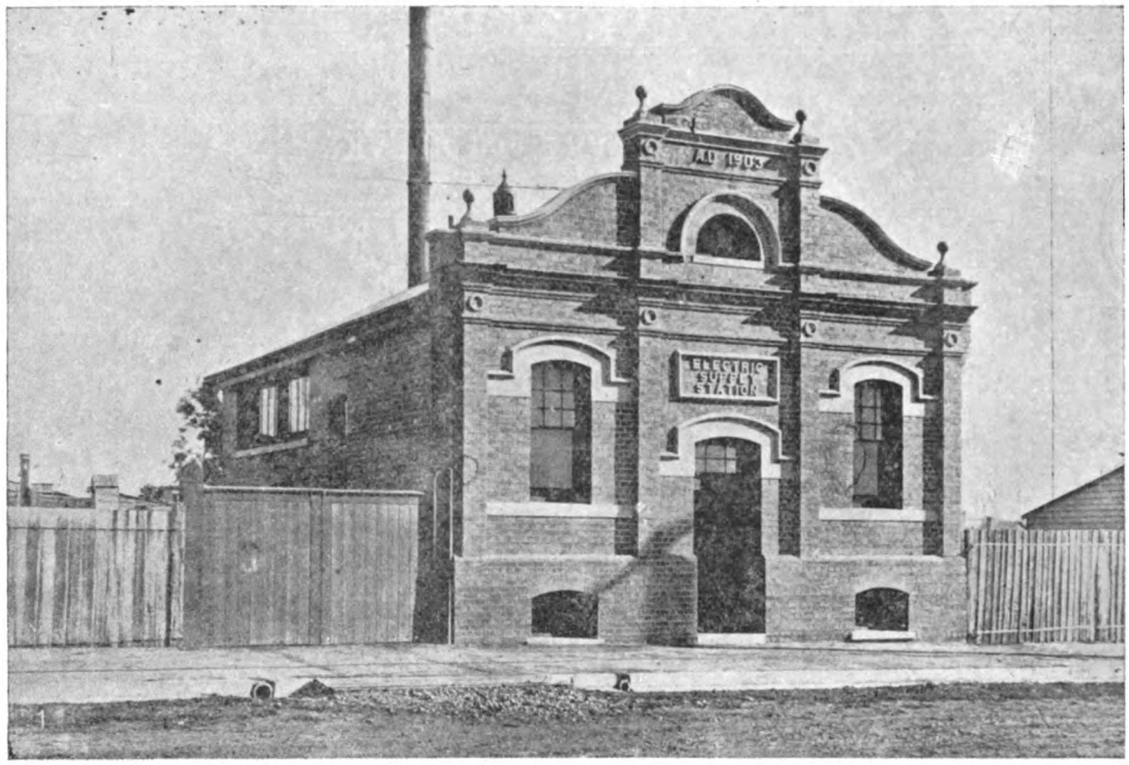
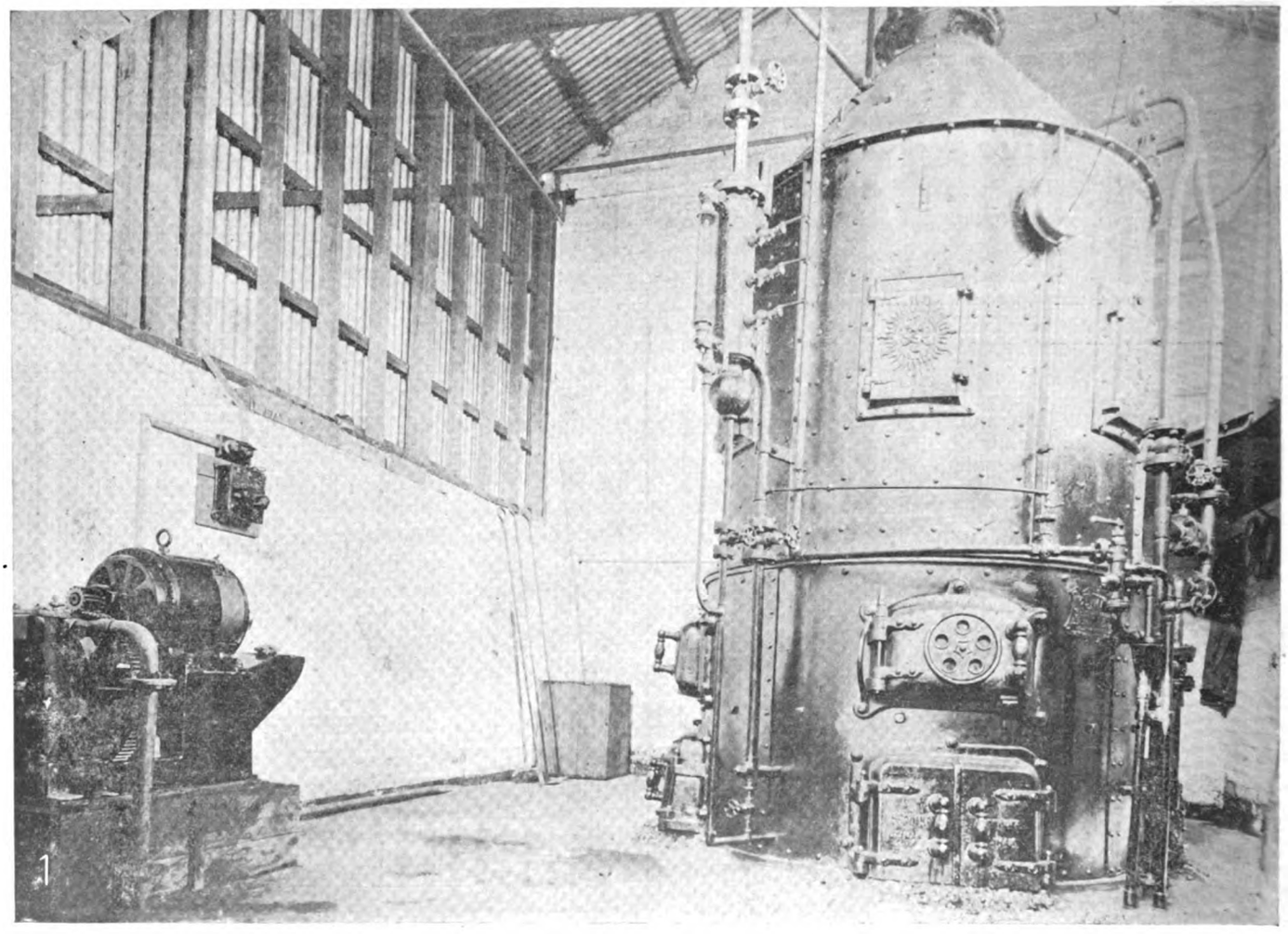
accomplished in a small town in far-off Tasmania may therefore be not uninteresting to our readers. Very hazy notions exist in the minds of many English people as to where Tasmania is. It is thought to be somewhere in Australia or New Zealand; it is known chiefly by the Tasmanian apples with which the London market is regularly supplied for three months of the year; and the natives are supposed by some to be black people, by others to be the descendants of those who in days gone by were granted a free passage at His Majesty's expense, usually for some trifling misdemeanour, to Van Diemen's land as Tasmania was then called.



Exterior View of the Power House at Devonport, Tasmania.



The Boiler Room at Devonport, Tasmania, with Climax Boiler.

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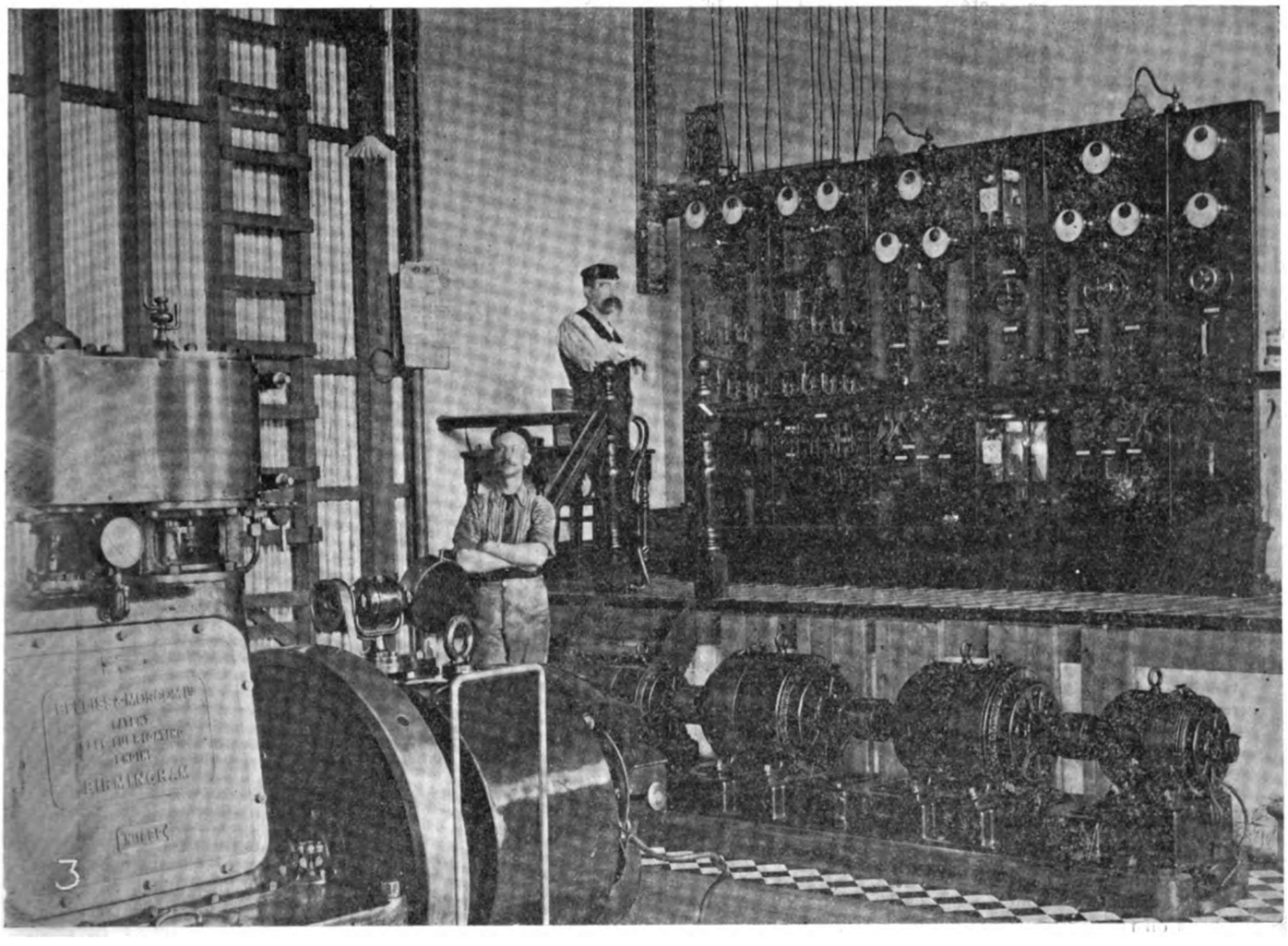
Actually Tasmania is the smallest of the States of the Australian Commonwealth. In its insular position and its proximity to the neighbouring continent, from which it is distant about 100 miles to the south, it offers a close analogy to the parent country, that "precious stone set in the silver sea," and like it, compared with the mainland, its equable climate and luxuriant vegetation combined, proclaim it another "Eden, demi-Paradise." The P. and O. and Orient mail steamers call regularly at Hobart, in the south of the island, during the apple season, which lasts about three months, and each week there are shipped from 20,000 to 30,000 cases of apples, each holding about 50lb. Recently a movement has been set on foot for the establishment of a deep-water port for Northern Tasmania, and Devonport is now vieing with the neighbouring city of Launceston to secure the distinction.

The town is situated on both sides of the River Mersey, which affords a safe anchorage for the largest vessels afloat.



The Engine Room, with Belliss Engine, Brush Dynamos, and Dorman and Smith's Switchboard.

Five years ago the population was only 1,800, and the Town Board's annual assessment £7,000; to-day the population approaches 5,000, and last year's assessment was over £17,000. That this expansion is likely to continue is evidenced by the number of new buildings, including a handsome brick church and a large hotel, now in course of erection. The town possesses a reliable water supply, and has just been furnished with a modern electric lighting equipment.

The Town Board is composed of smart and progressive business men, and to their zeal in its interest this latest undertaking is due. Two years ago the Board, after careful enquiry and the consideration of much expert and other evidence, unanimously decided to instal a system of electric supply suitable for public and domestic lighting and for the supply of power. The Board obtained the services of Mr. William Corin, A.M.I.C.E., M.I.E.E., once with the Metropolitan Electric Supply Company, but for the past eight years city electrical engineer of Launceston, Tasmania. Mr. Corin's first scheme provided for supplying the whole of West and East Devonport, but owing to a certain amount of opposition it was thought wise to commence by driving in the thin end of the wedge, and hence a diminutive scheme for supplying only the principal streets of West Devonport was adopted. Tenders were then called and contracts let, the Brush Company supplying the main part of the generating plant, Mr. T K. Steares, representing the Tudor Battery Company, receiving the contract for the accumulator. Contracts for the building and for wooden poles and arms were let locally. The Board subsequently appointed Mr. Geo. H. Lofts as their town electrical engineer, to act as clerk of works during construction, and to take over the control when completed.

Direct-current, three-wire, 440 volts across outers, with accumulators, is the system adopted. A 70-h.p. Morin's patent "Climax" boiler, by Rowland and Co., of Reddish, supplies steam to a 48-kw. direct-coupled set, the engine being by Belliss and Morcom, and the generator being a four-pole "Universal" Brush machine, with Mordey "chord" winding. The battery consists of 240 L E 7 Tudor cells, and a balancing and boosting set, also of Brush manufacture, is provided, the four machines being direct-coupled. The switchboard, by Dorman and Smith, was supplied by the Brush Company, as also was an electrically-driven feed pump of the "Hatfield" type, by Merryweather and Sons. A complete set of Weston instruments for standardising purposes is provided.

The building was entrusted by the consulting engineer to his colleague, Mr. C. St. John David, M.S.E., city engineer and surveyor of Launceston, Tasmania. It is of Queen Anne design, and is built in red brick, with a temporary side so arranged as to allow for extensions. The whole plant is laid down with this in view, and the switchboard, perhaps unnecessarily complicated for the present small area and small load supplied, will be sufficient for supplying the whole of East and West Devonport in the

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future. The building will accommodate one additional set similar to the present one, and by extending it northwards room may be provided for three more sets. But before this is necessary, if Devonport continues to grow, it is probable that a water-power transmission scheme may be adopted, which will make a large supply available, and in this respect Devonport will follow the example set by Launceston, where new plant, by Kolben and Co., to the extent of 1,200 kw. is now being erected. The consulting engineer was, however, unable to advise commencing the Devonport supply with water power, owing to the small initial demand contemplated and the heavy capital expenditure involved. With steam power, on the contrary, a balance of a few pounds to credit is shown on the first complete quarter's running.

Owing to the policy advocated by the consulting engineer, and adopted by the Board—viz., to undertake the wiring of houses on the hire-purchase system, or, if desired, to put in the wiring for 10 per cent. rental per annum—a nearly full load of 3,000 lamps was waiting for the plant before it commenced to run; and now, after eight months' running, a poll of the ratepayers has decided by a two-thirds majority to increase the loan from £7,000 to £11,000—*i.e.*, the full extent of the parliamentary powers obtained by the Board—in order to provide funds for the duplication of the plant.

The mains are all overhead, and the street lamps are suspended from ornamental iron brackets. With one exception, there is nothing particularly novel about the outdoor work; that exception is the method adopted for changing over from arc to incandescent lamps, which, so far as we are aware, has not been employed before, the idea being due to Mr. Corin. At present, in addition to 29 incandescent lamps of 25 c.p. each, there are only 10 enclosed arc lamps, 10 more incandescents being arranged to take

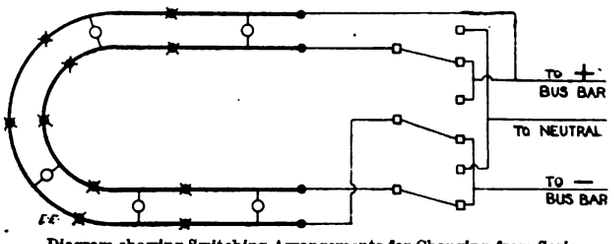

Diagram showing Switching Arrangements for Changing from Series Enclosed Arcs to Incandescent Lamps at Devonport, Tasmania.

their place when desired. The method of switching either the one or other set of these on is shown in the accompanying diagram. The arc lamp circuits are arranged as a pair, each with five lamps in series, and the alternative incandescent lamps are connected across the circuits, as shown in diagram. With the arc lamps running, the two circuits are in parallel across the outers. By means of a three-pole double-throw switch, both ends of one circuit are connected to either the positive or negative 'bus bar, and both ends of the other circuit to the neutral 'bus bar; with this arrangement, when the incandescent lamps are alight, they are all on the positive or negative side of the circuit; but with four circuits comprising 20 lamps, two would be on the positive and two on the negative, thus preserving the balance. The idea is, of course, capable of development for larger areas requiring a larger number of lamps. The fuel used is bituminous coal of a very fine quality obtained from a thin seam a few miles from Devonport.

This little scheme having been successfully launched, we shall hope in the future to place figures showing its progress before our readers. With all the disadvantages of heavy protective duties on machinery and somewhat dearer coal to contend against, it should encourage some of the smaller English towns to know that a commercial success may be made of electric lighting in such an out-of-the-way place as Tasmania.

Slight Accident at Blackpool.—One of the overhead wires on the Promenade tramway route at Blackpool collapsed on Tuesday afternoon. The front was crowded at the time, and there was an excited stampede, but the cut-off appliance worked successfully, and no harm was done beyond the dislocation of the tramway traffic for a short time.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

II.—On the Method of Training.

My Dear Young 'Un,—You have adhered to your intention of becoming an engineer, and an electrical one! I thought you would. Many ask advice: few take it. Now you want to know "the best course of training"! The problem is as difficult as the Hampton Court Maze. There are plenty of entrances: the job is to find the path that gets *there*. To make confusion worse confounded, each man has his own particular maze—no two temperaments are alike. If you want learned literature on the subject, read the discussions at the Institution of Electrical Engineers this year. There you will see how doctors disagree.

The points I should advise you to consider are, your physical constitution, your temperament, your pocket, and fortuitous circumstances. I don't know that this order is in degree of importance; you had better think them all over very carefully.

So far as I recollect, your health is normal. You did yourself credit the day we lunched at Slaters. I had to give the waitress twopence extra to save my face! Also, you are not full-back in your School Rugger team for nothing. So hard work will not hurt you. If you were a little older than fifteen, I should recommend you to go into the shops during the day and take classes in the evening. I am a trifle afraid of it at your age, however—you mustn't be an old man before you are a young one. Whether you take theory first and practice after, or *vice versâ*, is an open question—though you *must* have both. The best life to lead depends upon the liver. Above all things, you must keep fit, even if you have to go slow.

This is where your temperament comes in. If you were a very brainy man—preferring to sit down and swat rather than play cricket—I should emphatically send you into the shops right away to get some life knocked into you. The tendency for the head-work required in engineering being already strong, the aptitude for hand-work should be acquired while adaptability remains. Nothing is more pitiable than the office-man who has a horror of seeing his work through the shops; he is no more than a specialised clerk. And you should bear in mind that the ease with which technical education is now obtained, and the repugnance which exists in plunging from the College into the Shop, is turning out a glut of these paper-engineers.

But—if you will excuse my saying it as between friends—you are a trifle thick-headed as regards theory. I understand that the Binomial Theorem is rather outside your weight, and that you carelessly left the fume-chamber door open in the Practical Chemistry Class to see if sulphuretted hydrogen really was injurious to life. If you don't get some theory banged into you now, you'll never absorb it. So you had better go to a Technical College for a couple of years. And I humbly pray that patience and a saving sense of humour may be granted to your teachers. Of course, if your pater could afford it, the ideal plan would be to send you to College for, say, six months in the year, to a works as pupil for the other six, and to keep this up for three years. This would cost something, however; and I expect you would begin to grouse about losing your holidays! The ordinary college terms leave a good many gaps in the year. Why not try to get a job as odd man in a shop to fill up the time?

Fortuitous advantages may arise—you may have someone in tow who can pitchfork you into a place where experience may be gathered in armfuls. If so, haul on the tow-rope. (But don't think *I'm* on the other end of the line. I have no vacancies for beginners, and personally I think you will be a better man if you go through the rough fair and square with all the rest of them.) Don't use your influence to get salary or position. If it is a job where you are supposed to do what you *can't* do, don't touch it! There is no need to be a fool artificially—you have quite enough natural aptitude (speaking again as a friend).

Be careful not to specialise too soon. You have a lifetime before you; a long-bore gun carries further than a

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short-bore. If you can spend eight years in learning with disregard for salary, so much the better for you later on. Pocket again!—the longer you can hang on to poor salary and rich experience, the better in the long run. Become a general engineer first—an electrician after. Electrical engineering can be far more easily studied from books than mechanical practice. Rub your nose into the practice while you are young; there is plenty of time later on to wear white shirts.

As a relief from engineering, study finance. An engineering firm may turn out beautiful engines, but if it doesn't pay, the shareholders will grumble. While you are in the shops, study the economic aspect of speeding-up lathes and working double gangs. If you get into a supply station, try to understand the Maximum Demand system. It is worth an engineer's while to study for some of the Institute of Bankers' exams., if he can find time.

One thing more! Don't be haughty to men of inferior education who are slogging their own way up. Engineering, above all other professions, makes a constant appeal to fact. Education and influence don't count if a man's work is not right. A fool is found out quicker in engineering than in anything else. If a man has genius, it is not safe to sneer at him even if he drops all his aitches and says "*and* et cætera." *Every* engineer carries the bâton of command in his knapsack—if he has the right knapsack.—Yours, THE OLD 'UN.

RHYMES FROM THE OFFICE.

BY PABLO.

No. 3.—The Lady Typists' Reply to the Unknown Poet.*

O poet true, O gallant, courteous knight,
Thy welcome, welcome is; thy verses sweet
Have reached our inmost hearts. Would that we might
Reach thine! Would that we could attain the height
Of poet's skill, and give thee answer meet.

Thy form eludes imagination's eye—
He's dark! He's fair! He's short! He's tall! He's thin!
He's not! Thus disagree we; vainly try
To picture (as we echo sigh to sigh)
Thy mouth, thy nose, thy lustrous eyes, thy chin.

Declare thyself, we pray thee, great unknown,
That we, who now thy highest praises sing,
May, when the bell peals forth with hideous tone,
Withhold from thee—from thee, ador'd, alone—
Our "Botheration! let the bounder ring."

TRADE NOTICES AND NOVELTIES.

Wires and Cables.

From Messrs. W. T. Glover and Co., Limited, we have received a copy of their revised catalogue of electrical wires and cables. In addition to the inclusion of the firm's well-known vulcanised rubber cables, several new features have been introduced, notably the classifying of their various types of Diatrine paper, lead-covered cables for lighting and power mains, suitable for either low or high voltages. These cables can now be subjected to Messrs. Glover's patented method of testing by hydraulic pressure, which, it will be remembered, was described in our issue for Dec. 18 last. Special attention is drawn to several types of cables recently introduced, among them being Diatrine paper, leadless cables for underground mains and mining work; bitumen insulated cables, specially suitable for solid systems; leather-sheathed cables, specially suitable for rough usage; fire-resisting, for switchboard connections for train, theatre, and ship lighting, etc. Descriptions, it may be added, are included of these cables.

Water-Distilling Plant.

The Mirrlees-Watson Company, Limited, Scotland-street, Glasgow, have sent us a copy of a pamphlet describing their "Yaryan" water-distilling apparatus. It is pointed out that in many districts the supply of water is unsuitable for use in boilers, and cannot be satisfactorily treated by any chemical system. In such cases the only remedy is distillation. Hitherto the great objection to water distillers has been the cost of fuel, but with their sextuple effect Yaryan distillers the above firm claim that the amount of fuel used has been very greatly reduced, thus rendering the distillation of water thoroughly practicable. On railways the use of sedimentary water in loco. boilers causes a very heavy expenditure in upkeep, and there are many places where a decided benefit would be obtained by the installation of an economical distilling plant. The economy of the apparatus described is stated to be such that as much as 44lb. of water have been evaporated and condensed per pound of coal used.

Electric Fans.

We note from a circular recently received that the Brush Electrical Engineering Company, Limited, Victoria Works, Belvedere-road, London, S.E., have introduced a battery fan which will run from 250 to 300 hours. These fans may therefore be introduced when there is no electric lighting supply available. The same firm are supplying a neat type of lampholder fan which can be used wherever there is an incandescent lamp fixed, by simply taking out the latter and inserting the fan.

Resistance Apparatus.

Perfecta Resistance apparatus, especially adapted for operating electric lifts, is dealt with in a price list recently issued by Messrs. Monte-Callow and Co., 6, Ludgate Broadway, London, E.C.

A Million Horse-Power.

A new publication, entitled "A Million Horse-Power," issued by the British Westinghouse Electric and Manufacturing Company, Limited, contains particulars of the more important electrical installations which have been carried out by this firm within the British Empire.

Ferranti Apparatus.

From Messrs. Ferranti Limited, Hollinwood, Lincs., we have received three publications, dealing respectively with the firm's reverse-current relay for continuous-current circuits; moving-coil instruments, 8in. round type; and shunts for moving-coil ammeters.

Fittings.

The Progress sheet issued by the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., for last month illustrates various novelties in electric light fittings which should be found exceptionally useful for showroom and window lighting. They include adjustable brackets and shelf clips. Particulars are included of "Union" steel tubing and of a new protected wall plug. A new pattern fuse and switchboard is also shown, and several new designs in pendants. We note that prices in "Champion" fuses have been reduced.

PERSONAL.

Councillor Ralph Fream (chairman of the Gloucester Tramways Committee) and Mrs. Fream were the recipients of an interesting presentation at the Guildhall, Gloucester, last week. The presentation to Mr. Fream took the form of a handsome replica of one of Gloucester's new electric cars, made in silver and polished oak, designed as a smoker's cabinet. The elegant little model, which is 17in. or 18in. in length and about 12in. in height, bore the following inscription: "Presented to Councillor Ralph Fream by the Mayor, Sheriff, Aldermen, and Councillors of Gloucester as a slight recognition of the great services rendered as chairman of the Gloucester Electric Tramways during their construction and opening, May, 1904." The present to Mrs. Fream consisted of a family silver five o'clock tea service and a gold bracelet.

The Aston (Birmingham) Town Council have decided to retain the services of Mr. R. Green, of Pritchard, Green, and Co., Birmingham, as consulting engineer upon the terms of the existing agreement in relation to the reconstruction of the tramways about to be purchased from the City of Birmingham Tramways Company, Limited.

Mr. John McGown, St. Ronans, has been appointed manager of the Bo'ness electric supply works, under the National Electric Construction Company, of London.

The Gloucester City Council have awarded Mr. R. Read, the city surveyor, an honorarium of £500 for his services in connection with the conversion of the tramways to electric traction. A sum of £200 was voted to his assistants.

The Erith Urban District Council have appointed Mr. G. W. Blake clerk of works in respect of the alterations and additions to be made to the electric lighting station.

APPOINTMENTS VACANT.

Fitter Driver, wages 36s. per week, Switchboard Attendant, wages 25s. per week, Stoke-upon-Trent Electricity Committee. Applications by Aug. 13. See advertisement.

Lecturer in Electrical Engineering in the University of Sydney, N.S.W. Salary, £500 per annum. Applications by Sept. 10. See advertisement.

* The fair sex had been recently introduced into the typing department, and the office poet had written (anonymously) some effusive verses of welcome. The ladies either had not the gift of poesy or were too shy to make use of it, and the present writer, ever the willing servant of beauty, concocted the above for the occasion.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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WIRELESS TELEGRAPHY.

The policy of the Government with regard to wireless telegraphy is embodied in a Bill to be passed—organised opposition permitting—during the present session. The first paragraph in a memorandum attached to the Bill says, "The object of this Bill is to give the Government control over wireless telegraphy, in order to preclude its improper use in time of war or in any other national emergency, and to regulate the working of different stations in such a manner as to secure the greatest efficiency of communication between all stations." We agree with the policy. We have read the Bill, and it is not worth the paper it is printed upon. The Bill, if passed as drafted, will be utterly useless to effect the object desired, and its only result will be to increase the number of curses hurled against Government departments. Clause 1 of the Bill reads: "A person shall not establish any wireless telegraph station, or instal or work any apparatus for wireless telegraphy, in any place or on board any British ship except under and in accordance with a license granted in that behalf by the Postmaster-General, with the consent of the Admiralty, the Army Council, and the Board of Trade." Imagine for a moment that a ship in the Black Sea has installed upon it a wireless telegraph under license of the Postmaster-General, and there is a station at Odessa, to which port the ship is bound, also that the Russian authorities take into their heads to issue licenses and regulations diametrically opposed to those of the Postmaster-General; or, further, assume that no nation with ports permits wireless telegraphy to be used in accord with the regulations in the license. What then? Is a ship in a fog going to trouble about a lot of silly restrictions, or to care one iota what a license says? It will, of course, work its telegraph to its own salvation. In time of war the Government already possesses powers amply sufficient to close every station upon shores under its control. It can with its existing powers enter into occupation and control, and, therefore, need not fear the transmission of messages that would be a source of danger. So far as war is concerned, the Bill gives no powers over and above what already exist, in that any civilised Government can and does take whatever action it pleases relative to the necessities of the case. Law takes a back seat during war. The necessity of national existence then rides rough-shod over legal forms. But while the great point made by this Bill and the memoranda accompanying it is strategical necessities, one very real question is, What effect will it have upon social and commercial relations? War can and will take care of itself. A clause in one memorandum reads: "One of the great difficulties to contend with in wireless telegraphy is interference as between neighbouring stations, and this must be met with by limitation of the number of stations and careful selection of sites." Who is to select the sites? The Government with a view to strategical requirements, or the licensee with a view to commercial wants? Similarly, who is to decide as to the limitations, and what is to be the prevailing factor? The two classes of requirements are irreconcileable. If the Government wants strategy, let it erect and equip its stations; if it wants commerce, the Government has neither the knowledge nor the experience to determine what is wanted and why it is wanted. Practically, the granting of licenses will mean the creation of another monopoly, for once in possession it will be impossible for a second company, even if it has an improvement to exploit, to come along and obtain a license when limitation is strictly adhered to. Surely the history of telephony ought to make the Government pause before creating

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another monopoly. Progress is not so rapid as to warrant the cancellation of A's license because B comes along with a slight improvement—and improvements come gradually. Altogether, the Bill as it stands will give a monopoly to the company getting its license first, and those who come after will be nowhere unless the selection of sites brings about the bankruptcy of the first-comers. Can we suggest an alternative scheme? Frankly, no. Except (*a*) let the Government do the work itself, or (*b*) let commerce fight its own battle without restriction, when sooner or later natural selection will provide for the survival of the fittest.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY AT GLASGOW.

SIR,—Perhaps you will allow one of the "academical arguers" to say a word on this subject. My argument at Glasgow in 1897 was that the proposed scheme provided too little plant in proportion to the estimated number of working subscribers. The Table A, printed on your p. 152, amply proves the correctness of that argument. The table shows that there are twice the number of completed instruments that the estimate provided for, and it shows that to serve twice the estimated number of instruments, there have been required nearly four times the estimated length of wire, nearly seven times the estimated amount of trenching, nearly five times the estimated length of duct, and nearly seven times the estimated length of cable. The effect of this miscalculation on the finances of the concern is that the ratio of gross revenue to capital expenditure is only just over half what the estimate showed would be attained. In other words, for a given result in gross revenue the Glasgow Corporation telephone department have spent nearly twice the amount of capital that was estimated to be required.

It strikes me as a misuse of terms to describe these results as having "successfully proved in the concrete what was academically argued to be impossible." They show, on the contrary, that there has been a miscalculation of nearly 100 per cent. Nothing academical about that!—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, S.W., July 30, 1904.

[I am sorry to disagree with Mr. Webb, but venture to say that the Glasgow figures prove nothing of his view. The old adage, "A man convinced against his will, is of the same opinion still," applies in this case, and Mr. Webb will not, perhaps cannot, see that there is absolutely no connection between estimates for one thing and costs for another. Mr. Webb claims to be a man of experience. What really is his experience in comparison with that of Mr. A. R. Bennett's? Ironically he terms himself an "academical arguer, and he hits the goal by accident, not by intention. Here is a simple problem. Given a central telephone exchange at A, any number of instruments over a circular area with radius x, with capital cost per instrument y. Now double or treble that number of subscribers over area radius $2x$. Will the cost be $2y$ or $3y$, or if not, why not; or will it be any multiple of y, or can it be connected with y in any way; again, if not, why not? Is it not a fundamental fact that the controlling factor of length of wire, trenching, and ducts is area, not instruments?—THE WRITER ON TELEPHONY IN THE *E. E.*]

REGENERATIVE TRAMWAY MOTORS.

SIR,—I have been very much interested in reading your description of the demonstration at Gravesend on Wednesday last. Your observations of the energy expended and returned to the line are exactly such as the tramway world has been waiting for, and will undoubtedly convince the most sceptical of your readers as to the reality of the regenerative effect. I regret to find that some of the information which I supplied was not so clear as it ought to have been on the subject of the size of motor required for economical and satisfactory re-generation.

The demi-car with two 28-h.p. motors is obviously over-motored, but I cannot find any cheaper or lighter motors on the market. One motor would do the work easily, but if only one axle were driven, the adhesion on the grades would be insufficient. At Devonport, which has worse gradients, and more of them, the motors are of the same size—viz., 28 h.p.—and the cars are of the same size as the large cars at Gravesend—*i.e.*, about nine tons. The Devonport motors since their conversion have been in regular service eight months, and are quite as satisfactory as they were previously. It is obvious, however, to any tramway engineer that they are rather too small for the line, which is one of the most severe in the country. Albeit these cars are daily overloaded, and have carried over 100 passengers per car.

With regard to my note to the effect that the demi-car takes less than half the energy consumed by the ordinary car, this was intended to mean energy *per car mile*, not per ton-mile. The actual figures are ·4, as against ·9, which proves my claim that the demi-car not only saves half the labour, but also half the energy as compared with an ordinary full-size series-parallel car. Therefore, when substituted for an ordinary car on a lean line, it will run at half the cost per mile, and thereby transform a loss into a profit. These lean lines exist in great numbers, to the detriment of the financial results.

I have approached these subjects from the points of view of the tramway director and shareholder. The object of the invention is to increase the value of tramway property by raising dividends and by reducing risk of accident. That they will have these effects no one who witnessed the demonstration at Gravesend can doubt.—Yours, etc.,

JOHN RAWORTH.

2, Queen Anne's-gate, S.W., Aug. 1, 1904.

P.S.—A very simple calculation shows that the saving to be effected is equal to something in excess of £450,000 per annum in Great Britain alone.

ARTIFICIAL LOADS.

SIR,—*Re* tank for artificial loads for the dissipation of electric energy which appears in the *Electrical Engineer*, July 22, 1904, there is nothing particularly original in the method of placing one iron tank inside another in order to build up an artificial load suitable for dynamo testing, as many engineering works and central stations are using at the present time similar arrangements for the above purposes. Neither is it always advisable to earth the outer tank, especially in an engineering works where large foundation plates are used for bolting down machines which are about to be tested, because by so doing you practically reduce the insulation resistance of the machine down to one-half, which may cause trouble.

I should like to ask the writer how long he proposes to run a machine under test, because he mentions the fact that he does not like the use of canal water for the above purposes, owing to it changing its specific resistance considerably during the period from winter to summer. Surely he would not run a machine for six months in order to test its efficiency or general behaviour of same. Usually from 10 to 12 hours' run will satisfy any reasonable engineer, during which time he will find that the physical properties or the conductivity of the canal water has not altered much, if any, certainly not enough to interfere with the test. With regard to the use of chemicals, such as sulphuric acid, salts, and common soda, I beg to say that these should never be used upon any account where a very steady constant load test is required. If the tank is suitably designed, with ample electrode surface (both anode and kathode), together with some convenient arrangement for varying the distance between these electrodes, also with a large supply of cold water (either canal, river, town, or even condensed water) for circulating through the tank, then, with a reasonable small tank, there is not the slightest reason why any size of machine up to at least 1,000 kw. could not be run under full load without the use of any chemicals whatever.

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Some years ago I, for the first time, made it known to the engineering community (by giving analysis and specific resistances of various waters) that it was quite unnecessary to use chemicals of any kind for any waters when testing. Again, 2½ years ago, a discussion took place between myself and another well-known engineering gentleman upon the question of testing tanks, chemicals, various waters—in fact, on similar lines to this, when I gave a few particulars and dimensions of tank I had been in the habit of using. See *Electrical Review* for Jan. 17 and 31 and Feb. 7, 14, and 21, 1902.—Yours, etc., YRREB.

THE DIESEL OIL-ENGINE.

SIR,—In your issue of the 29th ult., while mentioning that at a recent consumption trial of a Diesel oil-engine of 160 b.h.p. the extremely low consumption of 0·37lb. of crude petroleum per brake horse-power was obtained, you state that "*other fuel* comes out as low as $\frac{1}{12}$d. per brake horse-power." There is apparently a slight misunderstanding here, inasmuch as it is the figure above mentioned—viz., 0·37lb. crude petroleum—which, on the basis of 42s. per ton, shows a fuel consumption cost of $\frac{1}{12}$d. per brake horse-power.—Yours, etc.,

DIESEL ENGINE COMPANY, LIMITED.

[N.B.—We are afraid that the word "other" is a stenographic error for "or the." The sentence was dictated to read, "Or the fuel comes out as low as $\frac{1}{12}$d. per brake horse-power hour."—ED. *E. E.*]

RUBBER CULTIVATION IN PARA.

A more optimistic view of the future of rubber cultivation than was given in the recent report by U.S. Consul Edward M. Conley, at Mexico City, Mexico, is held by U.S. Consul Louis H. Aymé, at Para, Brazil. In a recent report Mr. Aymé describes a rubber plantation owned by a Mr. Martins in a suburb of Para. Several years ago this gentleman cleared a property of five acres of sandy ground. He planted here a number of seeds of the Hevea brasiliensis, which have grown and flourished, chiefly on the higher ground. The success promised from these experiments encouraged Mr. Martins to plant several thousand seeds three years ago. This spring, for the first time, he tapped 40 of the best and largest trees, and from them secured a good output of rubber. Mr. Martins, when he planted the rubber trees, also planted a number of inaja palms, which furnish the nuts used in smoking the rubber. There are on this plantation to-day several hundred trees that are beginning to yield latex, and there are between two and three thousand young trees from 2ft. to 20ft. high. The usual forest "run" is about two miles long, and it is a good run that has 100 trees; but here, in a space of five acres, it is estimated there will be in 10 years at least 1,000 full-bearing rubber trees, which will produce more and better rubber than the tree on the forest runs, for it will be gathered more quickly and in a cleaner manner, and with greater care of the tree in tapping. The consul believes that there is no longer any doubt of the success of this experiment; and this would seem all the more important, as the Hevea brasiliensis trees of the great Amazon valley are being exhausted, and it is doubtful whether nature can replace them with sufficient rapidity to keep pace with the present demand for rubber. A possible reason for the unsuccessful attempts to raise these trees elsewhere is suggested. It has been found that the seeds of the tree germinate very soon after falling, but they lose the power of germinating quickly; hence it is very difficult to transport them in good condition. Consul Aymé thinks that there is an opportunity here for profitable investment of large capital, and the establishment of extensive plantations. Much study of conditions would be necessary, and it would probably take 10 years before the plantation would be yielding profitably, though, under favourable conditions, trees five years old would yield. To engage in this work a capital of not less than £10,000 would be required—preferably much more than this. We take the above from the *Electrical Review* of New York.

WIRELESS TELEGRAPHY.

BY R. G BLAINE, M.E., A.M.I.C.E., ETC.

(Continued from page 80.)

SPANISH EXPERIMENTS.

The Cervera System.—Spain has also recently added her quota to successful research in this branch of science and invention, and we find the system of Señor Cervera adopted and giving good results. In some respects this system differs from those already described, especially in the construction of the coherer. The transmitter has the usual vertical aerial with earthed connection, and the usual induction coil with spark gap, a condenser being inserted in each arm of the oscillator near the spark gap. The same antenna is used both for receiving and transmitting, there being a changing switch which cuts out the condensers and spark gap when receiving. The antenna is earthed through the primary of a small transformer, as before, the secondary of this transformer being divided by cutting out one spiral of winding at the centre of the coil and inserting a condenser between the terminals thus formed, after the manner of the Marconi "jigger." The terminals of the condenser are in turn connected to the terminals of the coherer, which consists of two small *ivory* discs, which may be adjusted by micrometer screws, having between them the conductors, which are in this case plugs of soft annealed iron with the usual powdered metal between them. The Cervera receiving apparatus has *four* separate circuits, which in turn fulfil the following functions: (1) operating the Morse machine, (2) making and breaking the coherer and relay circuit, (3) actuating the tapper, (4) interrupting the circuit of an electromagnet the function of which is to alter the sensibility of the coherer. The whole receiver, with its various circuits, is somewhat complicated, but is said to work well. The system has been successfully tried at various stations, and also across the Straits of Gibraltar, a distance of 34 km. (21¼ miles).

AMERICAN SYSTEMS.

The De Forest System.—This system is due to Dr. Lee De Forest and Prof. C. E. Freeman, of the United States. The

DR. LEE DE FOREST.

transmitter is not of the usual cell and Ruhmkorff coil type, but is much more powerful. A 110-volt continuous current from a dynamo or accumulators is transformed by a rotary transformer into an alternate current at a pressure of about 500 volts, which is further increased to 25,000 volts in an oil transformer, 3 (Fig. 70A). This high-pressure but low-frequency alternating current is used for charging a series of condensers, represented by 7, 8 in the illustration. The discharge of these condensers through the spark gap, 6, gives rise to the ether waves necessary for the transmission of the message. The aerial, 4, is connected to one spark ball or disc and the other to earth. The pressure being high, great disturbance of the ether takes place, hence long distances may be traversed and yet the effect be sufficiently powerful to give a readable message.

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A key, 2, working in oil is used to make and break the circuit of the transmitter. The receiver circuit is shown diagrammatically at B (lower figure). Its circuit includes the aerial, which is connected to the primary of a small transformer, the secondary of which is in the local circuit, the latter including the responders, 1′ 1″, inductance coils, 2′ 2″, resistance, 3′ (about 5,000 ohms), the condenser, 5′, and the telephone receiver, 6′. There are keys, 9′ 9″, for relieving the responders. There is also a battery, 4′, the current from which flows through the telephone all the time the apparatus is in use.

The responder deserves special notice. It is of the anti-coherer type, as its resistance is *increased* under the influence of impinging ether waves, and thus the current flowing normally through the circuit of the responder is interrupted. The responder is really a little electrolytic cell; the electrodes being of soft metal are placed in a paste composed of metallic particles, and a liquid which can be electrolysed by the current. The current flowing normally detaches minute particles of metal, causing them to pass from one electrode to the other, the normal resistance of the cell being small. When the ether waves set up by the transmitter reach the responder, hydrogen bubbles are generated at the kathode, and form a cushion which increases the resistance of the cell, momentarily interrupting the current, causing the telephone diaphragm to be momentarily released

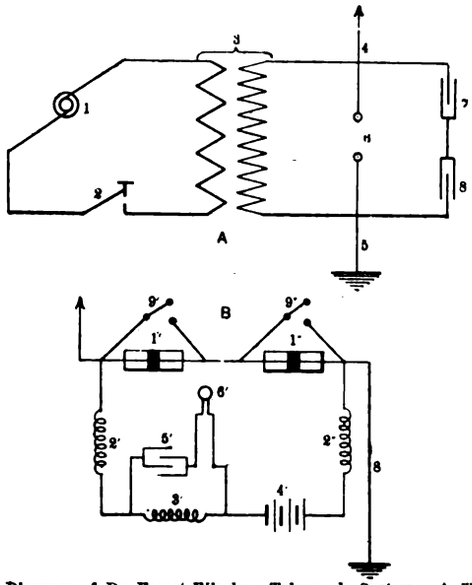

FIG. 70.—Diagram of De Forest Wireless Telegraph System. A, Transmitter; 1, Alternating-Current Generator; 2, Key; 3, Oil Transformer; 4, Antenna; 5, Ground; 6, Spark Gap; 7, 8, Condensers. B, Receiver; 1′, 1″, Responders; 2′, 2″, Choke Coils; 3′, Resistance 5,000 ohms; 4′, Battery; 5′, Condenser; 6′, Telephone Receiver; 7′, Antenna; 8′, Ground; 9′, 9″, Shunt Switches.—(From *The Engineering Magazine.*)

from the pull of its magnets, and a sharp click is heard in it. A series of impulses sent at proper intervals give rise to a series of clicks arranged to convey a message in the Morse code.

The system has been very successful. On Dec. 11, 1902, the Coney Island station of this company caught messages from the "Philadelphia" when the latter was 100 miles away, the vessel having Marconi apparatus. No tuning device is used at Coney Island. The "Philadelphia" was overheard calling up the Babylon station, and later the Sagaponack station. The aerials at Coney Island are simple two-stranded copper wires 210ft. high. In the dock at New York, with miles of metal warehouses intervening, conversation was carried on with the "Deutschland," which is equipped with apparatus of the Arco-Slaby system, but it was found necessary to replace the coherer of that system by the responder of the De Forest system. Messages have been received by a De Forest pocket receiver measuring 5in. by 4in. by 3in. from a distance of 100 miles. The equipment of trains has been taken in hand, and we understand that the "Twentieth Century Limited" express on the New York Central Railroad is to be fitted with the apparatus of this company to communicate with stations near the track 100 miles or so apart. The system has now, it is said, been adopted, after severe tests, by the United States army and navy.

A photograph of a complete De Forest transmitter set is shown in Fig. 71, kindly sent by Dr. De Forest—the key to the right, variable inductance or resistance in the centre, the oil transformer and spark apparatus to the left. American papers tell us that before the possibility of Transatlantic wireless telegraphy was demonstrated, this company had completed plans for establishing stations by which not only America, but the Pacific, could be spanned. One of the latter is to be at the southern end of California,

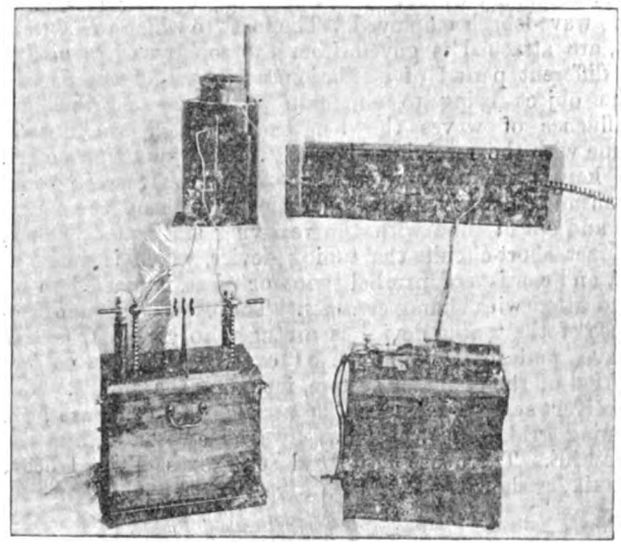

FIG. 71.—The De Forest System.

another (a relay station) at the north end of Hawaii, one near Manila, and one at Hong Kong. The towers at Manila and Honolulu are to be 250ft. high. They will support three screens of vertical wires at each station. The distance between Manila and Hawaii will be 3,500 miles, that between Hawaii and California 2,200 miles. Stations at Cape Hatteras, Key West, Havana, etc., are now being equipped or are in working order. Should Dr. De Forest succeed in negotiating these long distances, he may claim a place in the very front rank in regard to wireless invention and enterprise at the present time. Like Marconi, he is young—only 30. He is graduate (Ph.D.) of Yale.

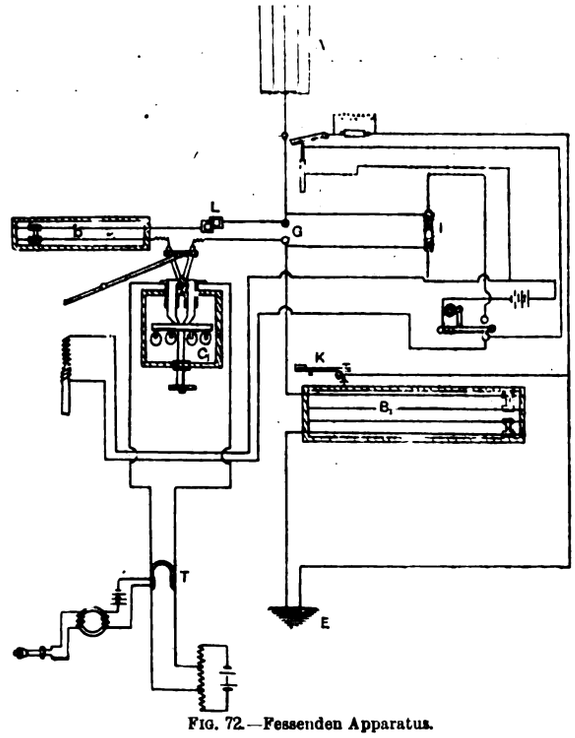

FIG. 72.—Fessenden Apparatus.

The Fessenden System.—This system has been successfully developed by Prof. Reginald A. Fessenden, of the United States Weather Bureau. Prof. Fessenden claims to use, not free Hertz waves, but "semi-free" waves. In his patent specification the professor says: "In the Lodge waves the electrical energy is a maximum when the mag-

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netic energy is a minimum, and all the energy not absorbed by resistance is recoverable; with the form investigated by me the electrical energy is a maximum at the same time as the magnetic, and none of the energy radiated is recoverable except by deflection." The "aerial," A (Fig. 72), may have several wires in parallel, and there is usually a secondary conductor joined on to these, which may be carried in a horizontal direction over buildings, etc., being earthed at each end. The length of each arm of this secondary conductor is approximately one-quarter of the wave-length employed. The mast to which the aerials, A, are attached is guyed from the top by wires having a different period of oscillation from that of the aerials, the object being to eliminate as far as possible the influence of waves the lengths of which are not in tune with the receiving apparatus. The induction coil, I, is kept continually in action when messages are being transmitted, a key, K, being employed to throw the aerials in and out of tune with the receiving station. The key, in fact, short-circuits the tuning device, which is shown at B', and consists of parallel strips or wires immersed in oil and fitted with sliding contacts. The capacity and inductance of the tuning device is arranged to give a true sine wave, and to agree in period exactly with the natural period of the oscillator system, including the aerials. The receiver system includes the aerials, the condenser, L, tuning grid, *b*, electromagnetic wave detector, C, and the earth, E. There are also head telephones, T, and other details, as shown in the illustration.

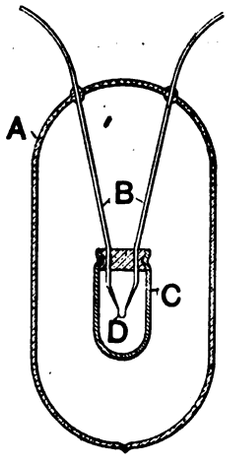

FIG. 73.—Fessenden Electromagnetic Receiver.

The electromagnetic detector or responder, C, is of special interest, and is shown in section in Fig. 73. It consists of a short loop of fine silver wire, D, ·002in. in diameter, with a core of platinum wire ·00006in. in diameter, and is fastened to the terminal wires, B, which are sealed into the glass bulb, A. The tip of the silver loop is dissolved or eaten away by nitric acid, leaving the platinum wire exposed, and to decrease the loss due to radiation, the loop is enclosed in the silver shell, C. The action of the receiver is practically that of the bolometer, and has already been referred to. The radiating or absorbing surface is here, however, very small compared with the mass. The heat capacity is therefore small, and a very small—in fact, nearly infinitesimal—quantity of heat suffices to raise, and sufficiently raise, the temperature of the wire. The glass bulb is exhausted to increase the sensitiveness of the receiver. C (Fig. 72) is a stand for a number of these detectors, it being considered best to have several, so that another can be immediately switched into circuit should the one in use fail.

Both the De Forest and Fessenden systems are said to admit of a high rate of word transmission telephones being used. They have also been subjected to severe tests during the United States naval manœuvres, and at other times, though on the occasion of the manœuvres the distances were not great. One very important phase of the Fessenden system is the possibility of syntony by the alteration of the frequency of the diaphragm in the receiving telephone. Prof. Fessenden found that a diaphragm clamped all round its circumference had a natural period of vibration, which could readily be varied, say, by altering the radius of the clamping ring. In this way the telephone could be made to respond to ether oscillations of its own frequency better than any other, and that frequency could be varied by the simple device referred to. Thus tuning or syntony, and to a certain extent secrecy of transmission, may be secured.

The Guarini Repeater and Guarini Wireless Fire-Alarm.

With a good and economical system, it may be that for land transmission, at any rate, great power and expensive stations are unnecessary; the use of an automatic repeater like that of M. Emile Guarini, of Brussels, may yet solve the problem of wireless telegraphic intercommunication. The object of the apparatus is to receive messages from a station and repeat or retelegraph them on automatically to a further station or stations. The circuits of the apparatus are shown diagrammatically in Fig. 74, where 1 is the aerial, 2 conductor connecting aerial to negative pole of relay 4, 5 conductor (placed in metallic tube) joining armature 6 of relay 4 to primary 7 of little transformer 8, 13 is a condenser, 14 the coherer, 24 tapper of same, 15 induct-

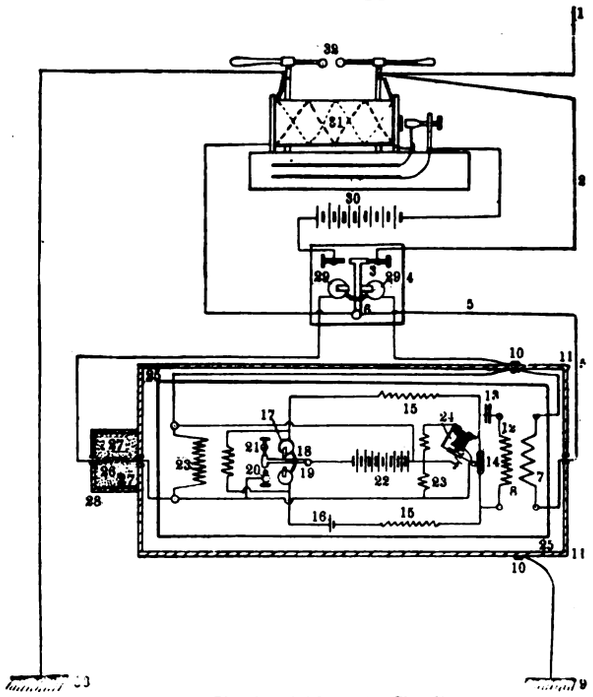

FIG. 74.—Guarini Repeater Circuits.

ance coils, 16 a cell, 17 coils of the relay 18, 20 and 21 terminals of the same, 22 source of electrical energy, 23 shunts, 25 the table on which the apparatus rests, 26 inductance, 28 a metallic box joined to the other metallic envelope 11, 29 arc coils of relay 4, 30 source of electrical energy, 31 induction coil, 32 the oscillator or spark gap, 33 the earth or a capacity. In the case where it is necessary to register the signals repeated, relay 4 works a Morse printer.

Action of the Apparatus.—Suppose that between two stations (transmitter and receiver) there is a single repeater, the Morse dot and dash code being used. At the transmitting station an electromagnetic wave of short duration is produced, say, by an oscillator like 32. This wave projected into space is too feeble to reach the receiving station, but is strong enough to affect the aerial, 1; is collected by 1, but is not able to traverse the secondary of coil, 31, and reach the earth (or capacity), 33, on account of the great impedance of the circuit. The wave, therefore, traverses the conductor, 2, the terminal, 3, of the relay, 4, the conductor, 5, of the primary, 7, of the transformer, 8, and reaches the ground (or capacity) at 9. On account of induction in the secondary, 12, of the transformer, 8, the coherer, 14, is impressed so well (the self-induction coils, 15, hindering the waves from following the circuit of the cell, 16) that the coils, 17, of the relay, 18, are energised, the armature, 19, of the relay is attracted, and leaving the position of rest, 21, applies itself against the buffer, 20; the current of the cell, 22, acting on the tapper, 24, the latter decoheres the coherer, 14, the same time that a current circulates round the coils, 29, of the

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relay, 4. The armature, 6, of the relay, 4, is attracted. It leaves its position of rest, 3, and places itself against the working buffer of 4 at the same time that the armature, 6, closes the circuit of the source of energy, 30, of the primary of the coil, 31, and a spark leaves the oscillator. It will be noticed that at this instant an interruption has been caused between the terminal, 3, and the conductor, 2, going to the receiving antenna. Thus the relay, 4, sends on the signal received, and it may also print it through the agency of a Morse printer. The lower part of the apparatus, being enclosed in a metallic box, is not affected by the spark of the oscillator, hence the apparatus is again ready to receive a fresh signal. A number of dots sent in quick succession form a dash, and so on, as usual by the Morse code. There may be a number of repeaters between the extreme transmitting station and the final receiving station, but the action is the same: No. 1 repeater repeats the short and long signals to No. 2, No. 2 repeats them to No. 3, and so on, till they finally are received at the extreme station. There is no danger that the signals of one repeater may react on another, for when a signal is reproduced to No. 2, the circuit of the receiving antennæ, 1, of repeater No. 1 is interrupted. It is only when the signal arrives at repeater No. 3—*i.e.*, out of reach of No. 1—that receiver No. 1 becomes capable of receiving and retransmitting a new signal from the extreme transmitting station. In practice, all this takes place as rapidly as if there were direct communication, for by diminishing the distance of transmission, the capacity of the station, the size of the induction coils, and hence the time constant, are all reduced.

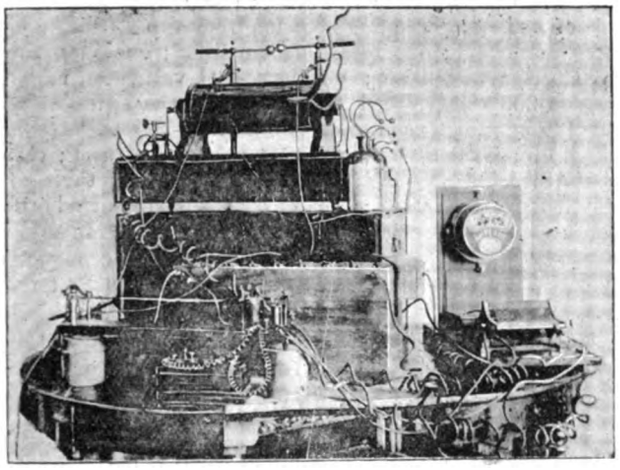

FIG. 75.

An illustration of the apparatus is shown in Fig. 75. Other forms of the apparatus which have been employed by M. Guarini need not be further referred to here. The apparatus has been thoroughly tried. Experiments were made between Brussels and Antwerp, with a repeater at Malines, in order to test the value of the repeater over considerable distances. The experiments proved very successful. An observer at Malines—Licutenant Fernand Poncelet, of the Belgian Artillery—had simply to note, watch in hand, the time of the passing of certain signals, and the printed records of these signals made by the repeater were, after the experiment was finished, compared with the records received direct from Brussels at the extreme receiving station at Antwerp, as well as with those sent out from Brussels. The printed records were found to be absolutely identical. All the messages sent out from Brussels were not received at Antwerp, but the latter station received correctly every one of the messages received at Malines and passed on by the repeater. The absolute fidelity of the repeater was thus proved conclusively.

M. Guarini has also made some experiments in the direction of securing the radiation of electric waves in any required direction only. Evidently this, if successful, will greatly aid other efforts to secure secrecy in transmission. M. Guarini attempted to do this by limiting the issuing waves to a narrow band directed towards the receiver he wished to communicate with. To effect this he carefully covered his central antenna or core with insulation, and enclosed it in a metallic sheath cylindric in form, with a vertical slit in one side, the slit facing in the direction in which the distant receiver was situated. The central core was connected to one of the oscillator or spark knobs, the outer sheath being connected to earth. It was supposed that by this arrangement only that portion of the core opposite the slit would send out Hertzian radiations into space. Considerable success attended this effort, we believe, especially when the screen was connected to earth, but it has been tried mainly for short distances. The matter, however, is of great importance, and is worthy

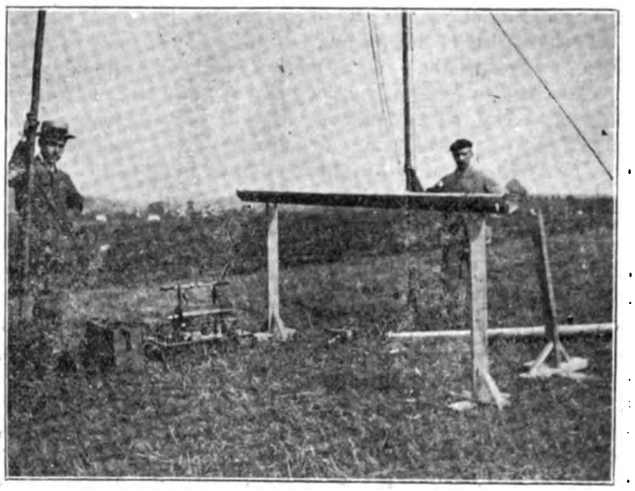

FIG. 76.—Experiments of M. Guarini on "Limitations de l'espace" (with Metal Envelopes.)

of further research. Fig. 76 shows some of M. Guarini's experiments in progress.

(To be continued.)

ILFORD ELECTRICITY ACCOUNTS.

The accounts of the Ilford electricity department for the year ended March 31, 1904, show a total expenditure on capital account to that date of £106,238. We give herewith abstracts of the revenue account and general balance-sheet.

Dr.	REVENUE ACCOUNT.	£	s.	d.
Generation of electricity		6,555	4	11
Distribution of electricity		415	12	4
Attending and repairs to public lamps		1,170	0	1
Royalties, allowances, and irrecoverables		213	12	7
Rents, rates, and taxes		365	18	11
Management expenses		1,997	7	2
Law and parliamentary charges		57	16	5
Special charges, insurances, etc.		212	7	6
		10,987	19	11
Amount carried to net revenue account		9,355	12	8
Balance to provide for bad debts		100	0	0
		£20,443	12	7

Cr.	£	s.	d.
Sale of current per meter	10,270	10	0
Rental of meters and other apparatus	634	12	5
Public lighting	5,114	0	0
Arc lamps and rentals	583	3	8
Received from slot meters	260	11	0
Current supplied to tramways	3,521	13	0
Balance from last account	59	2	6
	£20,443	12	7

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	92,312	14	11
Sundry creditors	1,156	15	7
Balance at credit of net revenue account	2,876	8	5
Due to treasurer on capital account	6,916	10	8
Due to accountant	1,885	0	5
	£105,157	10	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	99,228	13	11
Stores on hand	607	2	11
Sundry debtors for current supplied	5,316	7	8
Cash in hand	5	5	6
	£105,157	10	

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POWER DISTRIBUTION IN THE PINXTON COLLIERIES.

A most complete and up-to-date system of colliery electric power in the Midland Counties has recently been installed at the Pinxton Collieries, near Alfreton, Derbyshire. Labour saving by electric power is the essence of the system, which has been largely designed and carried out under the supervision of Mr. Benjamin Madew, the general manager of the nine collieries owned by the Pinxton Coal Company, Limited. The Pinxton pits are really amongst the oldest in the country, having been worked since the eighteenth century, and possibly longer in some form or other. Mr. Madew is this year the president of the Midland branch of the National Association of Colliery Managers, and to signalise his year of office he invited the members to hold their annual meeting at Pinxton on Saturday last, and to inspect the elaborate system of electric power now in full working order. The company assembled at noon at the colliery offices, where the visitors were received by the president. The company were conducted round the new workshops and electric station, and saw the various machinery in full operation. Everything is done by machinery, from the stitching of the horses' harness to the hammering of iron in the blacksmiths' shops, and, of course, the utilisation of electric power below ground is as elaborate as it is upon the surface. The following are the principal officials: Mr. J. Clarke, mechanical engineer; Mr. A. Lee, assistant engineer; Mr. J. F. Milnes, electrical engineer; Mr. J. Hartshorne, manager No. 3 pit; Mr. J. Jones, No. 2; Mr. Owen Houfton, No. 1; Mr. Job Smith, Nos. 7 and 9; and Mr. T. Savage, No. 8.

The following is a description of the electric high-tension three-phase power plant and workshops. The plant consists of two Lancashire boilers, each 30ft. by 8ft. diameter, 160lb. per square inch pressure; one horizontal cross compound condensing engine of 250 i.h.p.; one three-phase generator of 150 kw. capacity, rope-driven from the above engine; one Willans patent general valve triple-compound engine of 250 i.h.p. direct coupled to a three-phase alternator of 150 kw. capacity; one main and two sub-station switchboards, with switches and instruments; the necessary high and low tension cables; nine 5-h.p. motors for driving shop tools, mortar mill, etc.; 10 3-h.p. motors for similar purposes; four 1-h p. motors for driving leather-stitching and lamp-cleaning machines; four main and tail rope haulage gears with 3ft. drums; one endless rope haulage gear with 4ft. pulley; five 20-h.p. motors for driving same; two sets of three-throw pumps, each set driven by 5-h.p. motor; 10 three-core three-phase transformers, with the necessary switchgear and fuses—current for both motors and lighting is taken from the low-tension side of these transformers.

Boilers.—The boilers are two in number, and supply steam at a working pressure of 160lb. per square inch for the power plant alone. They are 30ft. long by 8ft. diameter.

Engines.—One engine is of the horizontal compound condensing type, the condenser air-pump ram being driven from the low-pressure piston tail rod. Diameter of high-pressure cylinder, 14in.; diameter of low-pressure cylinder, 25in.; length of stroke, 30in.; revolutions per minute, 107; steam pressure per square inch, 160lb.; indicated horse-power, 250. This engine is fitted with Hartnell's governor, which actuates the expansion valves of both cylinders simultaneously. A flywheel, 14ft. diameter and grooved for 10 1¼in. ropes, is fitted between the high and low pressure cylinders. In the case of the combined set the engines are of Willans's patent central-valve triple-compound type, fitted with automatic expansion gear. Number of cylinders, 6; diameter of each high-pressure cylinder, 12in.; diameter of each low-pressure cylinder, 17in.; length of stroke, 8; revolutions per minute, 375; steam pressure per square inch, 160lb.; indicated horse-power, 250.

Three-Phase Generators.—The generators are of the revolving-field type, "star" connected. The high-tension conductors are stationary and embedded in slots in the iron core. Total output in kilovolt-amperes, each, 150; current in amperes per phase, 80; volts between phases (virtual), 1,100; cycles per second, 50; revolutions per minute, rope driven 425, direct driven 375. The main shaft of the rope-driven generator runs in three bearings and carries a pulley grooved to receive the ropes from the engine flywheel and also a rope pulley for driving the exciter. Sliding bed-plates are provided so that the slack of the ropes may be taken up whilst running. The direct-driven generator is coupled to the Willans engine, and its shaft runs in a white-metal bearing fitted with ring lubricators, which render the shaft self-lubricating.

Exciters.—In one case the exciter is driven by ropes from the main shaft of the generator, and furnishes a continuous current of 30 amperes at 150 volts. In the case of the direct-coupled set, the exciter is carried on a continuation of the main shaft, and generates a current of 40 amperes at 100 volts.

Main Switchboard.—The main switchboard consists of white marble slabs supported by a framework of channel iron and placed on a gallery overlooking the engine-room, and contains the following: one synchronising panel with the following apparatus: one recording voltmeter reading to 1,200 volts; one measuring transformer with fuses; one synchronising voltmeter with lamps; two direct-current ammeters; two single-pole switches and fuses; one rotary synchroniser; two main regulating rheostats with multiple contacts and hand-wheels; one shunt regulating rheostat with multiple contacts and hand-wheels; one shunt regulating rheostat (multiple contact); two generator panels to control the circuits of two 150-kw. three-phase generators. Each panel contains the following: one high-tension three-pole oil switch; three high-tension removable tube fuses; three ammeters; one recording ammeter; one measuring transformer with fuses; one large-dial voltmeter, reading up to 1,200 volts, placed at the top of the switchboard; four feeder panels, each to carry one three-pole high-tension oil switch; three high-tension removable tube fuses; three ammeters; four feeder panels, each to carry one three-pole high-tension oil switch; four high-tension removable tube fuses; three ammeters. All the high-tension fuses are placed below their respective panels, and are mounted upon marble slabs and are protected in front by a strong steel wire grid.

Mains (High-Tension).—From the main switchboard the current is taken to No. 2 and No. 3 sub-stations by a three-core, paper-insulated, lead-covered, and steel-armoured cable, placed direct in the ground, the sectional area of each core being ·062 square inch. From the main switchboard down No. 6 shaft the cable is carried in strong pitch-pine casing specially made at the colliery workshops. The cable is a tight fit in the groove, which makes it self-supporting for the entire length. The covers are nailed on. The lighting at the pit bottom is taken from a 2-kw. single-phase transformer, which reduces the pressure from 1,100 volts to 230 volts in one phase only. This cable then leads to the motors at work on the various planes. At each point the cable is connected to a 45-kw. three-phase transformer fixed in the haulage room, which reduces the pressure from 1,100 volts to 520 volts. The low-tension side is fitted with a main triple-pole switch and four single-pole fuses. From the fuses the current is taken direct to the starting and reversing controller.

Hauling Gears and Motors.—The four main and tail hauling gears are of the following dimensions: diameter of drums, 3ft.; width of drums, 1½ft.; speed of rope, eight miles per hour. Each haulage drum is fitted with a friction brake, claw clutch, and the necessary gear for operating the same. The drums, spur gear, countershaft, and motor are mounted on steel girder bed-plates. The endless rope gear has a pulley 3ft. diameter. In each case the motor and hauling gear is fixed on the same bed-plate and drives the countershaft by means of a machine-cut spur wheel fixed on the countershaft, and a raw-hide pinion on the motor shaft. The motors are each of 20 effective horse-power, of the three-phase type at 520 volts, 960 revolutions per minute, but the motors are capable of working up to 50 h.p. for short periods. Each motor is fitted with a starting regulating, slip-ring rotor, which is completely enclosed. The rotor shaft runs in bearings of the self-oiling type.

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In-by Pump and Motor at No. 3 Pit.—The pump is of the diagonal three-throw mining type, and of the following dimensions: diameter of rams, 2½in.; length of stroke, 6in.; revolutions per minute, 46. This pump is fixed with independent and interchangeable pump barrels; independent and interchangeable suction and delivery branch pipes; independent and interchangeable suction and delivery valve boxes. The rams are of gunmetal attached to substantial cross-heads, and work in slipper guides on the bed-plate. The crankshaft is of steel running in three bearings on the bed plate, and carries a spur-wheel driven by a pinion on the countershaft. The countershaft is of steel running in two bearings on the end of the diagonal frame, and carries a machine cut-steel spur wheel which is driven by a raw-hide pinion on the motor shaft. The motor for diving this pump is of the three-phase type of five effective horse-power, the speed being 960 revolutions per minute at 520 volts. The pump and motor is self-contained, and is mounted on wheels and fitted with controller complete. This pump is about 800 yards in-by at No. 3 pit. High-tension current is conveyed to a 45-kw. transformer close to where the pump works by a three-core, paper-insulated, lead-covered, steel-armoured cable trom No. 3 sub-station switchboard. The cable is placed direct in the ground, and is carried down the shaft in special pitch-pine casings, similar to No. 6 shaft. The total distance from the power station to this pump is 1,750 yards.

Engineering Shops.—The engineering shops are situated close to the power station, and all the tools are electrically driven. In most cases each machine has its own motor. The number of machines fixed is as follows: one "Cyclone" blower, 5-h.p. motor, 250 revolutions per minute; one 14in. by 20in. lathe, 3-h.p. motor, 120 revolutions per minute; one 8ft. by 4ft. by 4ft. planer, 3-h.p. motor, 250 revolutions per minute; one 10in. slotting machine, 3-h.p. motor, 200 revolutions per minute; one 6ft. radial drill, 3-h.p. motor, 200 revolutions per minute; one 2in. screwing machine, 3-h.p. motor, 150 revolutions per minute; one milling machine, 3-h.p. motor, 200 revolutions per minute; one 15lb. power hammer, 3-h.p. motor, 300 revolutions per minute; one punching and shearing, 5-h.p. motor, 250 revolutions per minute; one 200lb. power hammer, 5-h.p. motor, 250 revolutions per minute; one 6ft. plate-bending roll, 5-h.p. motor, 250 revolutions per minute; one 20in. circular saw, 3-h.p. motor, 1,440 revolutions per minute; one 30in. band saw, one tenoning machine, one mortice and boring machine, one gulleting machine, one plane knife grinder, one band-saw sharpening machine (5-h p. motor, 360 revolutions per minute); one 12in. wood planer, 5-h.p motor, 960 revolutions per minute; one 24in. wood planer, 5-h p. motor, 960 revolutions per minute; one 40in. circular saw, 5-h.p. motor, 960 revolutions per minute; one cross-cut saw, 3 h.p. motor, 250 revolutions per minute; one mortar mill, 5-h.p. motor, 250 revolutions per minute; one corn mill, 3-h.p. motor, 360 revolutions per minute; one chaff cutter, 5-h.p., 250 revolutions per minute; one Saddler's sewing machine, 1-h.p. motor, 1,440 revolutions per minute; three lamp-cleaning machines, 1 h.p, 1,440 revolutions per minute. The total effective horse-power amounts to 84. All the motors have short-circuited or squirrel-cage rotors, and are started and stopped by a triple-pole switch. These motors work on a low-tension circuit at 400 volts, three-phase. The current is taken from a 65 kilovolt-ampere three-phase transformer placed below the main switchboard in the power station.

Transformers.—Three-core three-phase transformers are used throughout. The primaries are all wound for a tension of 1,100 volts at 50 cycles per second, and are fitted with high-tension removable porcelain tube fuses with spring clip connections. The secondaries are wound for a tension of of 400 and 520 volts respectively. The 520-volt transformers are used underground and are taken as far in-by as circumstances will permit. The 400-volt transformers are used above ground, and are fitted with a triple-pole switch and four single-pole fuses mounted on a marble slab, and are "star" connected and fitted with neutral terminals, so as to get two voltages from the same windings—*i.e*, 400 volts between the phases for supplying motors and 230 volts between any phase wire and the neutral for incandescent lighting. The whole of the lighting above ground is done in this manner, frequently with "out of balance" load of 20 per cent. without any appreciable drop in voltage.

Lighting.—There are at present installed about 460 16-c.p. incandescent lamps and six enclosed long-burning arc lamps, distributed as required in the offices, various shops, engine-houses, screens Nos. 1, 3, and 6, pit bottom, and sidings.

Sub-Stations.—There are two sub-stations provided—one at No. 2 pit, distance from power station 450 yards; and one at No. 3 pit, distance from power station 790 yards. Each sub station is provided with the following switchgear and instruments mounted on white marble slabs, supported by a suitable frame of channel iron, and consists of one main feeder panel, which receives the high-tension current from the power station, and contains one high-tension three-pole oil switch, three high-tension removable tube fuses, three ammeters, three distributing panels, each with one high-tension three-pole oil switch; three high-tension removable tube fuses and three ammeters; one lighting circuit panel with six double-pole switches and fuses and three ammeters; two large-dial voltmeters fixed on the top of the switchboard, one reading up to 1,200 volts and the other reading up to 500 volts. Beneath each sub-station is fixed a 15-kw. transformer for light and power on the surface in the immediate vicinity of each sub-station.

Coal-Cutting.—Several coal-cutters of the bar type are worked from this plant, the number being increased as found convenient.

Waterworks.—One treble vertical single-acting pump, 4½in. by 6in. rams, fitted with a 5-h.p. motor working at 350 volts, supplies water to the village for domestic purposes.

The Luncheon.

After visiting the electric works, Mr. Madew entertained the company at luncheon, which was served at the George Hotel, Pinxton. Mr. Madew presided. After the health of "The King" had been honoured,

Mr. J. Mein proposed the toast of "The Pinxton Coal Company, Limited." He said they were much obliged to the directors of the company for their kind permission to see their works that day. Coal-working had been going on there since 1745, and they had seen that day an example, if he might so put it, of an old man made into a young one. He had known the company for about 12 years, and when he first knew it, it was working on the old-fashioned lines. Electricity had come to the front during the past 12 or 15 years, and the Pinxton Coal Company had not been slow to take advantage of the latest improvements and inventions. In the works that day they had seen a splendid example of enterprise, brains, and money used to cheapen the cost of production. They were much obliged to the company for having permitted them to make that visit, which had not only been interesting to those of them who were using electricity, but instructive as well as interesting to those of them who were not. He had never seen on the Continent or elsewhere in the way of electrical plant anything to exceed what they had inspected that day at the works of the Pinxton Company. They had often had it dinned into their ears that the mining men of this country lagged behind their Continental competitors. That, unfortunately, might be true, but that did not apply to the Pinxton Coal Company. Such enterprise as they had witnessed was worthy of success. He had great pleasure in coupling with the toast the name of the company's worthy and capable manager, Mr. Madew.

The Chairman, in response, said he was extremely obliged to Mr. Mein for the kind remarks he had made with regard to the Pinxton Coal Company. He could tell them that since the works were started, 18 months or two years ago, they had not had a single hitch in them. Their breakdowns had not cost them five pounds during the whole of the time. He thanked them for the kind way in which they had accepted the toast.

Other toasts of a more general character followed, and the proceedings terminated with the usual votes of thanks.

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BEXHILL ELECTRICITY ACCOUNTS.

The accounts of the Bexhill electricity department for the year ended March 31, 1904, show a total expenditure on capital account of £47,863. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	2,909	18	2
Distribution of electricity	141	19	8
Attending and repairs to public lamps	528	2	10
Rents, rates, taxes, and insurance	221	16	1
Management expenses, salaries, etc.	742	7	11
Total expenditure	4,544	4	8
Amount carried to net revenue account	1,955	16	4
	£6,500	1	0

Cr. Income.	£	s.	d.
Sale of current per meter	3,920	14	5
Rental of meters and other apparatus	2,450	5	7
Miscellaneous items	215	16	9
	6,586	16	9
Less bad debts written off	86	15	9
	£6,500	1	0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—outstanding on loans	43,889	14	1
Treasurer's general account—amount overdrawn	3,156	0	6
Sundry creditors	267	18	8
	£47,313	13	3

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	43,362	2	10
Stores on hand	112	12	8
Sundry debtors for current supplied	1,722	2	2
Other debtors	9	7	7
Cash in hand	14	18	4
Balance at debit of net revenue account	2,092	9	8
	£47,313	13	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			429,662
Quantity sold	Public lamps	123,098	358,635
	By contract	4,759	
	Private consumers by meter	230,778	
Quantity used on works			12,835
Total quantity accounted for			371,470
Quantity not accounted for			58,192
Total maximum supply demanded (kilowatts)			326

Number of public lamps, 47 arcs; 211 incandescents.

COMPANIES' MEETINGS AND REPORTS

GENERAL ELECTRIC.

The ordinary general meeting was held on the 27th ult., Mr. G. Byng presiding. Particulars of the report were given in our issue of the 22nd ult.

The **Chairman**, in moving its adoption, stated that the year's work had been difficult, as the home trade had been exceedingly quiet. The Company had maintained their turnover, and in some departments they had increased it, but they had had to expend more money in doing so. After meeting various charges, there remained a surplus which enabled the Board to propose a dividend of 7 per cent. on the ordinary shares, and a more adequate return might be anticipated when conditions improved. The Peel Works at Manchester continued to be full with orders for their manufactures. The various departments were working all the year round at high pressure in order to cope with the increased output which was necessary to maintain the old profits. The telephone department had considerably benefited by the requirements of the Government. The engineering works at Witton had justified the expectations which had been formed about them. Important orders had been secured from the War Office and the Admiralty. The position of the Company's carbon works had aroused much public interest. The Board were satisfied that they had quashed the mistaken idea that carbons could not be produced in this country. In this connection the Chairman adverted to the politico-economic aspect of the question, and expressed the opinion that a protective tariff would greatly improve matters.

The report was adopted.

ANGLO-AMERICAN TELEGRAPH.

The half-yearly general meeting was held last Friday at Winchester House, Mr. Francis A. Bevan presiding. Particulars of the report appeared in our last issue.

The **Chairman** alluded to the loss sustained through the "Minia" having to lay up for repairs. The vessel would, however, be in use again in a few weeks. There was an understanding between the stockholders and the Board that when the renewal fund amounted to £1,000,000 the directors would only add to the fund, so long as it kept at £1,000,000, the interest earned by the investments forming it. The fund at the moment amounted to £987,676, but the nominal value of the securities was £940,345, while their real value, on account of depreciation, was less than that by £33,989. From the £987,676 they ought, therefore, in order to arrive at the true position, to deduct this £33,989, leaving £953,687, of which £47,331 was held in the shape of cable stock and for working expenses, for they had no working capital. He might therefore say that their securities were worth just over £900,000, and that they had about £50,000 in stock and plant. Together these sums came to about £950,000. He concluded by moving a resolution adopting the report and authorising the directors to carry into effect the pension scheme.

Sir Gerald FitzGerald (the deputy chairman) seconded the motion, which was carried unanimously.

CITY AND SOUTH LONDON RAILWAY.

The half-yearly meeting of this Company was held on the 29th ult., Mr. C. G. Mott presiding. Particulars of the report were given in our issue of the 22nd ult.

The **Chairman** remarked that the result of the half-year's working had been better than might have been anticipated, considering that the Company had the full competition of the electric trams, with the weather all in favour of the trams. There had been a decrease in the number of passengers using the railway, but this decrease had since been partly made up by increase in the number of season-ticket holders. The 1d. fares which they had instituted had amounted to nearly one-half of the whole traffic. The directors had done their best to encourage season tickets, with the result that there were 3 339 monthly tickets issued, and there were 3,400 quarterly tickets, as against 2 500 tickets last year. The chairman observed that the tendency was in the direction of rapid travelling, and that "tubes" were not subject to speed restrictions like the tramways.

The report was adopted unanimously, and a resolution was afterwards passed sanctioning the creation and issue of £300,000 further capital, with borrowing powers to the extent of £100,000.

GREAT EASTERN RAILWAY.

At the half-yearly meeting held on the 28th ult., **Lord Claude Hamilton**, who presided, stated that in regard to electric traction the directors were watching the development of the Liverpool-to-Southport section of the Lancashire and Yorkshire Railway, besides which representatives of the Company had recently visited France to see whether there was anything to be learnt in regard to the working of the French railways. They had come back thoroughly satisfied that there was nothing in what they had seen—though a great deal that was commendable—that would prove of use to the Great Eastern Railway. They were, therefore, continuing the policy of holding their hands until they found something which they could recommend with full confidence.

DUBLIN TRAMWAYS.

The report and statement of accounts for the past half-year show increased receipts and diminished expenditure. The gross receipts totalled £128,487, being £3,322 more than the corresponding period of 1903, while the expenditure, £71,172, exhibits a saving of £2,784. The directors propose a dividend on the ordinary shares at the rate of 6 per cent. per annum, against 5 per cent. last year. This left a balance of £9,000, of which £2,000 has been placed to reserve, the same amount as last year; £3,000 has been allocated towards the cost of electric welding on the Dalkey line, and £4,015 has been carried forward, being £1,158 more than was carried forward 12 months ago.

The half-yearly meeting of the Company was held in Dublin on the 26th ult., **Mr. W. M. Murphy**, the chairman of the Company, presiding. In moving the adoption of the report, he remarked that the trouble with the rail joints on the Dalkey line had been remedied by electric welding. The tramways and equipment had been maintained in a high state of efficiency, and at the same time an economy in maintenance had been effected. The generating station had accomplished remarkable results, for though 94,587 additional units of electricity had been produced, the cost had decreased by £396. The Company were at present engaged in making a short extension of the Palmerston Park line, about 539 yards in length along the Dartry-road, and land had been acquired at its terminus for building a car-shed, which was very much wanted in the locality, as all the cars had, after their last journey at night, to return from Palmerston Gate to Clonskeagh, a distance of just two miles, and the first cars in the morning had to make a similar profitless journey. This meant a dead mileage of about 17,000 miles in the year, which would be saved by the erection of the new car-shed in Upper Rathmines. It was intended that this tramway should be continued down from Palmerston Gate to join with the Rathmines tram at the south end of Rathmines-road, but the construction of this portion was awaiting a road widening which the Rathmines Urban Council were about to carry out.

Replying to questions, the Chairman stated that the Company did not project other extensions at present, but might consider them in the future.

The report was adopted unanimously.

METROPOLITAN DISTRICT RAILWAY.

The report of this Company for the half-year ended June 30 states that the work of electrification is making rapid and successful progress. The great power station at Chelsea is virtually completed, and the

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machinery is being installed. The sub-stations on the Company's lines are nearing completion. Four hundred and twenty new corridor cars, providing 60 trains, have been ordered and are being constructed. Many miles of cables have been drawn into the ducts. The litigation which has been going on for several years between the Company and the Metropolitan Railway Company, with reference to the division of traffic and the user of the western joint lines, has been brought to an end, an arrangement having been made which is believed to be mutually satisfactory. The working agreement between the two companies has been extended until such time as the railways are worked electrically, and the Company receives 57 per cent., instead of 50 per cent., of the pooled receipts, in addition to a payment for arrears. Allusion is made to the Act recently obtained enabling the Company to charge zone rates over certain sections of the railway. The three tube railways with which the District Company have interchange stations at various points—the Great Northern, Piccadilly, and Brompton Railway, the Baker-street and Waterloo Railway, and the Charing Cross, Euston, and Hampstead Railway—are being rapidly constructed, and arrangements are being made with these companies for the user of ducts through the Company's tunnels, and also for the joint user of certain sub-stations.

CENTRAL LONDON RAILWAY.

The report for the first half of the present year states that the receipts from all sources of revenue amounted to £184,962, and the working expenses to £95,126, leaving a balance of £89,836 carried to the net revenue account. After providing for interest on the debenture stock and other payments, the net revenue account shows a balance of £108,737, including £36,078 brought forward from last half-year. There was a decrease of 20,741 in the number of passengers carried on this railway as compared with the corresponding period of 1903, notwithstanding an increase of 146,490 in the number of workmen conveyed. The directors recommend a dividend at the rate of 4 per cent. per annum, and on the undivided ordinary stock and the preferred ordinary stock. After putting aside £10,468, the proportion applicable to the deferred stock—dividend on which is not payable until the result of the year's working has been ascertained—there remains an unappropriated balance of £48,737, as compared with £45,406 a year ago. This is considered highly satisfactory, having regard to the adverse conditions of the half-year. The Company is opening up a new source of revenue by letting the areas over the stations for building purposes. Only the Lancaster Gate, Notting Hill Gate, and Holland Park station sites now remain for disposal. In the certificate appended to the accounts the auditors draw attention to the desirability of establishing a fund for the depreciation of the working stock, machinery, and permanent way. Such fund has not yet been established, but a general reserve fund has been provided, which now stands at £31,262. The total number of passengers carried on the line since its opening in 1900 up to June 30 last was 169,333,806.

CROMPTON AND CO.

The report to March 31 last states that the net profits for the year amount to £14,584, and after providing for debenture interest and other items there remains, with the sum brought forward from last year, a balance of £8,054. No interim dividend was paid in January last for the half-year ended September, but the directors now propose to place £750 to the credit of doubtful debts account and to pay a dividend at the rate of 2½ per cent. for the year, carrying forward a balance of £1,221, as compared with £1,098 last year. There are now some signs of an improvement in trade. The directors have registered a company under the title of the Electric Supply Corporation, Limited, and have been engaged in obtaining business for that company. They have secured concessions or agreements in 17 towns in the United Kingdom for electric lighting and for tramways, and arrangements have recently been made for the necessary capital for carrying on the work. An agreement has been made with the new company that Crompton and Co. shall carry out all the contract work required for a period of five years at a satisfactory profit. An agreement has also been made with the Electric Supply Corporation to sell the whole of Crompton and Co.'s interest in the Chelmsford Electric Lighting Company, Limited, this company taking shares and debentures in the new company in payment. The directors have every reason to believe that the new company will be a successful one, and that the securities thus exchanged will prove a profitable investment.

CONSOLIDATED ELECTRICAL.

The report of the Consolidated Electrical Company, Limited, for the period ended March 31 last, to be submitted at the meeting on the 8th inst., states that the Anglo-Portuguese Telephone Company, Limited, in which this Company is largely interested, continues to make satisfactory progress. The Private Wire and Telephone Installation Company, Limited, which was formed to take over a branch of this Company's business, has, the directors understand, had a satisfactory year's trading. This Company holds £2,000 of debentures and a majority of the share capital of the Private Wire Company. The net revenue account of the Consolidated Electrical Company shows a debit balance of £266. The items of salaries, office expenses, etc., should show further reduction in the next accounts. For many months the efforts of the Board were devoted to the reorganisation of the Company's finances, and these eventually were placed on a comparatively satisfactory footing. The whole of the debenture debt and other heavy liabilities were paid off, and at the present moment the Company is virtually free from floating debt. The directors have also been engaged in overhauling the affairs of the manufacturing branch. Until the close of 1903 business continued fairly good, but latterly there has been a great scarcity of remunerative orders in telephone and electric lighting work, and drastic economies have in consequence been effected in the administration and general management. The office of managing director has been abolished at a saving of £800 per annum. Mr. Leonard Redmayne has succeeded Mr. E. L. Joseph as works manager, and a further saving of £500 per annum has been effected by this change. Wages and other outgoings have been largely reduced, and these economies have been effected without loss of efficiency. Their effect had not been felt at the time of closing the accounts now under review, but will be apparent in the accounts for the current year. The removal from Coventry, so long talked of, is now an accomplished fact. The extensions at Canonbury, in progress at the time the Company was reconstructed, are completed, and the factory is now in a thoroughly efficient condition.

LIVERPOOL OVERHEAD RAILWAY.

The report of the directors for the half-year ended June 30, 1904, to be submitted to the thirty-second half-yearly general meeting on 9th inst., states that the gross revenue receipts amounted to £41,927. 13s. 3d., and the working expenses to £31,739. 16s. 11d. The number of passengers carried totalled 5,624,421 against 5,514,089 during the corresponding period of last year. The traffic, both on the railway and tramway, has suffered by the decreased work at the docks owing to the small crop of cotton, but bearing this in mind, the traffic has been fairly well maintained. The traffic working expenses show a satisfactory decrease, but there has been a further outlay on renewal of the permanent way, of which £1,000 has been charged to renewal fund. It is expected that the relaying of the permanent way will be completed this year. The contract for the construction of the northern extension to the Seaforth Station of the Lancashire and Yorkshire Railway has been let, and the work is now in progress. The revenue account shows that the receipts from passenger traffic amount to £41,137. 8s. 2d., and miscellaneous receipts and interest £790. 5s. 1d—total. £41,927. 13s. 3d., which, after deducting working expenses, £31,739. 16s. 11d., interest on mortgage debentures and on calls paid in advance, £3,948. 19s. 9d., and adding balance brought forward, £4,132. 1s. 11d., leaves available for dividend, £10,370. 18s. 6d. Out of this balance the directors recommend dividends at the rate (less income tax) of 5 per cent. per annum on the preference shares, and 1¼ per cent. per annum on the ordinary shares, £3,125, leaving a balance of £4,052. 5s. 10d. to be carried forward to next half-year. The mileage worked is: train system, 6 miles 57 chains; tramways, 2 miles 40 chains. The mileage run was: trains, 366,948, against 358,757 during the corresponding period of last year; and trams 134,646, against 134,599.

Abstract of Revenue Account.

Dr. Expenditure.	£	s.	d.
Maintenance of way, works, and stations	3,964	3	8
Locomotive power	8,708	4	0
Repairs and renewals of carriages	348	4	3
Traffic expenses	10,829	6	7
General charges	2,594	13	7
Law charges	93	19	9
Compensation	60	14	0
Rents, rates, and taxes	3,070	10	11
Government duty	70	0	2
Provision for renewals	2,000	0	0
	31,739	16	11
Balance carried to net revenue account	10,040	15	9
	£41,780	12	8

Cr. Receipts.	£	s.	d.
Passenger traffic	41,137	8	2
Parcels, etc.	72	17	0
Rents	565	1	4
Transfer fees	5	6	2
	£41,780	12	8

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Balance at credit of net revenue account	10,370	18	6
Interest payable or accruing and provided for	3,759	15	4
Sundry outstanding accounts	7,259	12	4
Renewal fund	27,559	1	7
Contingent fund	1,250	0	0
	£50,199	7	9

Cr. Assets.	£	s.	d.
Balance at debit of capital account	13,178	9	4
Cash in bank and in hand	30,056	3	1
Stock of stores and stationery	5,888	13	6
Sundry outstanding accounts	1,076	1	10
	£50,199	7	9

WATERLOO AND CITY RAILWAY.

The report for the half-year ended June 30 last states that the gross receipts of the line, less Government duty, amounted to £17,376, and the working expenses to £8,263, being at the rate of 47·55 per cent., as compared with 46 per cent. for the corresponding period of 1903. The balance available for dividend, after providing for interest on debenture stock, is £8,521, and a dividend at the rate of 3 per cent. per annum on the ordinary stock will absorb £8,100, leaving £421 to be carried forward to next half-year. The dividend will be payable on

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Aug. 13. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 2,227,350, showing a decrease of 53,783 compared with the corresponding period of 1903. The season-ticket holders on June 30 last numbered 1,611, as against 1,244 at the end of June, 1903.

DUBLIN AND LUGAN ELECTRIC RAILWAY.

The report of the directors to be submitted at the forty-sixth ordinary half-yearly meeting on the 18th inst., states that the total receipts from all sources show an increase as compared with the corresponding period of 1903 of £296. 11s. 5d., being equivalent to 10¾ per cent. The total expenditure shows a decrease of £173. 6s. 8d. on the half year, being equivalent to 9½ per cent. After providing for debenture interest there is a balance available of £1,211. 1s. 8d., out of which it is proposed that a year's dividend be paid on the 5 per cent. preference shares, being 10 per cent. on the half-year, absorbing £950, and reducing the arrears on these shares to a period of nine months. It is also proposed to pay a further sum of £100 off electrical equipment (capital account), and to carry forward the balance of £161. 1s. 8d. to next half-year. A resolution will be submitted at the meeting that the sum of £2,300 now standing to the credit of reserve account, which sum has been already paid on account of electrical equipment, shall be written off the balance standing at debit of capital account. The system is seven miles in length (single track). The miles run during the half-year totalled 54,625, against 51,513 during the corresponding period of last year.

ABSTRACT OF REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Maintenance of way, works, etc.	89	9	0
Motive power	574	11	8
Carriage and wagon repairs	105	7	9
Traffic expenses	402	5	10
General charges	303	4	2
Rates and taxes and income tax	131	11	11
Rents	20	19	2
Interest	60	0	0
	1,687	9	6
Balance to net revenue	1,334	16	6
	£3,022	6	0

Cr. Receipts.	£	s.	d.
Passengers, etc., periodical tickets	2,674	12	0
Parcels	149	9	9
Merchandise and minerals	149	0	1
Advertisements	37	10	0
Transfer fees	0	5	0
Sundry rents	7	15	0
Bank interest and discounts	3	14	2
	£3,022	6	0

ABSTRACT OF BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Net revenue account for balance	1,211	1	8
Sundry outstanding accounts	358	19	11
Dick, Kerr, and Co.'s account with interest to date	2,328	15	0
Debenture interest	208	0	0
Reserve for periodical tickets unexpired	57	17	6
Dividends outstanding	7	15	0
Reserve account	2,300	0	0
	£6,472	9	1

Cr. Assets.	£	s.	d.
Royal Bank	854	3	7
Cash in hand	16	4	4
Sundry outstanding accounts	221	1	7
Insurance unexpired	85	19	2
Stock of coal and stores on hand	163	10	3
Balance at debit of capital account	5,131	10	2
	£6,472	9	1

BLACKPOOL AND FLEETWOOD TRAMROAD.

The report for the half-year ended June 30 last, to be submitted at the meeting on the 26th inst., states that, including the sum brought forward from last half-year, the balance of profit, after providing for debenture interest, is £3,530, and the directors recommend a dividend at the rate of 4 per cent. per annum, writing off £500 to depreciation reserve, leaving £30 to be carried forward. The number of passengers carried during the half-year was 779,060. Receipts from all sources amounted to £10,257.

NEW COMPANIES REGISTERED.

Arnold Goodwin and Son, Limited.—Capital, £10,000. Objects: to, *inter alia*, adopt an agreement with A. Goodwin, and to carry on the business of railway proprietors, manufacturers of rails, sleepers, cables, and the like, electricians, electrical, mechanical, and general engineers, etc. Registered office: 56 and 58, Sumner-street, Southwark, S.E.

Galston Gas Company, Limited.—Registered in Edinburgh. Capital, £8,596. Objects: to purchase or otherwise acquire the business of manufacturers and suppliers of gas carried on under the name of the Galston Gaslight Company, at Garlston, Ayrshire, with all the assets thereof, and to carry on in the United Kingdom the business of manufacturers and suppliers of gas and electricity, etc.

Bastian Mercury Vapour Lamp, Limited.—Capital, £20,000. Objects: to acquire the benefit for the United Kingdom and Isle of Man of certain inventions from Bastian and Partners, Limited; to adopt an agreement with the said company and C. O. Bastian and A. E. Salisbury; and to carry on the business of mercury vapour lamp manufacturers, electricians, etc. Registered office: 39, Victoria-street, S.W.

Bowen's Electric and Motor Boats, Limited.—Capital, £20,000. Objects: to acquire the freehold yacht-building and electric works on Eel Pie Island, Twickenham; to adopt an agreement with K. Bowen; to construct and establish, in Eel Pie Island or elsewhere, a dock with patent and other slips, workshops, buildings, machinery, warehouses, and other conveniences, and to carry on the business of builders of and dealers in launches, yachts, ships, or boats of all kinds, whether propelled by electricity, steam, or other power, etc. Registered office: Northumberland-chambers, 23, Northumberland-avenue, W.C.

Empire Oil-Engine Syndicate, Limited.—Capital, £20,000. Objects: to acquire the inventions of J. Clay (for which provisional protection, No. 26,403 of 1903 and No. 11,971 of 1904 have been granted), relating to internal-combustion engines, together with the right to apply for patents in respect of the said inventions for all countries and colonies, and to adopt two agreements—(*a*) with E. R. Royston and J. Clay, and (*b*) with H. H. Perkes and W. Murray, and to carry on the business of manufacturers of and dealers in oil, steam, electric, and other engines and motors, motor vehicles, cycles, and vessels of all kinds, general engineers, etc. Office: 7, Great St. Helens, E.C.

Liens Registered.

Electrolytic Alkali Company, Limited, Middlewich.—Trust deed registered July 25 for £50,000 debentures. Trustee: Liverpool Mortgage Insurance Company, Limited; charged on freehold property in Middlewich and all other assets for the time being, including the uncalled capital.

British Electric Calibrated Fuse Company, Limited.—Issue on July 23 of £400 5 per cent. debentures, part of a series created Dec. 4, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,750.

Perth Electric Tramways, Limited, London, E.C.—Liens registered July 5 for £34,900 6 per cent. debentures, part of £50,000; amount previously issued, £100; charged on the benefit of certain agreements, deposit, provisional order, and Acts of Parliament, tramways and tramway undertaking, plant, machinery, etc., in Perth, West Australia.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Dickinson-street generating station of high and low pressure piping for two 750-kw. turbo-generators. Tenders by 10 a.m. on 9th inst.

Dublin.—The Lighting Committee of the Corporation of the City of Dublin are prepared to receive tenders for the supply of 500 alternating-current meters, single-phase and three-phase. Tenders to the Chairman, Lighting Committee, 3, Cork-hill, Dublin, by 12 noon on Aug. 23.

Plymouth.—The Corporation invite tenders for (25) steam alternator, etc.; (26) Lancashire boilers, with mechanical stokers; steam, exhaust, and other piping; ejector, condenser, valves, etc. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by Aug. 15.

London, S.E.—The Bermondsey Borough Council invite tenders for the wiring of the staircases and courtyards of the Fulford-street dwellings. Specifications, etc., may be obtained from Mr. Fredk. Ryall, town clerk, Town Hall, Spa-road, S.E. Tenders to be delivered at the Town Clerk's Office by Aug. 8.

Leeds.—The Corporation invite tenders for the supply of two 1,000-kw. turbo-alternators, with condensers, exciters, and high and low tension switchgear for same. Forms of tender, etc., can be obtained from Mr. J. B. Hamilton, general manager, Standard-buildings, City-square, Leeds. Tenders to the Town Clerk by 10 a.m. on Aug. 15.

Beverley.—The Visiting Committee invite tenders for various work in connection with the provision of new fire appliances at the asylum, including internal electric fire-alarm communications. Specifications, etc., may be obtained on and after 25th inst. at the office of Messrs. Maxted, Kuott, and Coles, engineers, Burnett-avenue, High-street, Hull. Tenders by 12 noon on Aug. 10.

Penang.—The Municipal Council of George Town, Penang, invite tenders for the supply and delivery of tramcars, complete with motors, controllers, trolleys, etc. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by 12 noon on Aug. 24.

Perth.—The Corporation invite tenders for the construction and equipment of about 4¾ miles of route length of tramways, constructed as single line with passing places—viz.: (1) permanent way and paving, including copper bonding; (2) overhead equipment; (3) cables, ducts, etc.; (4) cars and equipments; (5) car depôt building. Specifications, etc., can be obtained from the Town Clerk. Tenders before noon on Aug. 16.

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Argentina.—The *Boletin Oficial* contains a notice on behalf of the Government calling for tenders for presentation by Sept. 13 for the construction of a net of electric tramways between the Plaza de Mayo, Buenos Ayres, and the suburbs of Ortusar, Devoto, and General Urquiza. The *Boletin* containing the above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Manchester.—The Directors of the Manchester Dock and Warehouse Extension Company, Limited, invite tenders for the wiring (for power and light) and electric lighting of five transit sheds (now in course of erection) on the southerly side of dock No. 9, in the county borough of Salford. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Aug. 30.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

Reichenberg (Austria-Hungary).—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

RESULTS OF TENDERS.

Handsworth.—The order for 286 tons of bitumen has been placed with Rowland Carr and Co., through Johnson and Phillips.

Bromley.—The Borough Council have accepted the lowest tender, that of H. J. Godfrey, Balham, S.W., at £634. 6s., for the electric light at the dust destructor works.

Lancaster.—The Electricity Committee have accepted the tender of Aiton and Co., London, amounting to £229. 6s. 6d., for the new steam main to connect the old and new boiler at the electricity works.

Islington.—The Electric Lighting Committee recommend that the tender of W. J. Oakley, 9, Walbrook, at £210, be accepted for the supply of tail-rods for the three 1,000-h.p. engines at the electric lighting station.

Deptford.—The tender of the Electrical and Ordnance Accessories, Limited, Birmingham, at £340, has been accepted for the switchboard and connections at the town hall, and the tender of the Phœnix Dynamo Manufacturing Company, Bradford, has been accepted for the engines, dynamo, and booster in connection with the electric lighting.

London.—The London County Council Education Committee have received the following tenders for electric motor for propulsion apparatus at Culloden-street School, Poplar:—

Electrical Company, Limited, 121, Charing Cross-road, W.C.*	£103	0	0
J. Eason and Son, Fetter-lane, E.C.	192	3	9

* Recommended for acceptance with an addition of £9. 15s. for iron case.

Recent Orders.—We are informed by Browett, Lindley, and Co. that they have recently booked the following orders: J. Wrigley and Sons, paper manufacturers, Bury, a 430-b.h.p. two-crank compound engine; Mather and Platt, Manchester, for the Prestwich Asylum, 270-kw. engine; General Electric Company, Manchester, 33-kw. engine for Cairo Mill, also a 33-kw. engine for Cromer Mill, Middleton; Johnson and Phillips, Kent, 25-kw. engine; Mather and Platt, for the Admiralty Dockyard, Simons Bay, two 250-kw. engines; Industrial Engineering Company, Hyde, one 25-b.h.p. engine for the Magnesium Metal Company, Patricroft; Dick, Kerr, and Co., for the Gosport and Fareham trams, three 600-b.h.p. engines, each complete with surface condenser; Johnson and Phillips, for the Abosso Gold Mining Company, one 31-kw. engine; Trafford Power and Light Supply Company, one 15-b.h.p. engine; Dick, Kerr, and Co., for Bangkok, three 200-kw. engines; War Office, for the Royal Woolwich Arsenal, 500-kw. triple-expansion engine coupled to a generator by the British Westinghouse Company, complete with surface-condensing plant.

London, N.W.—The St. Pancras Electricity and Public Lighting Committee have received the following tenders for supplying and erecting a low-tension switchboard at the King's-road station:—

T. W. Broadbent	£798	0	0
Ferranti Limited (receivers and managers)	900	0	0
J. G. Statter and Co.	1,026	0	0
British Westinghouse Company, Limited*	1,035	7	0
Johnson and Phillips	1,059	0	0
Northcote, Heaver, and Co.	1,083	0	0
Electrical Company, Limited	1,095	0	0
Cowans, Limited	1,109	0	0
British Thomson-Houston Company, Limited	1,121	18	0
Bertram Thomas, Limited	1,153	0	0
Kelvin and J. White, Limited	1,170	10	0
Nalder Bros. and Thompson, Limited	1,215	0	0
Consolidated Electrical Company	1,220	0	0
Westminster Engineering Company, Limited	1,230	0	0
Veritys, Limited	1,249	0	0
E. F. Moy and Co., Limited	1,260	0	0
Siemens Bros. and Co., Limited	1,270	0	0
Elliott Bros.	1,296	0	0
Edison and Swan United Electric Lighting Company	1,332	0	0
Electric Construction Company, Limited	1,357	0	0
Aberdeen Electrical Engineering Company	1,490	0	0
Electric and Ordnance Accessories Company	1,560	0	0
Dorman and Smith	1,658	0	0
J. Fowler and Co.	1,665	0	0
Crompton and Co., Limited	1,955	0	0

* Recommended for acceptance.

London, W.—The Hammersmith Borough Council have received the following tenders for supply of high-pressure steam-boilers:—

Combined superheater.

Stirling Boiler Company (English)—watertube type	£3,800	0	0
B. R. Rowland and Co.—Climax watertube	4,410	0	0
Davey, Paxman, and Co.—Economic*	4,899	0	0
Stirling Boiler Company (U.S.A.)—watertube	5,369	0	0
Babcock and Wilcox, Limited—marine watertube	5,445	0	0
R. Hornsby and Son—watertube	5,879	0	0
Richardson, Westgarth, and Co.—Hornsby's type	6,056	0	0
R. Hornsby and Sons—Hornsby's type	6,155	0	0
Davey, Paxman, and Co.—Economic	6,336	0	0
J. Fraser and Co.—marine	6,945	0	0
Walther and Co. (German make)—Babcock and Wilcox	7,500	0	0
Clayton, Sons, and Co.—Lancashire	7,512	0	0
Willans and Robinson—Niclausse	8,173	0	0
J. Thompson—watertube and Lancashire	9,100	0	0

Separately-fired superheater.

Stirling Boiler Company (English)—watertube	4,253	0	0
E. Danks and Co.—Economic	4,967	10	0
E. Danks and Co.—Cahall vertical watertube	5,020	0	0
Stirling Boiler Company (English)—watertube	5,102	0	0
B. R. Rowland and Co.—Climax vertical	5,190	0	0
Stirling Boiler Company (U.S.A.)—watertube	5,335	0	0
Davey, Paxman, and Co.—Economic	5,563	0	0
Stirling Boiler Company (U.S.A.)—watertube	6,119	0	0
L. Burnett and Co.—Economic	8,323	0	0

Fitted with mechanical stokers.

Stirling Boiler Company (English)—watertube	3,898	0	0
Babcock and Wilcox, Limited—watertube	4,600	0	0
B. R. Rowland and Co.—Climax vertical	4,995	0	0
Stirling Boiler Company (U.S.A.)—watertube	5,110	0	0
R. Hornsby and Sons—watertube	5,395	0	0
Davey, Paxman, and Co—Economic	5,518	0	0
Richardson, Westgarth, and Co.—Hornsby's watertube	5,556	0	0
Richardson, Westgarth, and Co.—Hornsby's watertube	5,911	0	0
R. Hornsby and Sons—watertube	7,048	0	0

* Recommended for acceptance.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Bilston.—The District Council have decided to have a telephone laid on at the town hall.

Swindon.—The Town Council propose to spend some £6,000 on extensions of the electric supply plant.

Birkenhead.—The electric lighting undertaking shows a net profit for the past 12 months of £1,386, as against £1,195 the previous year.

Chelsea Electricity Supply Co.—The directors have declared an interim dividend at the rate of 4½ per cent. per annum on the ordinary shares.

Hull.—An enquiry has been held into the Corporation's application for sanction to a loan of £10,000 for additional machinery. There was no opposition.

Electrical Coal-Cutters.—Electrical coal-cutting machines have ben introduced, among several Lancashire collieries, into one of Lord Ellesmere's mines.

Panama.—The National Convention is reported to have voted a sum of £325,000 for various public works, including an extension of the electric lighting system.

Swansea.—The Town Council have decided to make formal application to the Local Government Board for sanction to borrow £2,000 for extension of telephone cables.

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Bideford.—The Mutual Electric Supply Corporation and Southern District Electricity Corporation have notified their intention of applying for lighting orders for Bideford.

Bexhill.—The Corporation, according to report, recently decided by a large majority to continue the electric supply undertaking themselves, instead of selling it to a private company.

Vickers, Sons, and Maxim.—The directors have declared an interim dividend for the half-year ended June 30 last of 1s. per share on the 3,689,500 ordinary shares, fully paid.

Promenade Concerts.—The Newman promenade concerts at Queen's Hall will be resumed on Saturday next, for which evening a full and interesting programme has been arranged.

Penge.—The Urban District Council have received notice from the Blackheath and Greenwich Electric Light Company of the laying of cables for electric lighting from Westow-hill to Palace-hill.

Charing Cross and Strand Electricity Supply Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year ended June 30.

Sydney (N.S.W.).—Electric light works of sufficient magnitude to supply nearly all the streets and buildings of the city are reported to have been started, thereby opening a considerable field for electric lamps.

Strokestown (Ireland).—A new concern, entitled the Strokeatown Electric Lighting Company, has been formed to whom will be transferred the plant and undertaking hitherto conducted by an enterprising inhabitant.

Devonport Dockyard Inspection.—The annual inspection of the electrical and torpedo stores at Devonport Dockyard and Bull Point naval ordnance depôt has just been completed, a thorough examination of all the apparatus having been made.

Scothill Nether.—Owing to the high price charged for gas by the Dewsbury Corporation, the Urban District Council have enquired of the Yorkshire Electric Power Company the terms upon which they will supply electricity in bulk for lighting and power.

Maydock.—The District Council have decided to apply for a provisional order for supplying energy, the opinion being expressed that it would enable them to obtain better terms from the Lancashire Electric Power Company, who are desirous of providing energy for the town.

Llantrisant and Llantwit.—The District Council have received notice from Mr. C. V. Fowler that he intends applying for a provisional order under the Electric Lighting Act for the district of Llantrisant. The clerk was instructed to write asking him for particulars of his scheme.

Aston.—The Electricity Committee have adopted the following resolution: "That the Council delegate to the Electricity Committee executive powers for the working, management, and control of the electric power station, the committee reporting thereon from time to time to the Council."

Stock Exchange.—The date appointed for the special settlement in respect of the London United Tramways (1901) 25,000 5 per cent. cumulative preference shares of £10 each, Nos. 100,001 to 125,000, is the 17th inst. An instalment of 15 per cent. is due to-day upon the London County 3 per cent. consolidated stock.

Spennymoor.—The Northern Counties Electricity Supply Company have secured the contract for the street-lighting of the whole district for the season of 10 months at £2. 7s. 6d. per lamp. Their former contracts with the Council have been for portions of the district only, the remainder being illuminated by the gas company.

New Premises.—Messrs. A. Vandam and Co., of Johannesburg (late Vandam, Marsh, and Co., Limited, of 15, Gerrard-street, Soho), inform us that they have opened a warehouse and offices at Johannesburg, where they have a large stock of electrical supplies on show. Their postal address is P.O. Box 4,941, Johannesburg.

Hanley.—All the electric lights went out for a few minutes on Saturday, and the Chairman of the Electricity Committee remarked that the incident illustrated the importance of obtaining the new engine, now under order, so as to be ready for the winter. It appears that the lights were extinguished through an armature coil being burnt out.

Lancaster.—The Rural District Council have received an application from the Hamsterley Colliery Company for permission to erect an electric cable along certain roads. The proposed route crosses a turnpike road, and the Council have decided to instruct their solicitor to draft a clause so as to protect the Council in case of the cable causing accident to life.

Datchet.—At a meeting of the inhabitants the following resolution was adopted: "That the Parish Council be authorised and is hereby empowered to enter into a five years' contract with the Slough and Datchet Electrical Supply Company to light the parish of Datchet upon the terms quoted to the Parish Council by the electrical company—£147 per year for five years."

Stoke-upon-Trent.—An agreement has been entered into between the Corporation and the canal engineer respecting the laying of cables along the towing path, the Council to pay an annual wayleave of £1. Mr. G. V. Fowler having given notice of his intention to apply for a provisional order under the Electric Lighting Acts, the Council decided to oppose any such application.

Newhaven.—The Urban Council have instructed the town clerk to reply to the Southern District Electricity Corporation and Mr. Fowler that if they will submit draft agreements embodying the terms under which they propose to apply for provisional orders for the supply of electricity in the district, the Council will consider whether they can give their sanction to the application.

Farnborough (Hants).—The Urban District Council have received a letter from Mr. G. Vaughan Fowler, with reference to the electric lighting order, enquiring if the Council were prepared to negotiate for the transfer and a lease of the order. The Council are not disposed to entertain the proposal.

Longside.—The Electricity Committee, after making enquiries into the question of letting motors on hire, recommend that the motor hire-purchase system be adopted, and that an agreement be entered into with the British Thomson-Houston Company to supply their motors in accordance with terms submitted, and that descriptive booklets be distributed among likely users of motive power.

Caerphilly.—The Bill to confirm the provisional order made by the Board of Trade to confer electric lighting powers on the District Council, which has passed the House of Commons Committee, was again opposed by the Rhymney, etc., Gas Company when the Bill came before the House of Lords Committee on Wednesday, but after a very brief deliberation it was allowed to proceed.

Stoke.—The Buildings and Estates Committee of the Guardians have considered the question of the substitution of electric motors for steam-engines at the school, well, and hospital laundry. They point out that the cost of the electricity would be practically nil, as the dynamo would run full load instead of half load as now, and that £100 a year would be saved. The cost of the motors is estimated at £150.

Tiverton.—Messrs. Suter and Co., contractors for the electric light under the Town Council, have issued a circular to householders and traders setting forth the advantages of electricity both for lighting and motive work. The price proposed to be charged for lighting is 5½d. per unit. The cost of installing electric light in a house will be 12s. 6d. per lamp, and a charge of 10s. per annum will be made for meters.

Bermondsey.—The Borough Council have agreed to the recommendation of the Electric Lighting Committee that an additional feeder in connection with the Rotherhithe extensions be purchased at a cost of £3,100, the money to be raised by loan and charged to the capital account. The Guardians have approved an agreement with the Borough Council for the supply of electricity to the infirmary at the rate of 3½d. per unit.

Poplar.—A recommendation of the Finance Committee, that the sum of £3,908. 0s. 8d., being the credit balance on profit and loss account of the electricity undertaking at March 31, 1903, be transferred to a reserve fund account, in order to provide for renewal of plant, has been referred back, a councillor desiring to know what had become of a sum of £4,000 which was to have been placed to the electrical reserve account.

Electricity and Lighthouses.—The Bournemouth and Poole Electricity Supply Company, Limited, having written that the charge for installing an electric light of 200 c.p. in the Lilliput Lighthouse would be £13. 10s., and that the charge for current would be at the rate of 3d. per unit, which would amount to £55 per annum, the Lighthouse Commissioners have replied that the cost would be too high to justify them in adopting the proposal.

Luton.—At the last meeting of the Electric Light and Power Committee the electrical engineer reported that the Council now had a total of 174 consumers with 10,990 lamps and 53 motors of 179 h.p., and that at the present time over 648 additional lamps and five motors of 18½ h.p. were being wired. He also reported that the number of units generated showed an increase of 37 per cent. over the number generated during the corresponding period of last year.

Belfast.—At this week's meeting of the Electricity Committee the electrical engineer (Mr. V. A. H. M'Cowen) presented a summary of the electric light rental for the six months ended June 30 last, which showed that the amount received for current was £13,887. 4s. 7d., as compared with £11,940. 2s. 8d. at the corresponding date last year, or an increase of 16·3 per cent. The average price per unit for the six months was 2·767d., as compared with 3·066d.

Wrexham.—The Guardians have adopted the suggestion of the electrical engineer that an electric alarm be fixed to the flood gates in the river bed adjoining the electricity works as an experiment. The Electricity Supply Committee reported that during the month 27,940 units had been consumed, compared with 29,094 last year. The committee fully discussed the extension scheme, and it was decided to send a committee to inspect the Chester scheme.

Bo'ness.—The Town Council have signed the agreement with the National Electrical Construction Company, Limited, the contractors for the electric lighting of the burgh. The agreement provides that the works are to be completed within the next nine months, and that the Town Council are to pay to the contractors a sum of £24,689, subject to deductions, amounting to over £1,200, for, among other things, a site for the generating station recently purchased by the Town Council.

Southwark.—The accounts of the electricity department for the year ending March 31 show a total income of £12,231 against working expenses of £7,279, leaving a gross profit of £4,952—an increase of £1 343 over the previous year. Interest and sinking fund absorb £4,728, leaving a net profit of £224. The units sold numbered 793,418, of which 538,832 were taken by private consumers, the remainder being used for public lighting. The public lamps now supplied total 582, the majority of which are Nernst lamps.

A.E.G. English Manufacturing Co.—We are informed by the company that they are now starting business at 4, New Compton-street, Charing Cross-road, where a large stock will be kept. This company has acquired the English Nernst lamp patents from the A.E.G. of Berlin, and will look after the Nernst lamp business in England. All lamps and burners will in future be marked "Aegma." Owing to the rapidly increasing demand for Nernst lamps it is intended to build a factory in this country. A price list containing many novelties will be issued in a few days' time.

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Keighley.—The Local Government Board has held an enquiry into the application of the Corporation for sanction to borrow an additional £11,500 for electricity purposes. The statistics put in showed that the estimated population at the present time is 43,250, the assessable value £134,296 and the outstanding loans £229,599. The expenditure already made on electrical works and plant has been £39,356. During the year ended June 30, 184,307 units had been sold, 70,008 being for motive power. There was no opposition.

Trade Notice.—We are informed by Mr. A. H. Hunt, of 115-117, Cannon-street, E.C., that the agency which he has conducted for the Walsall Electrical Company has been determined by mutual consent, though he still represents Messrs. Webb, Shaw, and Co., of Stourbridge, and also Messrs. Geoffroy and Delore. Mr. Hunt intimates that he has made arrangements by which he can still supply promptly and at favourable prices such appliances as dynamos, motors, arc lamps, switches, switchboards, instruments, circuit breakers, and iron-cased goods for high-tension and power work.

Dodworth.—Pursuant to a resolution passed by the Urban District Council at a special meeting held on the 11th ult., a public meeting of the ratepayers of the township was held on the 27th ult. "for the purpose of considering the question of the proposed public lighting of the urban district of Dodworth, and also of deciding what steps, if any, should be taken in regard to the said matter." Ultimately a proposal that gas should be used was negatived, the majority favouring the chairman's suggestion that electric lighting might be obtained in due course from the Yorkshire Electric Power Company.

Burnley.—At its meeting on Wednesday the Town Council had before them a recommendation by the Electricity Committee that the charges for meter rents should be reduced. For meters up to and including 50 amperes it is proposed to charge 6d. per quarter, and for meters over 50 amperes 1s. per quarter. Hitherto the charge has been 2s. 6d. per quarter for all sizes of meters. This movement is attributable to the action of the chamber of commerce and the tradesmen's association. The Electricity Committee were unable to entertain at present a request that the general electricity charges should be reduced.

Underground Telegraph Cables.—The following is the Postmaster-General's reply to a question by Sir Thomas Dewar as to what point the present system of underground telegraph cables to the North has been advanced, and whether the area which has suffered specially through storms in former years has now been passed: "The pipes in the underground system to the North have been laid as far as Carlisle, and also over Beattock incline. Wires in the pipes have been provided as far as Liverpool, Manchester, and Leeds, and are now being provided in the Warrington-Carlisle section. The original section—viz., that between London and Birmingham—traversed the area which had suffered especially through storms in former years."

Cork.—The following letter has been received from St. Martin's-le-Grand by the hon. secretary of the Cork Incorporated Chamber of Commerce and Shipping: "I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 23rd inst., in which you forward a copy of a resolution of the Cork Incorporated Chamber of Commerce and Shipping relative to the extension of the trunk telephone system to the principal towns in the South of Ireland, and in reply to say that a scheme for providing telephonic facilities in the district in question is now under consideration. Estimates of the cost are being obtained, and steps taken to ascertain what support will be forthcoming at several of the towns mentioned by you."

Wolverhampton.—An enquiry has been held by Colonel A. G. Durnford, R.E., on behalf of the Board of Trade, into an application by the Corporation for sanction to borrow £13,000 for the purpose of electric lighting. Evidence was given by the town clerk, the borough accountant, and Mr. C. E. C. Shawfield, the borough electrical engineer. The sum of £3,000 was required for the provision of an electric generating plant at the new refuse destructor in Crown-street; £2,800 would be spent on feeder and distributing mains to deliver the electric current into the existing network of mains to supply a large manufacturing district in the vicinity of the destructor; and the balance of £7,200 would be utilised for the extension of mains throughout the borough.

Grimsby.—At a meeting of the Grimsby Electric Lighting Committee last Friday it was reported that there had been an increase of 3,212 units for traction during June as compared with last year, and 8,606 units for private consumers. In the first quarter of the year 16,570 units were sold for power purposes, as compared with 16,519 during the whole of the year 1903-4. The Chairman, in moving the adoption of the annual report, pointed out the rapid progress that had been made. From the report they anticipated that the thing would pay its way. They had thought if they sold one million units they would be master of the whole thing, and they had now got within a hair's-breadth of that. He considered the small coal bill a subject for congratulation. The report was adopted.

Inverness.—A largely-attended meeting of consumers of electric light was held last Friday in reference to a circular received from Claud Hamilton, Limited, who supply the current, and who, it appears, have intimated that the current will be discontinued unless the consumers comply with a certain demand. The consumers agreed not to take any notice of the demand made by the company. It was agreed to petition the Town Council with reference to the matter, and to ask them to take public action. The curious position of the consumers and the company has excited considerable interest in the town, and as the 10 days have now expired, the question is discussed whether the intimation in the letter, that the electric current will be cut off, will be given effect to. The subject, it is understood, will be considered by the Town Council.

Sheffield.—The Electric Light Committee having considered a report by Mr. S. E. Fedden, the general manager of the electric supply department, decided to recommend the Corporation to reduce the charges for electrical energy for power purposes as from Dec. 26, 1904, as follows: for all power used in motors, driving hoists, cranes, passenger lifts, and similar machinery, 2d. per unit; for other motors, 1½d. per unit; to consumers satisfying the general manager as to the continuous running of their motors throughout the whole of the working hours of each day, whose consumption does not exceed 5,000 units per annum, 1½d. per unit; and to consumers complying with the preceding clause whose consumption exceeds 5,000 units per annum, 1d. per unit. Discount on a graduated scale will be allowed.

Southampton.—The accounts of the electric supply department for the year ended March 31 show that the gross receipts amounted to £27,639, with an expenditure of £14,124, the gross surplus being £13,515. Interest and sinking fund take £8,704, leaving a net profit of £4,811, part of which has been applied to meeting the cost of re-erecting at the new station the plant removed from the old works, which is running satisfactorily. Latterly the tramways have been partially supplied from the new works. The committee pay a tribute to the work of Mr. H. F. Street (the borough electrical engineer) and his staff. The units sold totalled 1,298,013 against 1,752,013 in the previous year. Private consumers accounted for 654,034 units, public lighting took 137,353 units, while the tramways were responsible for 1,298,392 units. The number of consumers continues to increase.

Belfast-to-Londonderry Telephone.—At the meeting of the Londonderry Chamber of Commerce the subject of the trunk telephone service from Belfast to Londonderry, *via* Ballymena and the local service in Londonderry, was discussed. A trunk telephone service is being laid by the Post Office authorities from Belfast to Londonderry; but when the line reached Londonderry it would be almost useless, one of the members remarked, unless the local service in the city was changed by the National Telephone Company into a loop-line service. If this change be not made, subscribers will have to go to the post office when they wish to communicate with Belfast, whereas if the city local service were made into a loop line, subscribers could communicate with Belfast from their own offices. It was suggested that the chamber should request the Corporation in any negotiations they had with the National Telephone Company to insist upon this loop-line service in the city being made.

Stourbridge.—At the meeting of the Urban Council, the Electric Powers Committee reported that the Board of Trade had intimated that they would defer consideration of the question of revoking the Council's electric lighting order for 12 months. Notices under the Electric Lighting Act, 1882, of intention to apply to the Board of Trade for provisional orders to supply electricity within the Council's area had been received from two London companies. The committee would take the necessary steps to safeguard the interests of the Council. Notice had been given to the Bromsgrove Rural Council of the Stourbridge Council's intention to ask for a provisional order to confer extended powers on them under the Electric Lighting Acts. A draft agreement had been submitted by the Midland Electric Corporation for Power Distribution, Limited, for the proposed supply of electricity in bulk to the Council. Nine tenders for the laying down of electric mains had been received by the committee, who recommended the acceptance of one of these conditionally on the sanction of the Local Government Board to a loan for the purpose. The clerk read a letter from the Government Board with regard to a further public enquiry on the subject of loans for the supply of electricity, the Board intimating that the Council should be prepared to show there was such a demand for the electric light as would justify them in carrying out the work.

Croydon.—The Corporation have reduced the price for current supplied to places of public worship to 4d. per unit. The price hitherto charged has been 4½d. per unit. The committee are obtaining particulars with a view to considering the practicability of making some concession also to private consumers. The borough electrical engineer reported: Current sold this year for private lighting, 72,611 units (corresponding period last year, 51,141); public lighting, 26,629 (24,948); traction, 103,426 (92,080). A 200-kw. motor-alternator is to be bought for use during the hours of light load for the alternating-current supply, to save running an extra engine, so reducing the running costs during this time. By the use of this machine it is estimated there will be a saving in coal consumption of not less than £300 per annum. The estimated cost of motor-alternator and switchgear and cables is £1,350. The following is an estimate of capital expenditure required during 1904-5: For works—one direct-current generator, £7,000; foundations, etc., for same, £400; switchgear for new generator, £250; contingencies (10 per cent.), £765; motor-alternator, £1,100; switchgear for same, £250—total, £9,765. Of the foregoing estimate, £8,415 is part of the sum of £70,950 adopted by the Council on July 27, 1903 (of which sum of £70,950 sanction has already been received to the borrowing of £27,975), the remaining £1,350 representing the cost of the motor-alternator referred to above.

London Gazette.—The partnership between James Carson and Herbert Francis Borman, carrying on business as engineers at Hooper-street, Spring Hill, in the city of Birmingham, and trading as Carson, Borman, and Co., has been dissolved by mutual consent. The partnership between Lewis Percy Brenchley, Arthur Brenchley, and Harold Frederick Holman, carrying on business as general, electrical, and mechanical power engineers, at 36 and 38, New-street, Ashford, trading as Brenchley Bros. and Holman, has been dissolved by mutual consent. A general meeting of the members of the Electric Construction Corporation, Limited, will be held at 109, Dashwood House, New Broad-street, London, E.C., on Sept. 29, 1904, at 12.30 p.m., for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted and the property of the corporation disposed of. A receiving order has been made out on creditors' petition in the estate of Warner and Co., builders and electricians, 12, Holbein-place, Sloane-square, London. The first meeting will be held at 12 noon on Aug. 11, 1904, at the Bankruptcy-buildings, Carey-street, London. A receiving order has been made out on debtor's petition in the estate of John William Thomas, engineer,

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trading as Spetch and Thomas, and carrying on business at West End Mills, Longside-lane, Bradford. The first meeting will be held at 3 p.m. on Aug. 12, 1904, at the Official Receiver's Chambers, 29, Tyrrel-street, Bradford.

Annual Outing.—The first annual outing of the engineering staff and employés of the Ealing Corporation electricity department was held on Saturday last. The party, numbering 33, made an early start from Ealing for Windsor by the Great Western Railway, proceeding thence by steam launch to Marlow, where they arrived at 11 a.m. A cricket match was commenced between the "inside" and "outside" staffs, an adjournment being made at 1 o'clock to the Crown Hotel, where the company did justice to an excellent repast provided by Mr. J. Douglas Knight (borough electrical engineer) and Mrs. Knight. At this function the chair was occupied by Mr. Knight, with Mr. A. E. Pullen as vice-chairman. The greater part of the afternoon was taken up with the cricket match, a good game resulting in a victory for the "outsides," for whom Messrs. A. E. Pullen, Ablee, and Stockley showed good form with the bat, while on the other side Messrs. Payne and Hudson were most successful with the willow. In the tug-of-war which followed, however, the "insides" turned the tables after a keen contest, twice hauling their opponents over the line. The party returned to the Crown Hotel at 5 o'clock for tea, and at 6.30 p.m. a start was made for home. During the journeys out and home an excellent entertainment was furnished by the musical section of the party, Mr. Hudson presiding at the piano, while Messrs. Gordon, Watts, Payne, J. House, and others contributed to the harmony. Ealing was reached shortly before 11 p.m., a thoroughly enjoyable day having been spent by all.

Erith.—The Electric Lighting Committee's report recommends that a lamp be placed at the entrance of the passage way near Bedonwell-hill. The whole of the quarter-ampere Nernst burners on the street lamps have been replaced by two incandescents of 8c.p. each. The committee having considered the resident electrical engineer's report upon the distribution system, endorse his recommendation that an additional transformer of 100-kw. capacity be installed, and that the estimate of the British Electric Transformer Company be accepted. The committee have fully considered the question of the extension of the mains for private lighting in Lower-road, Belvedere, and also in Mayfield-road and Poplar-mount. The resident engineer's estimate for these extensions, including the necessary transformer station, amounts to £461. 19s. 5d. As a number of applications for the supply of current have been received from the owners or occupiers of houses in Lower-road and Mayfield-road, including the Education Committee for their offices and the pupil teachers' and cookery centres at Picardy, the committee recommend that supply mains be laid in these roads and the necessary transformer station provided. The committee will also be prepared to recommend the laying of a main in Poplar Mount and other roads in the vicinity upon receiving sufficient applications for the supply of current to justify the expenditure. The resident engineer has applied to have certain alterations made to the offices at the electric light station, and the committee have approved of the engineer's suggestions. The contractors have been instructed to commence the additions to the generating station.

Islington.—The following reports and recommendations of the Electric Lighting and Finance Committees respectively will be considered at to-night's meeting of the Borough Council: (1) "The electrical engineer has informed us that a supply of electricity will probably be required at the postal sorting office which is being erected in Goodwin-street, Foothill-road, but before making the actual application, the Post Office authorities desire to be informed whether in the event of their requiring the current, the Council would be prepared to make the necessary extension of mains at their own cost and to dispense with the usual statutory requisition. The cost of laying the requisite main is estimated at £300, and the probable revenue at at least £125 per annum. We recommend that the Post Office authorities be informed that in the event of their requiring a supply of electricity for the premises referred to, the Council will lay the necessary mains and will dispense with the usual statutory requisition." (2) "We have had under consideration a letter from the London County Council intimating that they are prepared to accede to the Council's application for sanction to the borrowing of the sum of £15,636 for electric lighting purposes, upon an undertaking being given that during the currency of the loan all replacements and renewals of plant, machinery, and works purchased by money raised under the sanction shall be defrayed out of the sinking fund to be provided for that purpose, or from maintenance account. We recommend that in the event of the London County Council sanctioning the borrowing of £15,636 for electric lighting purposes for a period of 42 years, the Islington Borough Council hereby undertake that during the currency of the loan no further loans will be raised to replace any of the plant, machinery, and works the cost of which is to be defrayed out of such loan, and that any renewals required during the period thereof shall be provided out of a sinking fund to be created for the purpose or from maintenance account."

Insurance.—The following are details of the revised rules issued by the Associated Fire Offices for electromotors, and dynamos used in connection therewith, employed in textile and corn mills and other buildings where motors are exposed to dust, to which we referred in our last week's issue: "(1) Motors when not in an engine-room or in a separate compartment expressly set apart for their use and built of or lined with incombustible material must be completely enclosed in an efficient metal case forming part of the designed construction thereof. Ventilation by direct communication with the outer air or by openings in the vertical portion of the metal case protected by two thicknesses of approved wire gauze is allowed. Induction motors may have unprotected ventilation openings in their metal cases, the superficial area of each opening not exceeding ¼in. and the openings being at least ¼in. apart. Slip rings and brushes or any other sliding contacts must be completely enclosed in metal cases. Inspection holes fitted with plate glass are allowed. (2) No unprotected woodwork or combustible material must be within 18in. of any motor, and wood flooring beneath any motor must be protected by a sheet of metal. (3) The motor pulley (or other mechanical device for transmitting power from the motor) must be external to the metal case enclosing the motor. Only the shaft and the connecting conductors may be carried through into the metal case or through the wall of the compartment. No belts, ropes, or other corresponding gear may be so carried. (Note.—Holes in the case to admit connecting conductors must have proper bushings, and exposed terminals must have proper protecting caps fitted to prevent short-circuiting; each connecting conductor must be provided with a proper switch and proper cut-out.) (4) Dynamos must be treated as motors. (5) Resistances and starting transformers must be similarly situated, and must be enclosed as required for motors. (6) All metal cases, tubes, etc., must be efficiently connected to earth. (7) Motors must not be supplied with current from dynamos or conductors having an earth return."

TRACTION.

Bradford.—The receipts from the electric cars on Bank Holiday amounted to £1,379.

Bournemouth.—The electric tramways achieved a record on Bank Holiday, over £500 being taken.

Dover.—After a long sitting the Town Council decided to settle the question of Sunday running by *plébiscite*.

Scarborough.—The laying of the tramways on the approach road to the Marine Drive has been deferred until the autumn.

Salford.—The Corporation have adopted a resolution directing the Tramways Committee "to furnish the cars with an efficient system of ventilation."

Erith.—It is expected that the engineer's report on the tenders for the tramways will be received in a week or two, when a special meeting will be held to consider them.

Aston.—The Board of Trade have approved the reconstructed tramway between the city boundary and Aston Cross, and sanctioned a maximum speed of 10 miles an hour.

Ipswich.—The receipts on Monday amounted to £210, the number of passengers approximating to 52,500. The receipts on Sunday totalled about £110, making £320 in two days.

Belfast.—The notices which had been put on the order paper of the House of Commons of resolutions to refer the Corporation's Tramway Bill to a hybrid committee have been withdrawn.

Gosport.—Good progress is being made with the reconstruction of the tramway system, and the High-street section has been commenced It is expected that all the rails will be laid in two or three weeks' time

Halifax.—At the monthly meeting on Wednesday the Corporation were asked to authorise the laying of tramlines between Calder Bridge and the coal yard on the West Vale route, at an estimated cost of £1,762.

Hartlepool.—It is reported that, commencing on Monday last, the steam-driven trams of the North-Eastern Railway Company between Hartlepool and West Hartlepool have been entirely superseded by a new service of electric motor vehicles.

Accrington.—It is reported that the Corporation have submitted plans for the laying of a tramway along Market-street and Union-road, which scheme they propose to embody in the Tramway Bill they will submit for parliamentary sanction.

Waterloo and City Railway.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended June 30, carrying forward a balance of £422. A year ago the dividend was at the rate of 3¼ per cent. per annum, with £170 forward.

Huddersfield-Halifax.—The Greetland District Council have received a letter from the solicitors to the promoters stating that the plans of the proposed system would soon be prepared, and that when running powers were obtained the scheme would be carried out expeditiously.

Birkenhead.—The year's working yielded an increase of some £3,600 in the receipts, the expenses being proportionately heavier. The gross profits amount to £21,198, and after appropriating £19,314 in respect of the debt, there remains a net profit of £1,883, which has been placed to the renewals fund.

Paisley.—The sections of the Paisley District Tramways Company's systems from the Cross to Potterhill (south) and to Johnstone (west) were inspected last week by Colonel Yorke on behalf of the Board of Trade. He was accompanied by members of the Paisley and Johnstone Town Councils and officials of the company. The inspection proved satisfactory.

Liverpool.—The Corporation tramways show an income during the past 12 months of £531,483, an increase on the previous year of £18,058. The total expenditure was £341,463, an increase of £1,652. After meeting charges for interest and sinking fund there remained a net surplus of £96,242, of which £64,000 was apportioned to reserve, renewal, and depreciation fund, and £32,000 to the relief of city rates.

South Shields.—The amended tender of the British Electric Traction Company was considered at a meeting of the Town Council on Wednesday. The new tender, upon which the Tramways Committee has resolved to base further negotiations, proposes to omit that portion of the authorised line between the termination of the present system at Tyne Dock and the end of Stanhope-road, and as an alternative the company agrees to apply at once for powers for the construction of a line from Bertram-street to the entrance of Tyne Dock, and in addition a line from Westoe to Harton. After a long discussion the matter was referred back to committee.

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Stretford.—The Urban District Council Bill has passed the House of Commons Committee, and has been ordered for third reading, power being given to the Council to run a service of omnibuses as a connecting link between the Stretford and Withington tramways.

Stockport.—The Stockport and Hazel Grove Tramways Company, for the purchase of whose undertaking abortive negotiations took place lately with the Corporation, have made a profit for the last half-year of £630. 16s., which, with the £898. 4s. brought forward, permits of a dividend at the rate of 10 per cent., after carrying £891. forward.

Derby.—The opening of the first two sections of the Corporation tramways, alluded to in our issue of last week, was celebrated by a banquet given by the Mayor at the Derby Royal Hotel, which was attended by most of the councillors and officials. The toast given by the Mayor, "Success to the Undertaking," was received enthusiastically.

Bristol.—The Bristol Tramways (Extension) Bill, which has already passed the House of Lords, came before the Select Committee of the House of Commons on Unopposed Bills on the 28th ult., Mr. J. W. Lowther presiding. Mr. J. Clifton Robinson tendered evidence in support of the Bill. The Bill passed the committee, and was ordered to be reported to the House.

Gloucester.—It was reported at last week's meeting of the Corporation that the work at the Barton-street level crossing had been carried out to the satisfaction of the Midland Railway Company, and that the Board of Trade inspector would probably meet the railway officials on the spot in a few days, after which, if sanction were given, the cars would run over the crossing forthwith.

North Metropolitan Tramways Co.—The accounts of the company for the half-year ended June 30 last have been submitted to the Board, and, subject to final audit, the directors will recommend a dividend at the rate of 3½ per cent. per annum, carrying forward about £200 to next account. During the half-year the number of miles run were 6,943,973, and passengers carried 64,301,765.

London Traffic.—Mr. Stephen Sellon has been instructed by the Royal Commission on London Traffic to make a report upon the tramway undertakings in the principal cities and towns of the United Kingdom, and investigate the traffic and operative results obtained in connection therewith, and the conditions in regard to tramway transportation existing in such cities and towns as compared with London.

Railways and Electrification.—The report of the Barry Railway Company (South Wales) states that, as the result of the enquiry undertaken by the directors and officials into the question of electrification, in the course of which they investigated a detailed account of the working of electric railways on the Continent, the directors are of opinion that under present conditions the application of electrical power to railways which deal with a heavy mineral traffic is impracticable.

Southampton.—The tramway accounts for the year ending March 31 show a net profit of £6,206. The revenue amounted to £53,501, the total working expenses to £36,640, and interest and sinking fund charges to £10,654. The local rates will be relieved out of the profits to the extent of £5,000. The car miles run during the year amounted to 1,144,350, and the passengers numbered 9,890,952. The Town Council have decided upon extending the tramways by continuations of four existing lines.

Bath.—Good progress is being made with the repair of the tramway track. At the meeting of the Rural District Council last week there was an hostile expression of opinion in regard to the company's proposed loop line at Batheaston, to which the District Council have already refused consent, one councillor intimating that he should, if necessary, organise a petition against the project. The inhabitants, he stated, strongly objected to a double line. The Council have decided to communicate with the company representing that it would be desirable not to run the trams on Sunday before 1 p.m.

Exeter.—It is reported that there is considerable likelihood of a *modus vivendi* being arrived at between the Corporation and the Heavitree Urban Council in regard to an extension of the tramway system to Heavitree Park. As stated in a former issue, the Corporation stipulated that the Urban Council should first consent to the Corporation obtaining a provisional order for electric lighting in Heavitree, whilst the Urban Council stated that if the tramway system were constructed to their town they would then consider the question of the electric lighting order; and so the matter remained in abeyance. The Urban Council, however, are now desirous of reopening negotiations.

Swansea.—At its last week's meeting the Town Council again had before it a letter from the tramways company as to the approximate date when the Council would be prepared to pay the company the sum of £6,640, being the agreed price for the Morriston overhead electrical equipment. Eventually the following decision was arrived at: "That this Council will be prepared to take over the electrical equipment on the Morriston section on Oct. 1 next, and to let the same to the tramways company at a rental equivalent to interest, sinking fund, and depreciation on the sum paid until such a date as the Corporation are able to supply current to the tramways company."

Swindon.—The question of taking a *plébiscite* in regard to a proposal that the Corporation trams shall run on Sunday has been referred to committee. At last week's meeting of the Corporation a report was adopted with regard to the grant to be made by the Wilts County Council for the maintenance and repair of the main roads in the borough for the 12 months ending March 31, 1905, having regard to the disturbance caused to a considerable section of the main roads owing to the construction of the tramways, recommending that the County Council be informed that the Corporation will be prepared to enter into an agreement with the County Council for the payment by the County Council to the borough of the sum of £4,880 (being £240 less than the amount claimed by the Corporation) subject to its being clearly understood that this figure is for the current year only, and that in accepting this figure no question of principle such as might arise out of the construction of the tramways should be raised by the County Council.

Hythe-Sandgate.—The authorities at these towns are considering a project for an electric tramway between the two places. At a meeting of the General Purposes Committee of the Hythe Town Council last week, the question of an electric tramway service, upon which Mr. Sellon had been invited to report, was discussed. The following resolution was adopted: "That the Council are prepared to favourably entertain the promotion of a light railway order for a system of tramways between Hythe and Sandgate, and up the hill to the boundary near the Hotel Metropole, such order to be promoted in the ensuing session of Parliament by Mr. Sellon. Details as to road-widening, the routes, and other matters incidental thereto to be hereafter agreed to by the promotors and the Council."

Baker-street and Waterloo Railway.—Presiding at a meeting of the company on the 27th ult., Mr. Theodore J. Hare stated that all the tunnelling had been driven in the section between Waterloo and Melcombe-place. On the Elephant and Castle extension only 960 lineal yards of the main-line tunnel remain to be driven. One tunnel has now been driven right through from close by the Elephant and Castle Station site to the Marylebone Station of the Great Central Railway. At the depôt site the siding tunnel has been completed, and there only remain about 187 lineal yards of the branch line tunnel to be driven. On the extension of the company's line west of Baker-street possession has been obtained of the land for stations at Edgware-road and Lisson-grove, adjoining the Great Central terminus. The Edgware-road site has been cleared, and the shafts are about to be commenced. The up running tunnel has reached Lisson-grove, and the shield to enable the down running tunnel to be proceeded with is in course of erection, and will be finished shortly. The works generally are being pushed on as rapidly as possible, and the line is likely to be opened some time in the course of next year, though at present it is impossible to fix a precise date.

Aberavon.—At last week's meeting of the Town Council Mr. Lewis, of the firm of Messrs. Lewis and Fletcher, electrical engineers, Cardiff, attended on behalf of the syndicate which is promoting a scheme for the construction of an electric tramway from Briton Ferry to the sea beach at Aberavon. Mr. Lewis stated there would be a connection with the Neath trams at Briton Ferry, but the syndicate would not have running powers over the Neath lines. Two-thirds of the proposed line would be within the Aberavon area. It was not intended to run out Margam way, as it was not considered worth while. The main road along which the tramway would run could be lighted from the pillars of the electric system at a cheaper rate than the Council at present paid for gas. The Council would have the option of purchasing under the Tramways Act, and the promoters would also be prepared to offer other terms. The Council's provisional order expired last month, but had been renewed for 12 months. Mr. Lewis said the syndicate could not get their order until August of next year, and it would then take 18 months or so to complete the tramway. A resolution that the Council approve of the scheme, subject to satisfactory conditions, was carried unanimously, and it was arranged that Mr. Lewis should meet the Highway Committee to discuss terms.

Newcastle.—The annual report of Mr. Thomas Bowden, auditor to the Corporation, deals at some length with the question of depreciation. Alluding to the contention that the repayment of borrowed capital over the authorised term is a provision for depreciation, Mr. Bowden quotes the opinion of experts that the periods for which the loans have been obtained (permanent way 30 years, electrical equipment 20 years, cars 15 years) are considerably longer than the "life" of those assets, apart from the question of any exceptional renewals, and he emphasises the recommendation in his last year's report that the matter should receive serious consideration. It may be mentioned that in March of last year the tramways manager and the city engineer presented a report, in which they expressed the opinion that depreciation should be provided for by the investment and accumulation of £24,700 annually, in addition to the repayment of loans. At Wednesday's meeting of the Corporation a resolution was submitted that the consideration of the Tramway Committee's estimate of income and expenditure for the year ending March 25, 1905, be deferred, in order that the opinion of the town clerk, after consultation with counsel, if necessary, may be obtained as to whether the Newcastle Tramways Act of 1899 renders it compulsory to insert a definite sum in such estimates for depreciation.

Manchester.—An unusual accident occurred on the Heaton Park route last week. A few hundred yards from the park the roadway only permits of a single track. A bogie car returning from the park reached the loop, where the trams pass each other, before an advancing outward car of a smaller type had arrived at the points. Instead of waiting for the smaller car to get into the loop, the bogie car continued its progress, with the result that just as the other car was about to enter the loop the bogie car collided with it. The front of each car was knocked out of shape, and the windows were shattered into splinters. The cars recoiled with the impact, but remained on the rails. The passengers were precipitated from their seats, and some of them sustained severe cuts and bruises, while many of the female travellers naturally exhibited nervous symptoms. Both drivers appear to have escaped uninjured. The tramway officials on duty did everything possible to ensure prompt care for the injured, doctors being immediately telephoned for. An enquiry will be held into the collision in due course. It is stated that the driver of the bogie car asserts that the track was "greasy," and that the wheels skidded when he applied the brake. The Improvements Committee have adopted a proposal that a return be compiled showing the amount expended by the committee in connection with the tramways, the object being to demonstrate that the Tramways Committee, in showing large profits,

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were largely indebted to the Improvement Committee for street widenings.

Colchester.—The opening ceremony of the Corporation tramways was performed, as intimated in our note of last week, on the 28th ult. The proceedings commenced with a reception at the town hall by the Mayor and Mayoress, and a luncheon given by the chairman of the Tramways Committee, the numerous company including several councillors, Mr. R. Sillar (the borough electrical engineer), Mr. R. C. Bullough (the tramways manager), Messrs. A. M. Conmett, Craufurd, and Tracey (representing Messrs. J. G. White and Co., the contractors), and Mr. H. Scholey (representing Messrs. Dick, Kerr, and Co., who supplied the cars). At this function compliments were interchanged between members of the Corporation and the contractors. A car containing several officials subsequently made a run to Lexden, the journey being performed quickly and smoothly. Later in the afternoon a five minutes' service was opened to the public, and was extensively patronised. The steep gradient of North-hill was easily surmounted by cars bearing the full legal complement of passengers. The total length of the line is 5 miles 1 furlong, of which 1 mile 7 furlongs is double. The contracts for the system, which is on the overhead principle, amounted to some £29,000 in the case of Messrs. White and Co., and to £16,298 in the case of Messrs. Dick, Kerr, and Co., making, with the cost of street widening, a total of about £55,000, which is well below the original estimate of £63,500. The cars are fitted with the Newell magnetic brake. The tramway receipts on Sunday amounted to £81. 10s. 3d. For Bank Holiday the receipts are estimated at nearly £120.

Brighton.—The tramcars are now running to the Brighton Central Railway Station. The opening of this latest addition to Brighton's system of tramway routes on the 27th ult. followed within a couple of hours on the official Board of Trade inspection made by Colonel von Donop. A car carrying the inspector, the Mayor (Alderman E. M. Marx), Alderman Stafford (chairman of the Tramways Committee), several members of the Corporation), and the tramways engineer (Mr. Holliday), ran smoothly to the top of Gloucester-road, where the double lines commence. The curve from Queen's-road into North-road was admirably negotiated. Then the car took the single rails to Gardner-street, where the double lines restart. Much interest was next evinced in the meeting of the new route with the old one at the bottom of North-road, where overhead there is quite a network of wires. The points here worked perfectly. The car then ran round the Pavilion terminus, circling the Victoria-gardens till the rails branched out from the up route to the station. Only a short distance of North-road was re-traversed, the car soon returning for the testing of other points on this "cross" system. Colonel von Donop expressed every satisfaction with the route, observing that he would have no hesitation in recommending the Board of Trade to grant the necessary certificate, on which assurance the route was opened the same evening. It is proposed to run a 10 minutes' service morning and evening, and a five minutes' service every afternoon. Both the Tramways Committee and the tramways engineer (Mr. Holliday) are to be congratulated on the rapid completion and the opening of the new route.

York.—It is reported that the question of the provision of electric tramways is likely to engage the attention of the city at no distant date. During the past year the City Council have insisted on the tramway company carrying out certain repairs to their permanent way, which has involved the company in considerable outlay; and it appears that the company have found the conditions imposed on them to be of an onerous and irksome character. The requirements of the Corporation have resulted in a letter from Mr. J. Kincaid, chairman of the York Tramways Company, which was read at a meeting of the Streets and Buildings Committee. The terms of the communication have not been disclosed, but it is understood that they may facilitate action by the Council in regard to taking over the system, substituting electric traction, and extending the system to other parts of the city. The further consideration of the matter was deferred to a special meeting of the committee to be held in September. The Corporation have the right to take over the lines by arrangement at any time by agreement, but they cannot promote a Bill to obtain compulsory powers within seven years of the promotion of the last Bill, February, 1902, when the proposal was defeated by a poll of the inhabitants. Since that time the company have proposed to extend the system from Blossom-street by way of Holgate-road to Acomb, but the Corporation refused to sanction the scheme. Public opinion in the city has, however, since undergone a decided change in favour of the acquisition of the tramways and the provision of electric traction, while it appears probable that the company would be quite prepared to sell. The extension of the Corporation power station has, it will be remembered, just been completed. It is stated, however, that there is little likelihood of the Corporation promoting a Bill in the next session of Parliament.

London United Tramways Co.—At the meeting of the Surrey County Council held last week, it was reported that Mr. Clifton Robinson had been interviewed as to the intentions of the London United Tramways, Limited, with reference to Hampton Court Bridge. Under the company's Act the tramway over this bridge is to be completed by the present month, but the company have applied for an extension of two years. It has been agreed that the County Councils of Surrey and Middlesex and the representatives of the company shall hold a conference in two or three months' time. In regard to Kingston Bridge, it is understood that the company desire also to exercise their powers of running over this bridge. The present width of the bridge is 25ft. Mr. Robinson submitted a scheme providing for a widening to 41ft. The two county surveyors reported upon the scheme, and recommended that the bridge should be widened to at least 50ft., and the Surrey County Council have adopted this view. With reference to Kew Bridge, the company have intimated their intention of promoting in the next session of Parliament another Bill for power to construct tramways over the bridge, a clause for this purpose contained in the Bill promoted by the company during the present session having been withdrawn. In the meantime the company are desirous of coming to terms with the two County Councils. The bridge, which was originally designed to be 45ft. wide, was ultimately constructed, at considerable extra cost, with a width of 55ft., so that there will be sufficient space for the tramways. The company are under an obligation, when electrifying the tramway between Kew Green and Richmond, to adopt some system which will obviate the use of overhead wires, and the County Councils consider that the same system should be used in the tramway over the bridge. Subject to this, an annual rental of £2,000 (£1,000 to each Council), and a few more conditions, the County Councils are prepared to consent to the scheme. On Monday some 300 cars carried 345,000 passengers, 107,000 going to Southall and Uxbridge, and 238,000 to Kew and Hampton Court. The whole of the traffic passed off without a hitch. Last year 315,000 passengers patronised the cars, but at that time the extension to Uxbridge was not opened.

Liverpool.—At Wednesday's meeting of the Corporation the question of applying for a provisional order to include the township of Fazakerley in the city area was down for discussion. The draft of the agreement with the Sefton Rural District Council (the authority for the Fazakerley district) provides, *inter alia*, that the Corporation shall within three years extend the electric tramway from the present terminus in Longmoor-lane to the Fazakerley station of the Lancashire and Yorkshire Railway. The report of the city engineer, the consulting electrical engineer, and the general manager on the permanent way, wheels, and overhead equipment of the tramways states that considerable benefit is expected to arise from the continuous welding of the rails. The life obtained from portions of the heaviest traffic lines had already exceeded the city engineer's original estimate, and it was probable that from such lines a life of 7½ to 10 years would be obtained. The durability both of the permanent way and of the car wheels depended on the relative suitability of the materials used and the care taken to maintain accurate adjustment not only of the rails, but of the rolling-stock. The cost of maintenance also depended very largely on the care taken by the drivers in approaching curves and crossings, and in the judicious use of brakes. As a result of experiments carried out for the last two years, a steel-tyred wheel was now being assembled and finished at Lambeth-road works which would cost 50 per cent. less than the price at which such wheels could at present be bought, and which it was believed would afford a life considerably in advance of the average of these wheels, which might be estimated at 60,000 miles, the average mileage of chilled wheels in Liverpool being 35,000. It was hoped that on trial this new wheel would be found suitable for general adoption. As to electrical equipment, the system adopted had proved satisfactory in work. The only alterations which it had been found advantageous to make had been in small matters of detail in some of the overhead fittings, by which the durability of these parts had been increased and replacement facilitated, with consequent reduction in the cost of maintenance. At the meeting of the Corporation Tramways Committee last Friday, it was reported that the traffic receipts for the past fortnight were £25,938. 19s. 10d., an increase over the corresponding fortnight last year of £4,423. 5s. 6d., attributable to the Royal visit. The passengers carried numbered 5,487,944, an increase of 865,992; the mileage was 493,725, increase 40,001 miles; cars running 462, increase 47. It was decided to continue the service on the Park-lane route for another three months, there having been a substantial improvement in the traffic on that route. The Traffic Subcommittee recommended that, having regard to the width of Edge-lane, a single line of tramway with passing places, and a double line where possible, be laid in Edge-lane, and that the necessary estimates be obtained by October in time for an application for powers to Parliament. An amendment that the recommendation be not confirmed was defeated by a large majority, and the proposal was adopted.

PROVISIONAL PATENTS, 1904.

JULY 25.

16393. A new or improved automatic electric cut-out switch. Emile Julien Javaux, 18, Buckingham-street, Strand London.

16395. An improved combined electric switch and lamp-holder. Charles Ernest Hunter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16396. Improved method of producing zinc from sulphate solutions by electrolysis. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

16408. Improvements in and relating to electric circuit controllers, especially applicable in connection with the governing of elastic-fluid turbines. The British Thomson-Houston Company Limited, The Warwick Machinery Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

16409. Improvements in and relating to electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16410. Improvements in and relating to electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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16411. Improvements in pneumatically-operated signalling devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16418. Improvements in electrically-driven winding engines. Anton Raky, 77, Chancery-lane, London.

16422. Improvements in the manufacture of electrical resistances. Electric Equipment and Securities, Limited, and Charles Ruzicka, Clun House, Surrey-street, Strand, London.

16423. Improvements in the manufacture of electrical resistances. Electric Equipment and Securities, Limited, and Charles Ruzicka, Clun House, Surrey-street, Strand, London.

16424. Improvements in the manufacture of electrical resistances. Electric Equipment and Securities, Limited, and Charles Ruzicka, Clun House, Surrey-street, Strand, London.

16425. Improvements in the manufacture of electric incandescence bodies. Electric Equipment and Securities, Limited, and Charles Ruzicka, Clun House, Surrey-street, Strand, London.

16426. Improvements in and relating to contact breakers for induction coils. Frederick Rowland Butt and Harry William Charles Cox, 70, Chancery-lane, London.

16447. Improvements in electric switches for use in pole changing. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Voight and Haeffner Aktien-Gesellschaft, Germany.)

JULY 26.

16461. An improved electric locomotive. David Liddell Crawford, 26, Queen-street, Dunoon, Scotland.

16479. Improvements in telephone repeaters. George Washington Kretzinger, 46, Lincoln's-inn-fields, London. (Complete specification.)

16483. Improvements in or connected with electric arc lamps. James Brockie, 33, Chancery-lane, London.

16489. Improvements in or relating to apparatus for controlling electric ignition currents of internal-combustion engines. Humber, Limited, and Samuel Henry Halford, 111, Hatton-garden, London.

16509. Improvements in telephone directories. Frederick Drowns, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 29, 1904, being date of application in United States.) (Complete specification.)

JULY 27.

16573. Improvements in Morse telegraph transmitters or instruments for transmitting telegrams by means of Morse signals. Richard Wolters, 37, Essex-street, Strand, London. (Complete specification.)

16579. Improvements in incandescent electric lamps. Richard Aloysius Gill, 6, Lord-street, Liverpool.

16581. Improvements in electrical binding screws or terminals. Maurice Bouchet, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 15, 1904, being date of application in France. (Complete specification.)

16595. Improvements in and relating to supporting devices for electric fans. Sidney George Leach and Edward Bergtheil, 1, Queen Victoria-street, London.

16601. Improvements in telephone central-station systems. Gustaf Lambert, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 18, 1904.

1903.

14172. Systems of electrical distribution. Le Tall. (Cooper Hewitt Electric Company.)

17662. Electric lighting of trains. Hill.

17871. Electric arc lamps known as flame arc lamps. Oliver.

20137. Electric arc lamps. Ewart.

20522. Electric switches. Eckstein and Krause.

20620. Dynamo-electric machines. Chitty.

23192. Dynamo-electric generators and motors. Jones and Jandus Arc Lamp and Electric Company, Limited.

25905. "Frog" or plate for making connections between the ends of line wires, at junctions, or crossovers, or any place where the line is not continuous in conductors used in overhead wiring for electric tramcars and the like vehicles. Perkins and Massey.

26811. Multiplex telephony. Fairweather. (Miner.)

1904.

9236. Continuous-burning arc lamp with amalgam electrodes. Hoffmann.

9914. Magneto-electric igniting device. Hauptmann.

10618. Device for winding up clocks automatically by means of an electric motor. Barile.

10906. Apparatus for electrically stopping railway trains. Lichtenfels.

11272. Electrical safety apparatus for signalling on railways. Mackenzie. (Soc. Cousin and Co.)

14026. Electrostatic apparatus for measuring electrical potential differences. Marchant and Worrall.

14231. Electric sparking plugs for internal-combustion motors. La Force. (Date applied for under International Convention, June 24, 1903.)

14545. Thermo-electric couples or apparatus. Bristol.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	⅞-1
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	1-1⅛
British Insulated and Helsby Cables, Ord., 1-100,000	5	—	5⅛-5⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5¼-5 xd
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	101-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	—	3⅛-3⅜
—— 4 per cent. Mortgage Debenture Stock	100	—	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	—	¾-1
—— Non. Cum., 6 per cent. Pref.	2	—	¾-1⅛
—— 4½ per cent. 1st Debenture Stock	100	—	96-99
—— 4½ per cent. 2nd Debenture Stock	100	—	71-76
Callender's Cable, Debentures	100	—	101-105
—— Ordinary	5	—	9¼-10¼
—— 5 per cent. Pref.	5	—	5-5⅛
Crompton and Co.	5	—	14-8
—— 5 per cent. Debentures	100	—	94-97
Edison and Swan United, "A" Shares, 1-99,261	5	—	1-1⅛
—— "A" Shares, 01-017,139	5	—	1-1⅛
—— 5 per cent. Debentures	100	—	78-82
—— 4 per cent. Deb. Stock, Red.	100	—	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1-1¼ xd
—— 7 per cent. Cumulative Pref.	2	—	2-2⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	—	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	—	93-98
W. T. Henley's Telegraph Works, Ordinary	5	—	11-12
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	18¼-18¾
—— 4 per cent. Debentures	100	—	100-103
Parker, Thos., Limited, Ordinary	10	—	10-10¼
Telegraph Construction and Maintenance	18	—	36-39
—— 5 per cent. Bonds	100	—	99-102
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅞-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	—	102-106
Bournemouth and Poole, Ordinary	10	—	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	—	101-104
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	—	100-103
Brompton and Kensington, Ordinary	5	—	10⅜-11¼
—— 7 per cent. Preference	5	—	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	—	7-7⅛
—— Nos. 20,001-30,000	5	—	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	—	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	—	105-108
Charing Cross and Strand, Nos. 1-70,000	5	—	7⅛-8
—— 4½ per cent. Cum. Pref.	5	—	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	—	102-104
Chelsea Electricity Supply	5	—	6¼-6⅜
—— 4½ per cent. Debentures	100	—	105-109
City of London, Ordinary	10	—	10⅜-11¼
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	102-105
County of London Electric Supply, Ordinary	10	—	7¼-8¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	100-103
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	—	5¼-6¼ xd
—— 6 per cent. Cum. Pref.	5	—	5¾-6
—— 4½ per cent. First Mort. Deb.	100	—	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	—	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	—	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	—	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	—	98-102 xd
Hove Electric Lighting, Limited, Ord., 1-13,000	5	—	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	—	12-13 xd
—— per cent. Debenture Stock Red	100	—	102-106
Kensington and Knightsbridge and Notting Hill	100	—	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	5	—	1¼-1¾
—— 5 per cent. Pref.	5	—	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	94-97
Metropolitan Ordinary	10	—	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	—	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	—	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	—	98-101
—— Preference	4	—	100-103
Notting Hill Electric Lighting	10	—	15¼-16¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	100-103
Oxford Electric, Ordinary, 1-96 and [illegible]-14,310	5	—	5¼-6
—— 4 per cent. Debenture Stock	100	—	97-100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2⅜-3¼
—— 4 per cent. Debenture Stock	100	—	83-88 xd
South London, Ordinary	—	—	3⅜-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15 xd
—— 7 per cent. Pref.	5	—	8-9
—— 3½ per cent. Deb.	100	—	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	—	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	4¼-5
Westminster, Ordinary	5	—	12-13 xd
—— 5 per cent. Cum. Pref., 110,101-138,251	5	—	6-6¼

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 –	89-91
—— 4 per cent. Pref.	100 –	102-104
—— " " deferred	100 –	79-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid).	100 –	106-109
City and South London, Consolidated Ordinary	100 –	47-49
—— 4 per cent. Debenture Stock	100 –	106-109
—— 5 per cent. Pref. Stock '91	100 –	123-126
—— " " " '96	100 –	120-123
—— " " " '01	100 –	118-122
Liverpool Overhead, 5 per cent. Pref.	10 –	10-10¼
—— Ordinary, 1-50,000	10 –	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	– –	99-101
Waterloo and City, Ordinary	100 –	88-92
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 –	5¼-5⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 –	137-141
Blackpool and Fleetwood Tramroad	10 –	13⅝-15⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 –	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 –	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 –	96-101
British Columbia Electric Railway Co., Ord. Def.	100 –	100-103
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 ..	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 –	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	97-100
British Electric Traction Ord. 1-500,000 & 60,001-80,000	10 –	8¾-9
—— 6 per cent. Cm. Pf., 50,001-60,000	10 –	10¾-11¼
—— 5 per cent. Perpetual Debenture Stock	100 –	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	2¼-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 –	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-37,500	5 –	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 –	105-108
—— Prov. Cert., all paid	100 –	101-104
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅛-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 –	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10 –	9¼-10
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18-19
—— 6 per cent. Cum. Pref.	all –	14-14½
—— 4½ per cent. Deb Stock	100 –	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 –	3¼-4
—— 4 per cent. Debenture Stock	100 –	88-91
Kidderminster and District Lighting and Traction, Pref.	5 –	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10½-10⅝
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	103-105
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 –	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 –	¾-1
New General Traction, Ordinary	5 –	¼
—— 5 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 –	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12¼
—— 5 per cent. Cum. Pref.	10 –	9¾-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 –	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	9-10
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,132 5 per cent. Preference	1 –	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. –	100 p.c.
Telephones.—		
National Telephone, Preferred	100 –	103-105 x
—— Deferred Stock	100 –	86-89 xd
—— 6 per cent. Cum. First Pref.	10 –	12-14 xd
—— 6 per cent. Cum. Second Pref.	10 –	11-13 xd
—— 5 per cent. Non-Cum. Third Pref.	5 –	5-5½ xd
—— 3½ per cent. Deb. Stock, Red.	100 –	97-99
—— 4 per cent. Deb. Stock, Red.	100 –	103-105
Oriental Telephone and Electric Company	1 –	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 30	1,653	1,251	+ 402	— h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	,, 30	40	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 31	1,155	1,107	+ 49	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 30	5,489	5,111	+ 378	+10,670	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 29	999	855	+ 144	+ 1,555	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 28	1,958	1,534	+ 424	+ 1,345	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 30	1,232	1,176	+ 115	—	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 31	1,929	1,791	+ 138	—	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 20	1,166	1,022	+ 144	+ 1,099	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 23	4,880	4,120	+ 760	+13,238	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 31	1,322	1,033	+ 288	— h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 29	5,309	5,114	+ 195	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 30	986	830	+ 156	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 31	6,238	—	—	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 23	2,162	2,136	+ 26	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 30	222	234	− 12	+ 308	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 30	5,835	6,175	− 230	− 1,421h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City & South London Railway	,, 31	2,384	2,555	− 171	— h	6⅝	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 28	565	737	− 171	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 29	210	208	+ 2	− 105	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 30	297	270	+ 27	—	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 29	148	196	− 38	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 29	4,197	4,410	− 213	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 29	1,231	1,164	+ 67											
Dundee City Tramways	,, 27	990	977	+ 13	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 30	748	657	+ 91	+ 1,289	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 30	12,975	12,408	+ 567	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 27	387	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 27	3,343	3,066	+ 277	+ 1,871	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 30	1,312	1,247	+ 65	—	34	34	March 31	55,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 30	2,270	1,827	+ 442	+ 4,672	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 9	528	552	− 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 28	148	190	− 42	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 27	339	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 30	5,854	5,606	+ 248	+ 5,908	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 16	1,466	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 23	14,144	10,816	+3,328	+10,827	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 31	1,642	1,728	− 86	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— e
London County Council	,, 2	13,329	11,495	+1,834	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 31	357	332	+ 19	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 30	12,818	12,227	+ 591	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 30	118	85	+ 33	+ 855	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 30	3,769	3,489	+ 280	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 20	558	496	+ 138	—	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 23	2,492	2,026	+ 466	+ 3,051	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 28	476	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 1	4,887	4,257	+ 330	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	July 30	347	—	—	—	7⅔	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 31	4,735	4,697	+ 38	—	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 28	1,031	1,109	− 77	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 27	510	401	+ 109	+ 620	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 29	650	376	+ 374	+ 4,582	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 31	1,373	1,548	− 175	—	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	5·4
Wallasey U.D.C.	,, 30	869	838	+ 31	+ 824	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 21	1,127	—	—	—	1⅔	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 27	726	473	+ 253	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Includes rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Electric Railway Accidents.—Mr. R. Bell, M.P., the general secretary of the A.S.R.S., has again officially approached the Board of Trade with a view to compelling the railway companies to adopt some protection for the newly-electrified railways.

Lucknow Tramways and Lighting.—The concession for the building of the tramway system for Lucknow and also for the supply of electric light and power has been obtained by Messrs. Kincaid, Waller, Manville, and Dawson. We understand that the terms offered by the Municipal Board have been substantially accepted by this firm. The larger portion of the scheme is the tramway undertaking, but there is no doubt that a considerable demand will arise for light and power.

Electricity in Railway Carriages.—We understand that the Great Northern Railway Company are now equipping, at their Doncaster works, a number of the luxurious dining cars used on the East Coast Scotch expresses with electric lights, fans, etc. This step has doubtless been taken so that the East Coast Scotch trains may, in this respect, conform with those of the rival routes, the latest types of coaching stock of both of which were some time ago equipped with electric illuminating apparatus.

Wireless Telegraphy Control in the States.—President Roosevelt has approved the report of the Evans Commission, awarding the control of the Government's coastal system of wireless telegraphy to the Navy Department, on the ground that it is part of the country's defence, and of more importance to the navy than to the army, with the exception of the stations necessary for communication between army posts. The report recommends legislation to prevent private companies from interfering with the Government's coastal system of wireless telegraphy.

Personal.—We are informed that Mr. W. B. Esson, having held the position of manager of Messrs. Johnson and Phillips's Electric Light and Power Works for the past 10 years, retires from Charlton at the end of the present month. During the above period many large and important contracts have been carried out by the firm at home and abroad, for all the designing in connection with which Mr. Esson has been responsible. We trust that Mr. Esson's technical knowledge will still be applied to the advancement of the profession.

British Science Guild.—The committee engaged in organising an institution under this title are circulating a memorandum in all parts of the Empire amongst those likely to be of assistance in conducting the scheme, inviting their co-operation in promoting the objects of the movement, the chief of which is to secure the application of scientific methods to every branch of the affairs of the nation by means of conferences, lectures, publications, etc. The active supporters of the scheme include a number of influential names in scientific circles. All British subjects, men or women, are eligible for membership of the guild, the subscription to which will be of a nominal character.

Electric Traction in Sweden.—The Swedish Government is, says the *Scientific American*, thinking seriously of using electric traction on the State railroads, the current to be obtained from the numerous waterfalls which are found in that country. To this end Parliament has been asked to vote a large grant for the transformation of the system. Preliminary trials are to be carried out on a section of the Varta railroad, also on a portion of the line running from Stockholm to Jarfra. The current for this purpose will be furnished by the Stockholm central station and from a temporary plant which is to be installed at Tomteboda. Four large electrical firms have already submitted plans for the trial of their systems—the Siemens-Schuckert, Allgemeine, Oerlikon, and British Westinghouse Companies.

Telephone Sketching Chart.—We have received from Messrs. W. T. Glover and Co. an interesting sketching chart to be used in connection with telephonic communication, which will be of great service when ordering special work in a hurry. The idea of the chart is that both the sender and receiver shall have before him a piece of squared paper with the ordinates and abscissæ numbered to correspond. On this chart at the sending end there is sketched the article which is required. The sender then instructs the engineer at the receiving end of the line to draw lines from point to point on the squared paper until the drawing is complete. The idea has been worked out by the manager at Messrs. Glover and Co.'s works, and we can quite see that in certain cases it will be of very great value to engineers. A boy could take down the instructions as to drawing, which could then be handed over to a draughtsman to prepare on the receiving chart. These charts are being supplied free to the friends of Messrs. Glover and Co., and seem likely to come into general use.

Open Arc Lamps and Ice.—Mr. W. A. Thomas, of the Abingdon Electric Company, Illinois, communicates to *Electricity* of New York a "wrinkle" for obviating the difficulty encountered in street-lighting when sleet and ice are prevalent. Mr. Thomas's company use open arc lamps for this purpose, and during the earlier part of last winter, which was a very severe one, great trouble was experienced from these sources. Whenever the carbons started to coat with ice, pieces of rather stiff manilla paper, about 4in. square, folded cone shaped, were placed, after removing the ice from the ends of the carbons, above the top of the lower carbon and fastened in place with a small piece of magnet wire. This makes a complete break between the carbons and prevents the ice from forming on the upper end of the lower carbon. When the current is turned on the paper burns out, and the lamp is seen to be unaffected by the ice. As the result of this experiment the problem was solved so satisfactorily that the company were relieved from all further trouble, while neighbouring plants were unable to run.

Electrical Standards.—Elsewhere in this issue will be found in full the interim report of the Engineering Standards Committee on the question of the use of standards for electrical machinery. This report reached us too late for comment this week, as it deals with such a wide range of subjects. It will be gathered, however, from the introduction that the sub-committee appointed for the purpose have gone most carefully into the matter, and have had done for them a considerable amount of original work, which renders their decision more valuable. We are sure that all interested in the electrical profession will do their best to adhere to the standards now fixed. The fact that the Admiralty, the War Office, the Crown Agents for the Colonies, and the National Physical Laboratory were all represented on this committee is worthy of special note. The first three departments are large purchasers of plant, and their custom alone will do much to secure the adoption of standard electrical machinery. It will be of great assistance to English manufacturers if the number of types of machines they are called upon to supply can be reduced to those included in the committee's schedule.

Faraday House.—We have received a copy of the August issue of the *Faraday House Journal*. The articles from students and old students include papers upon "The Theoretical Consideration of the Steam-Turbine," by H. W.

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Swann; "The Advisability of Earthing the Middle Wire in Three-Wire Installations," by D. M. Hutchison; "The Method of Reducing the Pressure Drop in Rails of Electric Tramway Systems," by A. Murray Coombs, and upon "Electricity in Use in Gold Mining," by G. M. Dyott. It also contains an interesting article upon the Reading Electric Supply Company, which is affiliated to the institution. The opening paragraphs deal with the appointments obtained by former students, and also refer to the new establishment which is being erected in Southampton-row, which will afford about twice the accommodation provided by the existing premises. The journal also contains notes from a number of affiliated companies connected with this institution, covering a great variety of work in electrical and mechanical engineering. It is evident that this institution, which was the first to combine instruction in scientific knowledge with practical engineering training, has met with considerable success.

Discrimination of the Demand upon Individual Transformers.—The *Western Electrician* of Chicago gives an account of a simple method for the determination of the demand upon individual transformers, which was described by Mr. G. S. Haley at the last meeting of the National Electric Light Association. Mr. Haley states that the easiest way to determine the demand is to measure the primary current passing through the transformer. The author used the insulator-type primary cut out supplied by the General Electric Company. A duplicate plug was made of hardwood, with an extended handle 6in. long and 2in. in diameter. Two of the brass clips from an old plug were placed upon the wooden one, and through two holes in the handle two No. 6 rubber-covered cables were connected to the clips, the cables being about 8ft. long and connected to a 30-ampere Wright discount ammeter mounted upon a board about 8in. by 12in. Upon the back of the board are two pieces of wrought iron of suitable size to hook over an ordinary cross-arm. To test the transformer it is only necessary to place the ammeter upon a convenient cross-arm, pull out the plug in one of the transformer cut-outs, and insert it at the end of the cables. Mr. Haley states that he usually leaves the plug in service for two nights, and then removes it to some other transformer.

Wireless Telegraphy and Meteorology.—It will be remembered that a few weeks back the committee appointed to consider the working of the Meteorological Office recommended that wireless telegraphy should be experimented with for obtaining advance news of atmospheric conditions in the Atlantic. Pending the adoption of this suggestion officially, the *Daily Telegraph* has arranged with the Marconi Company and the Atlantic steamship companies for a temporary service, the vessels to transmit messages as soon as they come within range of the signalling stations. The distance from which the vessels can transmit messages to the land is at present limited to about 100 miles, but the messages will report not only the weather conditions at the moment of dispatch, but those of the previous days, during each of which the vessel may have travelled 400 or 500 miles. This excellent idea was inaugurated at the end of last week, three messages received from the "Tunisian" appearing in Saturday's issue of the *Telegraph*. Greatly improved apparatus is being devised for the vessels—and will be installed on the new Cunarders—with a view to the transmission of messages from mid-Atlantic, so that practically the whole area of the ocean west of Ireland—so momentous to the meteorology of this country—may be under observation. It is somewhat early yet to speak of the efficacy of the system, especially considering its present limited scope, but one can see that it may prove invaluable in heralding the approach of storms.

American Institute.—We have received a copy of the *Transactions* of the American Institute for June, which contains the discussions on the following papers: "Theory of the Regulation of Alternators," "The Mechanical Construction of Revolving-Field Alternators," "European Practice in the Construction and Operation of High-Pressure Transmission Lines and Insulators," "The Conductivity of the Atmosphere at High Voltages," "The Relative Fire Risk of Oil and Air Blast Transformers," "Group Switches in Large Power Plants," "Oil Switches for High Pressures," "Terminals and Bushings for High-Pressure Transmission." A summary of the proceedings at the annual meeting is given, with abstracts of the following papers read on that occasion, and of the discussions thereon: "Predetermination of Sparking in Direct-Current Machines," by W. L. Walters; "Effect of Self-Induction on Railway Motor Commutation," by E. H. Sanderson; "The Calculation of Line Batteries," by W. E. Winship; "Data and Tests on a 10,000-cycle-per-second Alternator," by G. B. G. Lamme; "Notes on Flywheels," by H. H. Barnes, jun.; "The Single-Phase Induction Motor," by W. S. Franklin; and "Wave-Form Variations on a Long-Distance Line," by G. H. Rowe. There is also a paper on the "Operation of Synchronous Converters," by S. C. Lindsay.

Electrical Machinery for Panama.—Mr. G. E. Walsh, in the *Electrical Review* of New York, prophesies that there will be some splendid contracts for electrical manufacturing firms in connection with the completion of the Panama Canal. He assumes—and we are afraid he is correct in his assumption—that only American firms will have a chance to get this work. In the earlier history of the enterprise, when French engineers were responsible for the work which ended so disastrously, English firms had a good share of the contracts, and we think that even now they should be allowed to compete. Of course, if protective duties in favour of American firms are enforced, it will be a waste of time to attempt to secure contracts for this country. Mr. Walsh adds that electricity will play a large part in the excavation and equipment of the canal, and that there will be hardly a machine, repair shop, or operating plant which will not have electric power in some portion of it. He further states that within six months the designs and specifications for the first part of the machinery will be completed, and that the delivery of certain machinery may even be required this year or in the early part of next. After considering the local conditions, he is inclined to favour oil as the cheapest fuel, owing to the high cost of transporting coal or wood to the sites where power will be required. The article concludes with a prediction that the American plant used in the construction of this canal will do much to secure for the United States the electrical orders from South and Central America which heretofore have come to England or Germany. May he prove a false prophet!

The Operation of Textile Mills Electrically.—An address was delivered by Mr. S. B. Paine to the members of the British Association of Managers of Textile Mills at Manchester on Tuesday, the subject being "Electrical Centralisation of Power: The Operation of Textile Mills from a Central Power Station." Mr. Paine said that in the United States the electric drive in textile mills had passed the point where its utility and advantages could be questioned. Its many points of superiority were very generally admitted. The advantages of the electric system included greater reliability and facility for enlargement or rearrangement. The cost of power was

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generally the first objection raised to the purchase of current. It was assumed that the station could not compete with the mill in that respect. That, however, Mr. Paine contended, did not follow necessarily—in fact, the reverse should be true. Wherever the electric drive had been used, he said, by manufacturers who had previously used the mechanical system, they had, without exception, remarked upon the steady and uniform speed which resulted. That steady speed must tend to greater production, improved quality, and less repairs to the machinery. In the present age of competition, the provision of a central power station freed the manufacturer from the consideration of all questions connected with the generation of power, and to that extent enabled him to devote his energies more efficiently to his business. If he purchased his power from a central station, fluctuations in the price of coal and kindred questions caused him no anxiety. Mr. Paine expressed the view that there should be but one power plant in each community, local conditions determining whether that power plant should be owned by the mill or by the central station. A discussion followed the reading of the paper.

British Association.—In our last week's issue we outlined the general programme of the meeting to be inaugurated at Cambridge on the 17th inst., and we now give the provisional programme of the branch devoted to engineering—Section G: Thursday, Aug. 18—11.30 a.m., address by the Hon. C. A. Parsons, president of the section; 2 p.m., lecture by Mrs. Ayrton, "The Origin of Sand Ripples." Friday, Aug. 19—Mr. C. Dugald Clerk, "Flame Temperatures in Internal-Combustion Motors"; Prof. B. Hopkinson, "Some Tests on a Small Gas-Engine" (to be followed by a general discussion). Monday, Aug. 22—Mr. C. H. Merz, "The Use of Electricity on the North-Eastern Railway and on Tyneside"; Mr. A. A. C. Swinton, "Electricity from Water Power"; Mr. W. M. Mordey and Mr. A. G. Hansard, "Energy Losses in Magnetising Iron"; Prof. J. A. Fleming, "Large-Bulb Incandescent Lamps as Secondary Standards of Light"; Mr. Clifford Paterson, "Investigations of the Harcourt Pentane Lamp." Tuesday, Aug. 23—Major Sir Hanbury Brown, K.C.M.G., "The Control of the Nile"; Mr. J. H. Wicksteed, "A Universal Testing Machine of 300 tons for Full-Sized Members of Structures"; Mr. S. Cowper Coles, "A New Process for the Protection of Iron and Steel from Corrosion"; Mr. J. W. Hayward, "The Effects of Receiver Drop in a Compound Engine." Other papers: Dr. W. E. Sumpner and Mr. R. W. Weekes, "The Hopkinson Method applied to Induction Motors"; Mr. Killingworth Hedges, "The Action of Lightning Strokes on Buildings"; Prof. E. Wilson, "The Electrical Conductivity of certain Aluminium Alloys as affected by Exposure to London Atmosphere, and a Note on their Microstructure"; Mr. A. H. Peake, "Superheated Steam: throttling and other experiments"; Prof. J. O. Arnold, "The Effect of Rapidly Alternating Stresses on Structural Steels."

Electricity in Coal Mines.—A paper on electricity as a motive force in the working of collieries was presented on Tuesday to the members of the Manchester Geological and Mining Society by Mr. Philip C. Pope and Mr. Norman D. Cameron. Colonel Hollingworth presided. The title of the paper was "On Practical Comparisons of Direct-Current and Polyphase Systems as applied to British Collieries." The authors put aside the question of the suitability of electricity as a means of transmitting power about a colliery. That was a well-worn subject, they said, which had been thrashed out many times over, and on the whole they believed that the balance of decisions was in favour of the newer power agent. It was rather their purpose to elicit such a discussion as would be likely to assist a colliery manager who had already decided to adopt electrically-driven machinery, in settling which of the two electrical systems he should employ at his own pit. A few years ago there was only one practicable system for use in a mine—continuous current—but more recently electrical engineers had brought the three-phase alternating-current system to such a state of perfection that its practical utility could no longer be questioned. That it was thoroughly reliable and practically economical was amply demonstrated by the fact that the large power supply companies had decided without exception to generate three-phase current only. In deciding which system to adopt at a colliery, one must consider their relative advantages under three main heads: first, which would give the greatest freedom from breakdowns, and consequently the maximum economy in maintenance expenses; secondly, which would be most efficient in transmission, distribution, and transformation of energy; and, thirdly, which was cheapest to instal, given equally good material and workmanship in each case. All these points were considered, and the conclusion was in favour of the three-phase alternating-current system. The paper will be discussed at a later meeting.

Earth Shields in Transformers.—In one of the papers read before the American Institute of Electrical Engineers at its June meeting in Chicago by Mr. J. S. Peck, the advantages and disadvantages of ground shields in transformers is discussed. The general conclusion of the paper is that in all transformers to some extent, and particularly in large transformers, the grounded conducting shield between the primary and secondary windings does not convey adequate protection without marked additional expense. It is suggested that a cheaper and better substitute for the ground shield is a grounded secondary circuit. The above conclusions appear very sound. It is not as though the ground shield within the transformer dispensed with the inconvenience and expense of establishing a reliable ground connection on customers' premises. Whether a grounded shield or a grounded secondary circuit is used, the ground has to be made near the transformer on installation. If the ground wire is properly connected to the secondary circuit, a permanent and reliable protection for the latter should be secured. If, in order to secure insulation for the secondary circuit, a grounded shield is interposed, extra insulation must be used and valuable space sacrificed to the detriment of the transformer's behaviour. From every standpoint a permanently grounded secondary circuit seems preferable. Moreover, as the paper points out, even if the ground shield may be regarded as forming a perfectly reliable safeguard against accidental crosses between the primary and secondary circuits within the transformer, it is powerless to protect against crosses between the primary and secondary circuits occurring in the leads emerging from the transformer, or in the neighbouring wiring. There can be no doubt, however, that the proper point at which to ground a secondary circuit is the neutral point of the transformer secondary winding. We are indebted to the *Electrical World* for the above interesting summary of Mr. Peck's paper.

Worship by Telephone.—Another example of the Protean uses of electricity is given in the *American Telephone Journal*. It occurred to a well-known Philadelphian pastor, whose daughter was confined to her room by illness, that, as the telephone had been employed for such a variety of purposes, it might be utilised for transmitting a sermon or a hymn to a distant audience. Accordingly, a megaphone fitted with a telephone connection was placed in the church, which possesses favourable acoustic qualities, and the patient was enabled to follow the entire course of the sermon and to hear the hymns distinctly. This result

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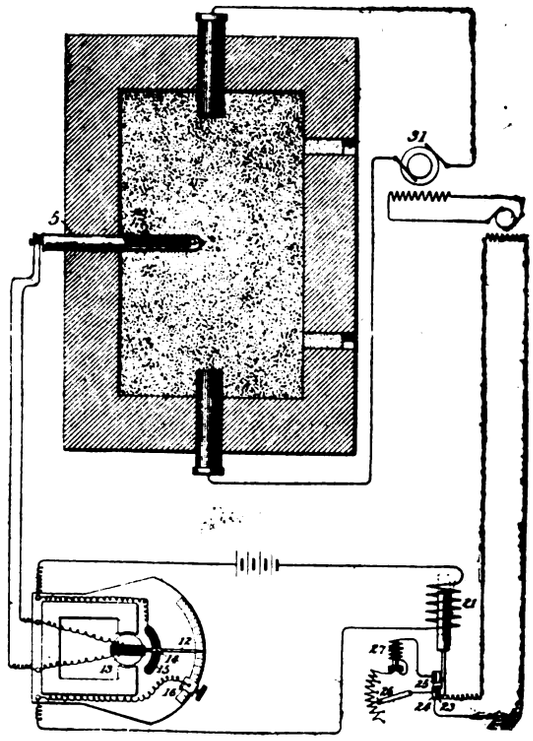
encouraged the cleric to carry out the idea on a larger scale, and half a dozen megaphones were suspended in front of the pulpit, enabling the service to be transmitted to a hospital in the city. For those too weak to hold the receiver head attachments were provided. The experiment was so successful that other hospitals are reported to be arranging for similar telephonic connection. It appears that this innovation is not unique, for, curiously enough, an idea of the like nature was put into practice almost at the same time in Texas, though in this case the absent votaries were not invalids, but "stay-at-homes." The Citizen's Telephonic Company of that State have installed a telephonic connection at a Presbyterian church, such members of which as subscribe to the company being now able to perform their devotions at home. The idea is attributed to the manager of the telephone company, who claims to have projected it for some years. This new mode of worship prompts our contemporary to advance an observation which seems to offer a way out of the "empty church" problem. The suggestion is a no less sweeping one than the church—*i.e.*, the church building—should be dispensed with altogether. Thus: "One might almost fancy that if the idea should be extended much farther, the entire necessity for a church building would be obviated, and that the congregation could follow their rector, and even join in chorus singing, in the privacy of their homes, while the pastor sat talking into a large megaphone in the retirement of his study." As our contemporary adds, that the "congregation" would be able to select their favourite preacher or to change from one sermon to another.

Electrical Progress in Italy.—A recent report by Mr. A. P. Bennett, commercial attaché to the British Embassy at Rome, refers at some length to the remarkable increase in the utilisation of electric power in Italy since 1890. At the present time a total motive force of over 200,000 h.p. is provided in that country electrically, while in 1890 it is improbable that the total electrical energy available exceeded 20,000 h.p. Milan alone disposes of 20,000 h.p., and the large new hydro-electric station at Vizzola, near Milan, distributes 18,000 h.p. to various points in the provinces of Milan and Como. Other stations of importance in Lombardy are those of Calvagese, Varese, and Campodolcino. In Piedmont four plants belonging to the Societa Alta Italia were erected between 1890 and 1901 at Lanzo, Bussoleno, Stambinello, and Germagnano, generating a total force of 12,000 h.p. Other important plants erected since 1890 are those of Cossogno, in the province of Novara, and of the Company Casalese, in the province of Alessandria. Further, in Lombardy and Piedmont, especially in the provinces of Turin, Novara, Bergamo, Brescia, and Como, numerous plants have been erected, which distribute a total motive force of over 5,000 h.p. The central station at Genoa generates and distributes over 8,000 h.p., and those of Rome and Naples over 10,000 h.p. respectively. The new plant at Celina will shortly be in a position to distribute a motive force of about 18,000 h.p. to the provinces of Udine, Treviso, and Venice. In Umbria there are two big plants utilised by local factories distributing over 15,000 h.p. In 1890 electric traction was only utilised on the Florence-Fiesole line; to-day, in addition to the complete urban and suburban lines at Milan, Naples, Rome, Genoa, Florence, Leghorn, Palermo, Perugia, and Varese, there are the electric lines of Milan-Monza, Milan-Callarate-Varese, Lecce-Colico, Terni-Collestatte, Lecce-San Cataldo, and some few lines on the Italian Riviera. In the aggregate there are some 320 miles of railway in Italy served by electricity. In 1890 there were about 400 communes in Italy either partially or totally lighted by electricity. To-day electric light is general in at least 600 communes. The development of electricity for industrial purposes in Italy has been very marked, and the water power with which the country is so richly provided offers scope for still greater progress.

Temperature Control of Furnaces.—A patent has been granted in the United States to Mr. W. McA. Johnson relating to a method of controlling the temperature in an electric furnace, of which a description is given in the *Electrical World* of New York. We reproduce a diagram showing a furnace of the resistance type, the energy being supplied from dynamo, 31, to two electrodes. Inserted in the furnace is the pyrometer, 5, of the Le Chatelier type, connected to a galvanometer with a movable coil, 13, the needle, 12, indicating on a graduated scale the temperature within the furnace. This needle is made of platinum, and is insulated from the movable coil, 13. It is provided with the metallic contact, 14, which dips into mercury, 15. The second contact, 16, which is also made of platinum, is secured to a movable block, which is placed on that point



of the galvanometer scale which corresponds to or slightly exceeds the temperature desired in the furnace. As the furnace temperature rises to this degree, the needle, 12, makes contact with the point, 16, thereby completing a circuit in which is inserted a battery and a solenoid, 21, which attracts a soft iron core, shifting the contact, 23, from 24 to 25, thereby introducing into the field of the exciter the variable resistance, 26, and the electromagnetic cut-out, 27. These devices are so constructed and adjusted that the electromagnetic cut-out will break the circuit only in case the resistance proves insufficient to reduce quickly the furnace temperature.

Live-Wire Testing Devices.—The *Western Electrician* of Chicago describes some apparatus for determining whether current is flowing in a cable, which apparatus is designed for use on alternating-current lines, but has also been found satisfactory for direct-current work, provided the current is supplied from a generator. The apparatus, which is manufactured by the Minerallac Company of Chicago, consists of a telephone receiver and a small current transformer with a hinged core. The secondary wiring of the transformer is connected to the telephone

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receiver, and the hinged core is clamped around or against the cable to be tested, the cable forming the primary of the transformer. This device will be found very sensitive. We reproduce two diagrams illustrating an electroscope designed to afford a simple means of determining the presence of a dangerous potential in an electrical conductor. The device consists of a glass tube, in which is hermetically sealed a copper plate carrying an indicating leaf similar to that in the ordinary gold-leaf electroscope In using, the

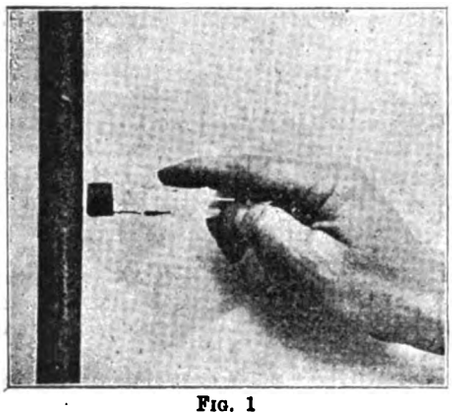

FIG. 1

end of the electroscope is held in close proximity to the conductor to be tested. It will indicate positively all potentials in excess of 500 volts. If the conductor is "dead," the indicating leaf will remain flat (as in Fig. 1). If the conductor is "alive," the indicating leaf will tend to take a position at right angles to the tube (as in Fig. 2).

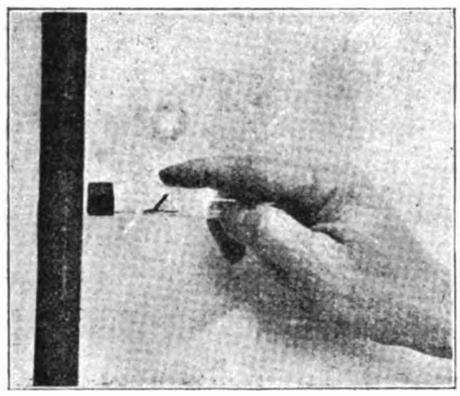

FIG. 2.

It will not, however, work on a grounded conductor, or a conductor surrounded with a lead sheath.

Baltimore and Ohio Third-Rail System.—About a year ago we referred to the sectional third-rail system installed on the Baltimore and Ohio line. The locomotive used on this system has recently been improved by an alteration in the collecting device. It will be remembered that the sections of the third-rail only became alive when the locomotive was over them. The system employed was that of a Hopkinson switch, using a high-voltage pick-up coil and a series holding-up coil. There has evidently been a certain amount of trouble with this arrangement, owing to the failure of the high-voltage supply, or to the reduction in pressure when heavy loads are on. In consequence of this a small dynamo driven by compressed air has now been added to the car, to energise the high-voltage pick-up coil The *Street Railway Journal* of New York illustrates this new apparatus, the air motor being a reversed air compressor. It is controlled by means of the arrangement shown in Fig. 1, and operates as follows: Assume the engine to be resting on a third rail, which is disconnected from the power-house or dead; that the tanks are full of air, and that the compressor also is at rest. Air is admitted to the compressor, and the magnet, E, being de-energised, the valve is at once shifted to engine position, the machine starts as an armature, and rapidly builds its dynamo up to voltage. The circuit connecting the compressor to the electric line is then closed. As the air pressure reduces, due to the demands of the compressor upon the tank, the pump governor closes its circuit also. This completes a circuit of the compressor from third rail to ground, and raises the potential of the third rail to 550 volts, and immediately picks up the sectional track switch. As soon as this occurs, current from the third rail enters the compressor system and proceeds to drive the machine as a motor. The magnet, with its additional excitation, now readjusts its sliding valve, and the valve shaft now moves to compressor position, and the machine now compresses air. This it continues to do until the tanks have been pumped up to 90lb., or to whatever pressure the pump governor is set. At this instant the

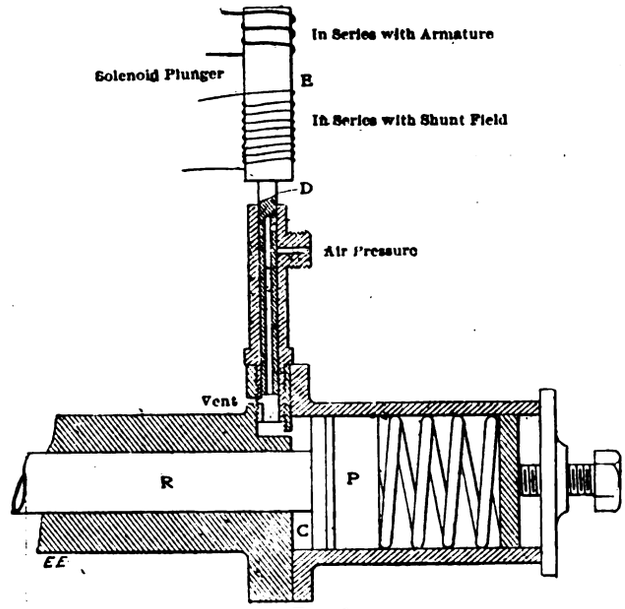

FIG. 1.

pneumatic governor flies open, the sliding valve drops, and the machine becomes an engine, and runs as such for a brief period until the cycle of operation is repeated. If the locomotive is running, the sectional track switch will, of course, not drop, for it is held up by the locomotive current in the series coil, but this will make no difference in the behaviour of the compressor, whether it be on a permanently live or on a sectional rail. When the locomotive is drifting over sections it is highly important that the current shall always be available to the motorman; therefore, the sectional switch must be kept up, and for this purpose the compressor is sufficient. If for any reason the switch should happen to drop, due to jar, it will instantly pick up again, because the compressor keeps the rail at a voltage equivalent to that of the line. In order to control the compressor from the motorman's stand, it is necessary that he have complete control of both the air supply and the electric supply. The latter is easily provided for by means of a switch at his station. The air supply, however, is controlled electro-pneumatically. An automatic air-valve is placed on the tank. On the right and left of this air-valve are two bobbins, which open needle valves which control a piston which operates a main valve. The needle valves are controlled by a dry battery, operated by two buttons at the motorman's stand, one of which will open and the other close the main valve. If the motor is resting on a dead section, and the motorman desires to start, he presses the starting button. This brings the compressor to rest, having cut off both of its sources of energy, and leaves him with air in the tank for starting purposes again.

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THE DERBY ELECTRIC TRAMWAYS AND ELECTRICITY SUPPLY.

This week, through the courtesy of Mr. T. P. Wilmshurst, we have had an opportunity of looking through the whole of the electrical work at Derby which is under his control. We had hoped to do so during the meeting of the

MR. T P. WILMSHURST, BOROUGH ELECTRICAL ENGINEER, DERBY.

Incorporated Municipal Electrical Association, of which Mr. Wilmshurst was president. The exceedingly full programme, however, prevented this, and we deferred our visit until now, when the first two sections of the tramways are opened and at work. It was in February, 1893, that we last went through the Derby electricity works, which had then commenced supplying only a few months. We were interested, therefore, in seeing what proportion of

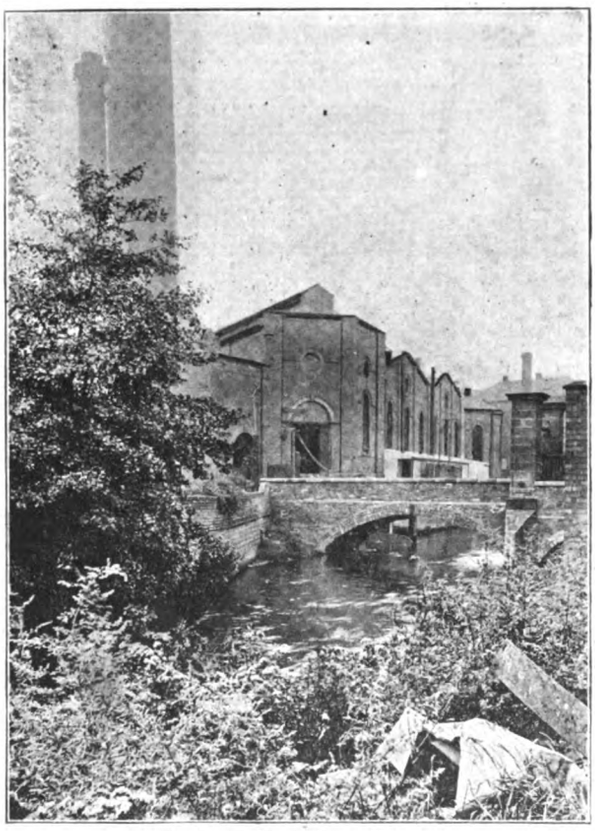

FIG. 1.—The Derby Power House.

the plant then installed is still in use. The first station might well be compared to an amphitheatre, the switchboard platform serving as raised seats for the spectators. The engine-room floor was then somewhat like an amphitheatre in plan, and it was covered with a variety of small units, which were of three different types. The basement, with its one point of ingress and egress, was like a prison, where steam and oil were applied to the unfortunate staff responsible for the steam-pipe joints. Amongst the plant there were the alternators directly coupled to their steam-engines. These were of the Siemens type, and they had the low frequency of 40 complete cycles per second. The exciters were also steam driven, and the arc lighting dynamos, again, had separate steam-engines to drive them. These arc-lighting dynamos were of the continuous-constant-current type made by Messrs. Siemens Bros., and the current was kept at a uniform value by means of brush rocking gear, which varied the point of collection on the commutator. These machines, which were then of a new type, have done remarkable service, and they are the sole survivors of the generating plant we saw in 1893. For economical reasons they are shortly to be replaced, and hence we have pleasure in illustrating in Fig. 2 one of these interesting dynamos.

In Fig. 3 we show the plan of the station as it now is with the new machinery in position. The extreme left-hand corner is the original site, and it has since been extended by the addition of a new boiler-house and the triangular engine-room, which now contains two out of the three Parsons turbo-alternators of 300 kw. each, two of the three 700-kw. Ferranti sets, and the two 150-kw. Siemens-Browett-Lindley sets. Even now the faults in design of the old station hamper progress to a certain extent, but under Mr. Wilmshurst's able supervision this is likely to be corrected in the future. The Corporation have obtained a large new site on the other side of Silk Mill-lane, which has nearly three times the superficial area of the present central station. When this site has been cleared there will be ample space for thoroughly up-to-date works, equipped on the most economical lines with direct-current machinery. At present the only building which has been put on the site is the accumulator house, one floor of which we illustrate in Fig. 4. In this there are two batteries of the Chloride Company's make, one being used for lighting and one for

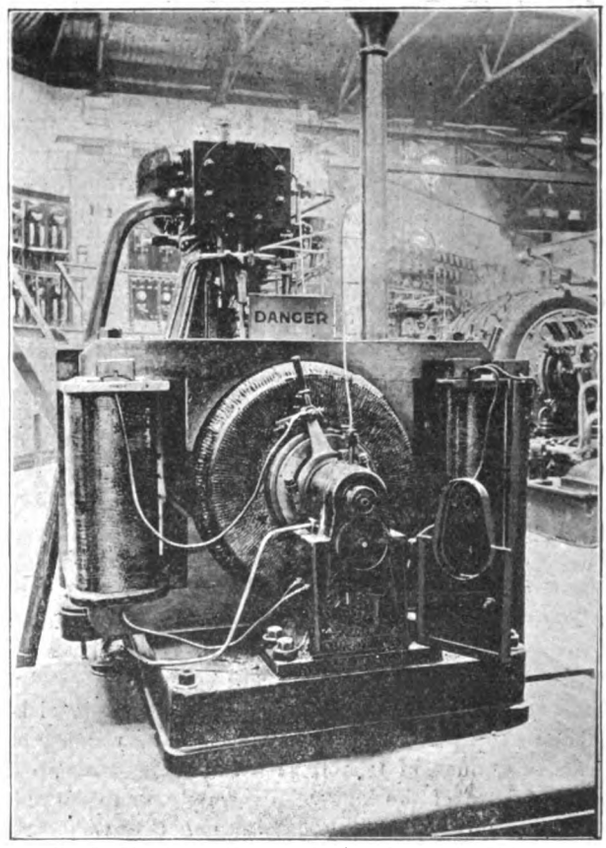

FIG. 2.—The Siemens 10-ampere Constant-Current Arc Lighter..

traction. Each battery consists of 240 cells of the R type in lead-lined teak boxes. The capacity of each battery is 350 ampere-hours on a one hour's discharge, or 600 ampere-hours when discharging over six hours. These two batteries will normally be quite independent of each other, but should necessity arise they can be coupled together in parallel and connected to either the lighting or the traction load. No regulating cells are used on either battery, so that no difficulty arises from the fact that the accumulators are at a considerable distance (about 100

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yards) from the switchboards. The extension of the station from time to time has been accompanied by the usual increase in the size of the generating units, and has involved the scrapping of a number of small units. Thus, when Mr. Wilmshurst first went to Derby, they were working 13 different steam sets in parallel when the winter peak was being supplied, and now there are only five steam alternators in the station.

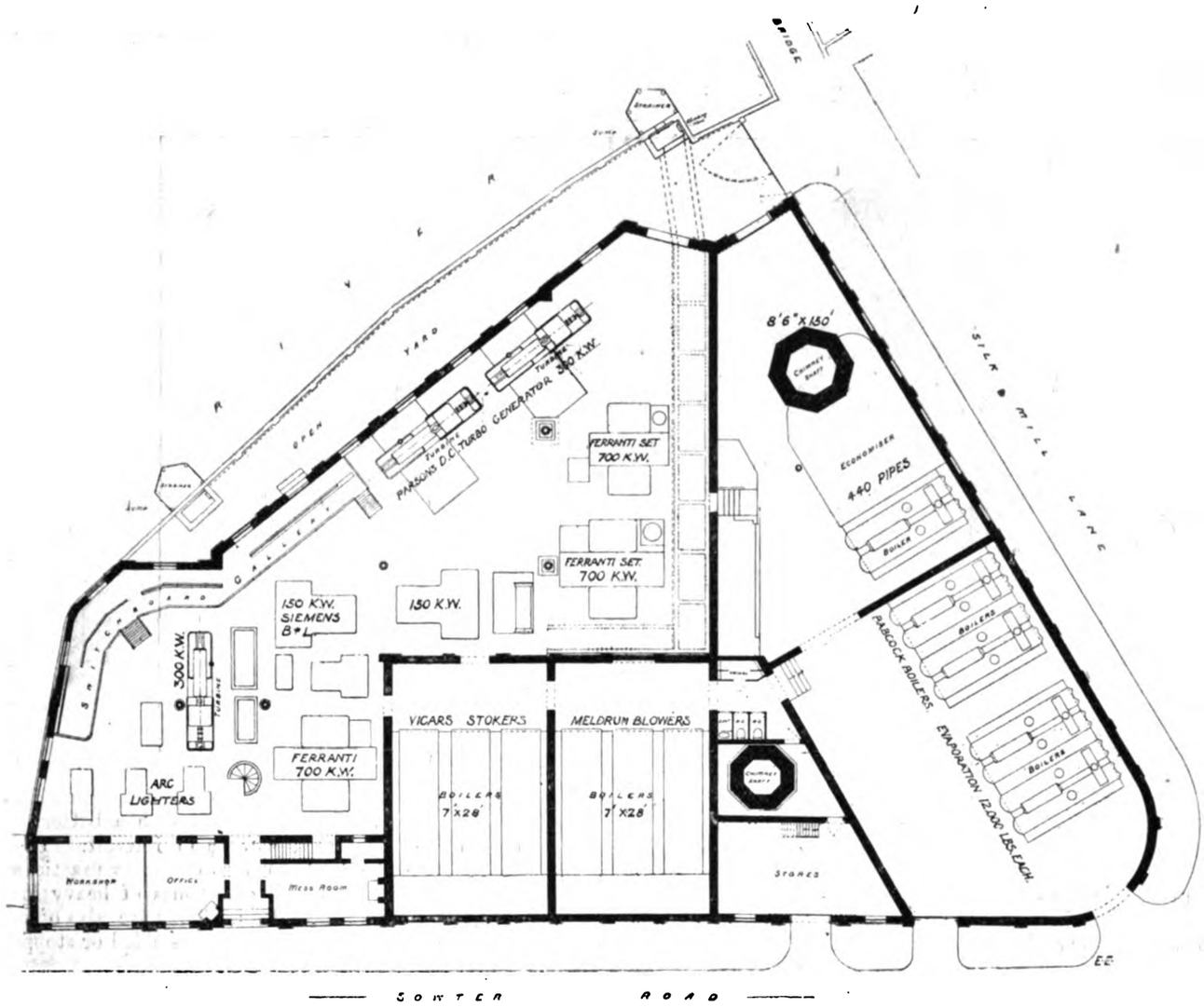

FIG. 3.—Plan of the Derby Power House.

With the introduction of tramways there has arisen a need for continuous current, which is also being introduced for lighting in the area within a half-mile radius from the station. This current is now being supplied from the three

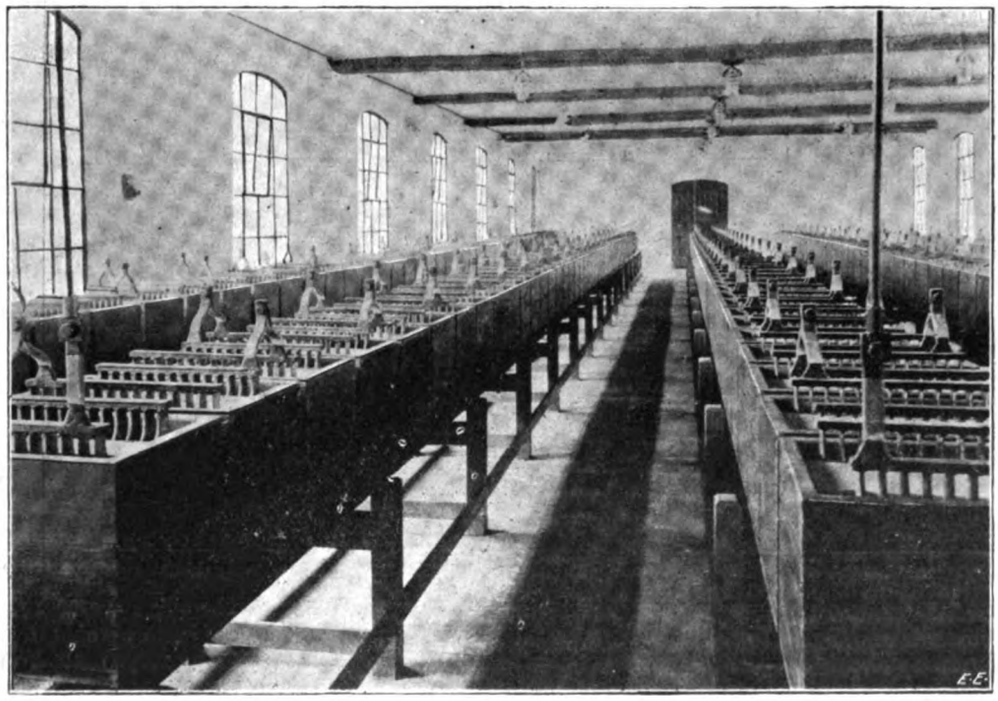

FIG. 4.—The Traction Battery (Chloride type) at Derby.

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300-kw. Parsons turbo-generators. Two of these machines can be seen in Fig. 5. The direct-current generators driven by these turbines are provided with series compensating windings in the field cores. These windings enable a fixed lead of the brushes to be maintained at all loads. The brush gear is of the usual gravity type, with gauze brushes pressing against a corrugated commutator. The dynamos can be worked either as shunt or compound machines, and the voltage can be varied from 480 up to 620 volts. When running as compound machines, they are arranged to give about 560 volts at full load and 500 volts at no load. These turbo-alternators run at 3,000 revolutions per minute, and the noise made by the ventilating vanes at the end of the armature core leaves no doubt as to which of the turbines is running. In connection with the battery for the tramway circuit a reversible booster is used of a new type. This booster was supplied by the Lancashire Dynamo and Motor Company, and is constructed under the Turnbull and McLeod patents. A view of this machine is shown in Fig. 6, which gives a good idea of the present appearance of the old station This booster is designed for a working current of 200 amperes normal, and 300 amperes for one hour, and to supply 70 volts for prolonged periods and 120 volts as a maximum. The machine runs normally at 800 revolutions per minute. The field magnets are laminated throughout, including the yoke, giving the quick reversal so necessary for traction work.

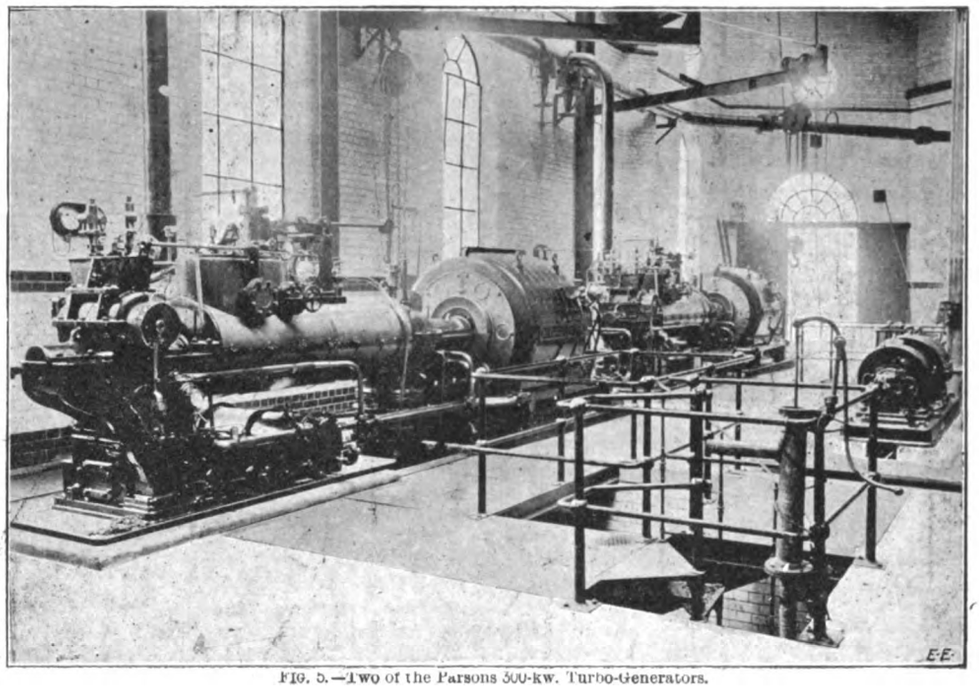

FIG. 5.—Two of the Parsons 300-kw. Turbo-Generators.

The following details of these boosters, which are chiefly used for working on traction systems with a battery in parallel with the generators, will be of interest. Their object is to keep the load on the dynamos practically constant, the battery discharging at times of heavy load and charging at times of light load. They are also of use in works where the motors are large, and started or stopped frequently, or in any other place where the load is of a varying character. Taking into account the large variations in the voltage of a battery (not only with varying current, but with the same current at different times), it is evident that the first requisite is an exciting coil which shall always make the sum of the battery and booster voltages practically equal at all times to the bus-bar voltage. This is accomplished by putting on a coil excited by the

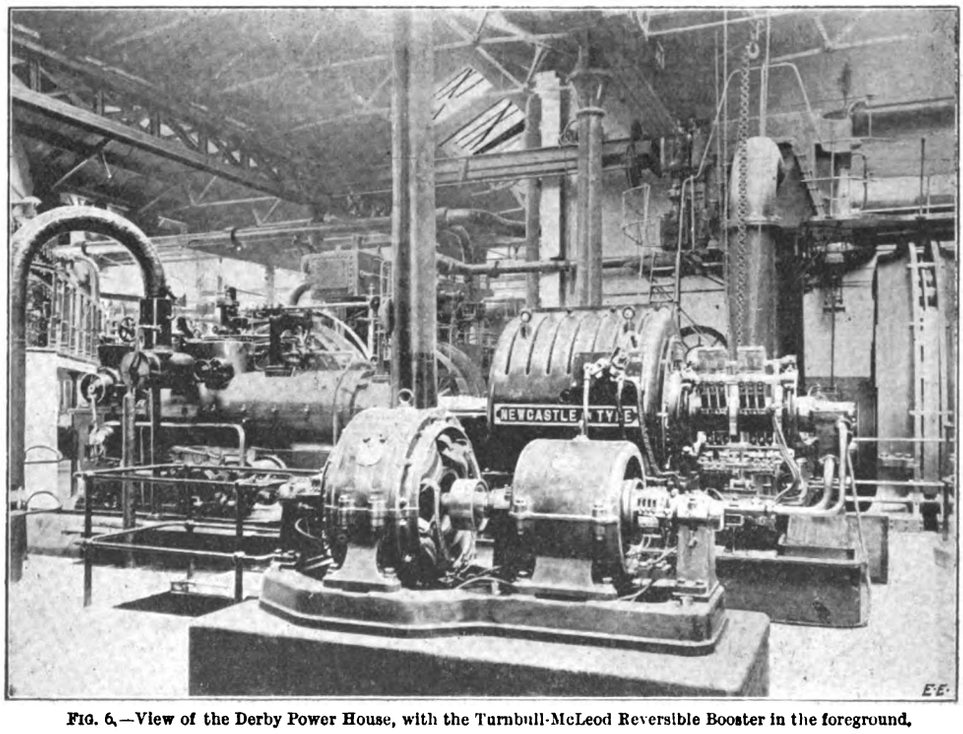

FIG. 6.—View of the Derby Power House, with the Turnbull-McLeod Reversible Booster in the foreground.

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difference between the battery and 'bus-bar voltage (Fig. 7, coil A). If the booster is worked on the straight part of the characteristic, it will be seen that this coil can be made to give a voltage on the booster armature always equal to the difference between the battery and dynamo

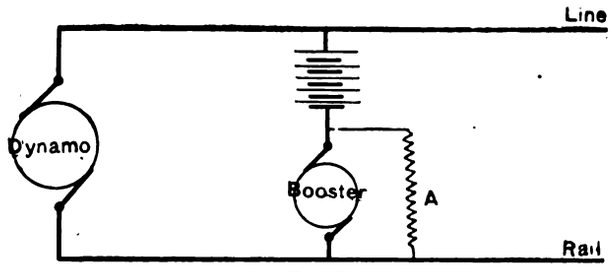

FIG. 7.

voltage, so that no matter what the state of the battery, the booster always brings the battery up or down to the 'bus-bar voltage. If, now, another coil is added, a very small current in this will cause a very large difference in the booster voltage. For instance, a shunt coil across the 'bus bars, B,

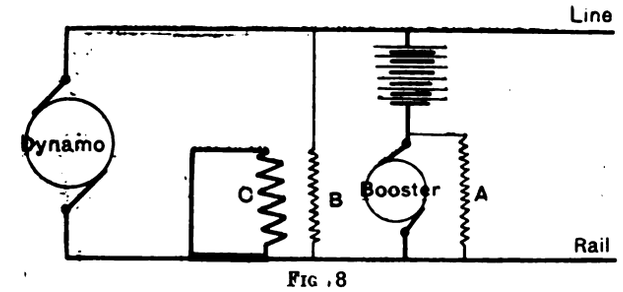

FIG. 8

(Fig. 8), would increase the voltage on the booster, which again would increase the strength of coil A, and the battery would heavily charge. If, on the other hand, instead of B, a coil is put on wound in the opposite way, the voltage of the booster would be altered so as to produce a heavy discharge. This last coil is a series coil, C, arranged to carry the whole or part of the dynamo current, and is arranged so as to oppose the coil B. Then any increase in the ampere-turns of B above C will cause the booster to build up so as to heavily charge, and any decrease of B below C will cause the battery to discharge. A few series turns are usually added in the battery or feeder circuit to make up for the armature reaction and C R drop of the booster itself. To take the case of the booster on a traction system, if the dynamo tries to take an overload, the coil C would overpower B and the battery discharge until equilibrium was restored. On the other hand, if the dynamo current tries to reduce on light load, B overpowers C and the battery charges until they are balanced. As the booster depends for its control on the dynamo current, and not on any balancing of voltage depending on the dynamo characteristics, compound machines can be used as well as shunt, and all trouble from hunting and kindred causes is avoided. Most boosters which do not depend on the falling characteristic of a shunt dynamo rely on the drop in volts on the battery and booster in discharging, which is balanced by a series coil in the feeder. If this coil is not exactly of the right strength, the battery discharges too much or too little, usually varying with the state of the battery. The particularly valuable property of a coil in the dynamo circuit consists in the fact that it can be made as strong as desired and always balanced by a regulator on the shunt coil to fix the dynamo current at anything required, and if the current *should* vary, acts with very great force to bring it back to the normal again, thus making the booster very stable and greatly facilitating

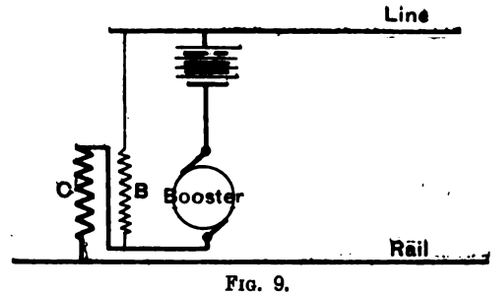

FIG. 9.

paralleling. If it is desired to use the battery and the booster on the line without the generators, coil A is disconnected and coil C connected to help B, giving the battery a constant voltage with varying load (Fig. 9).

The Lancashire Dynamo and Motor Company have also supplied to Derby a three-wire reversible shunt-wound booster for use on the lighting battery, having a capacity of 100 amperes continuously, 200 amperes for one hour, with a maximum boost of 70 volts per side; also two balancers, each made up of two four-pole machines of their standard make.

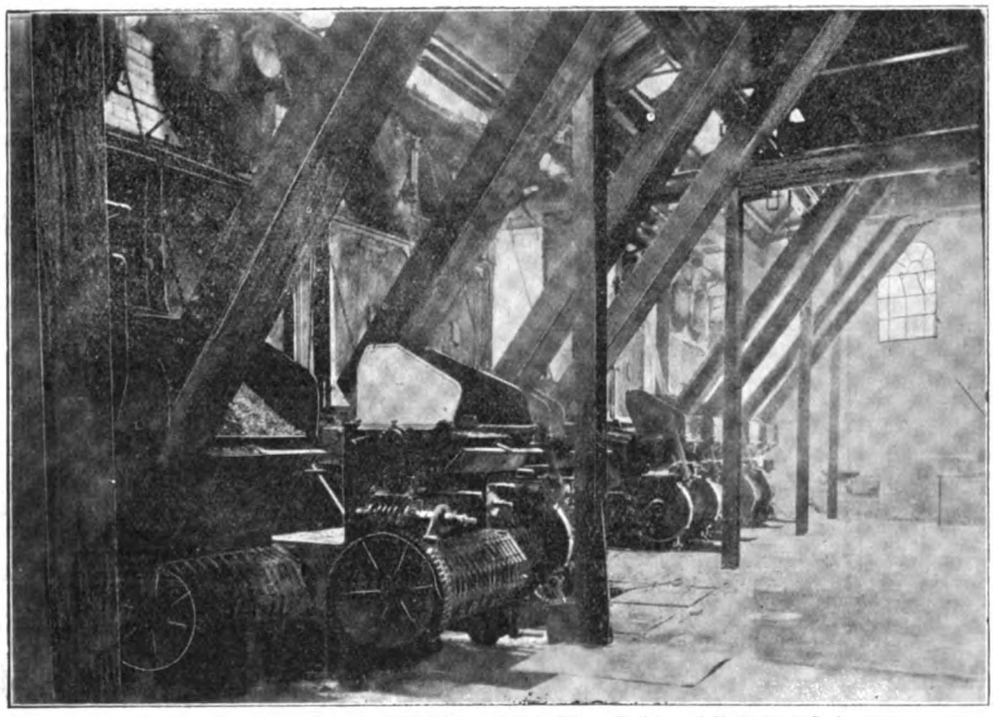

FIG. 10.—The New Boiler House at Derby—Babcock-Wilcox Boilers and Chain Grate Stokers.

In Fig. 10 we give a view of the new boiler-house, which contains five Babcock and Wilcox boilers, each able to evaporate 12,000lb. of water per hour. These boilers are

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fired by means of chain-grate stokers, which are fed from overhead coal bunkers. The coal supply for the works is not brought by water up the River Derwent, but it has to be carted through the town. The river is, however, exceedingly useful for condensing purposes. Owing to the fact that independent condensing plants are placed in the basement under each generator, it is possible to obtain a high vacuum, and 28in. is quite a common vacuum on the turbo sets.

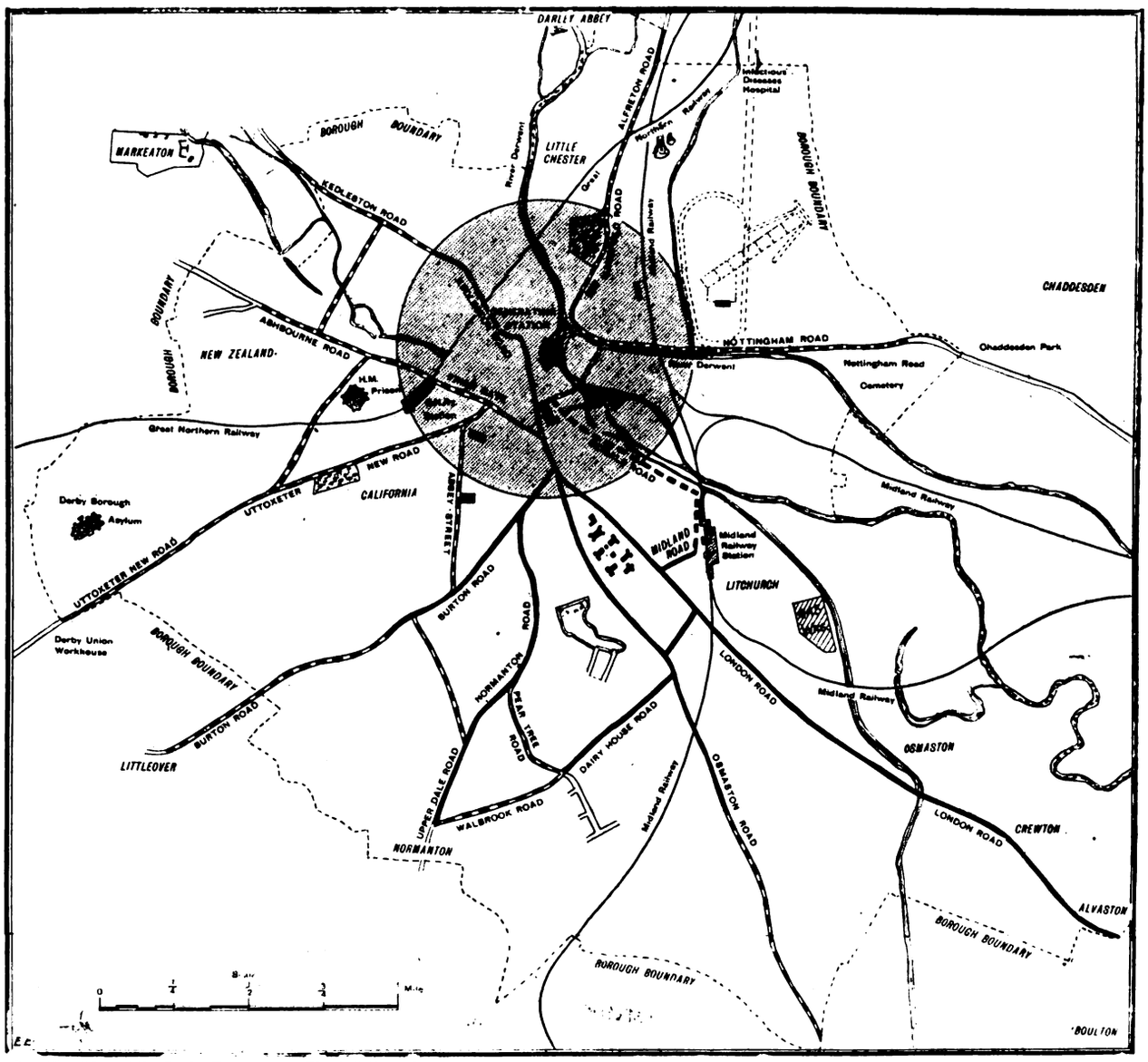

FIG. 11.—Map of the Derby Tramways. The full lines show tramways running or nearly completed. The dotted lines are authorised routes to be added when the sewers are completed. The shaded area denotes the portion of the town in which continuous-current supply is to be given

Steam is supplied superheated both from the Babcock and Wilcox boilers and from the older Lancashire boiler. This superheat, however, is not carried to an excessive point, as 120deg F. is about the limit.

Coming now to the load on the station, this has shown a steady increase, and is remarkable for the large number of motors supplied. Thus, in the year ending March, 1903, no less than 1,264,432 units were sold, and for the past year this has gone up to 1,490,611. These figures are independent of the tramways, as it is only during the past two or three weeks that tramcars have been regularly at work. The aggregate horse-power of the single-phase motors now being supplied is 1,350. These are giving great satisfaction, and are largely the property of the Corporation, let out to the consumers on the hire-purchase system. Out of this aggregate some 280 h.p. are used in one timber yard, in which there are some motors of 40 h.p. each. There is also in this yard a 6-h.p. Heyland motor

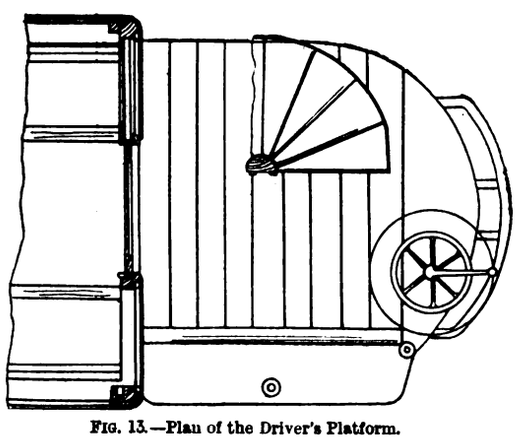

FIG. 13.—Plan of the Driver's Platform.

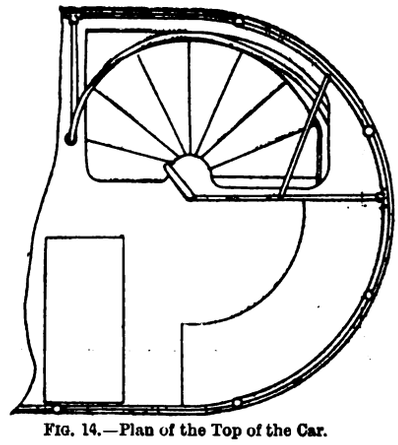

FIG. 14.—Plan of the Top of the Car.

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coupled on to a lift, which is giving great satisfaction. Some ironworks also take supply for motors at an ggregate of 270 h p.

The tramways at Derby are being constructed at the same time as the reorganisation of the sewers, and in consequence the lines cannot be laid in any street until after the new sewers have been put in. The map (Fig. 11) shows the routes which have been authorised and for the

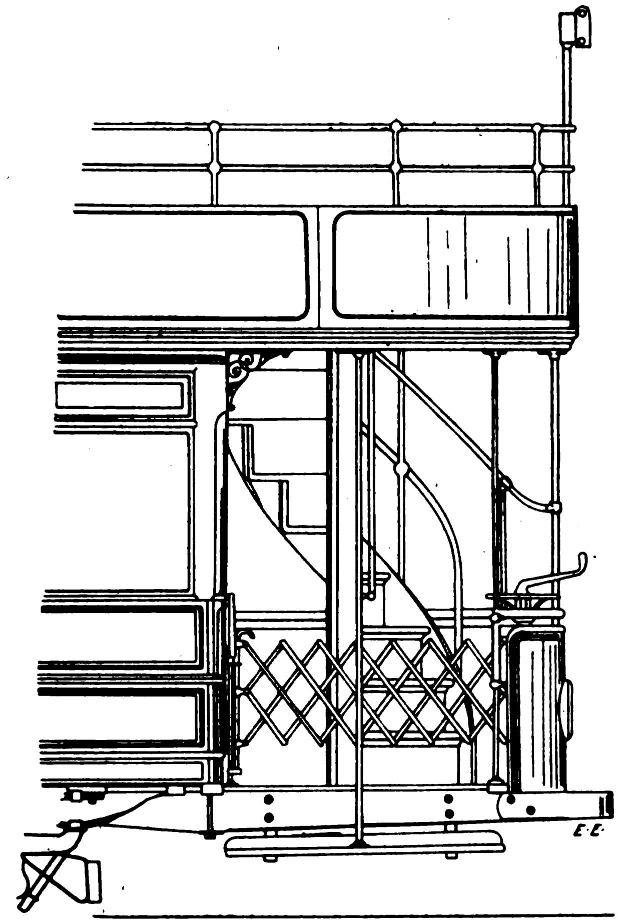

FIG. 12.—End of the Derby Car, showing Semi-reversed Stairway.

construction of which powers have been obtained. Those routes represented on the map by full black lines are either opened or in course of completion. The dotted lines represent routes which will be equipped as soon as possible after the new sewers have been laid. The tramways in the London-road and Osmaston-road, with their branch lines,

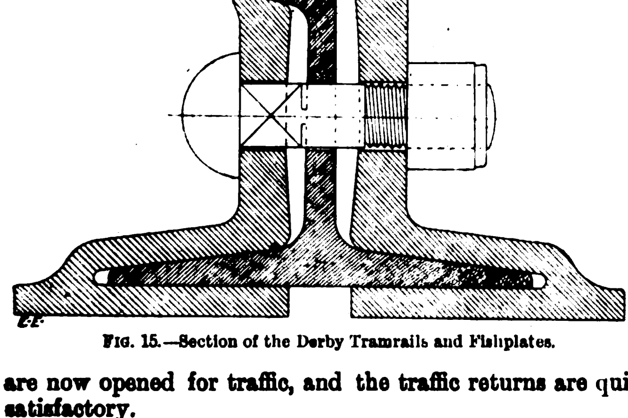

FIG. 15.—Section of the Derby Tramrails and Fishplates.

are now opened for traffic, and the traffic returns are quite satisfactory.

The car-sheds now completed in Osmaston-road can house 30 cars, and are complete with cleaning pits, repair shop, stores, etc. Eventually another car-shed will be constructed at the other end of the town. The cars now running are of the Brush make with Brush trucks and the B.T.H. K10 equipments. They have three brakes—*i.e.*, electric, hand, and slipper. One noteworthy feature of these cars is the semi-reversed stair shown in Figs. 12, 13, and 13. The advantage of this stair is that the view of the driver is not obstructed by the stairs, as is the case with the reversed stairs. The pitch of the stairs is, however, rather greater if compared with the tread in this new type of stair than is generally adopted. The car-shed was designed by and erected to the approval of the borough engineer, Mr. J. Ward, M.I.C.E., who also was responsible for the track work. This work, and also the overhead equipment, for which Mr. Wilmshurst was responsible, were carried out by Messrs. J. G. White and Co. Fig. 15 shows the section of rail adopted and also the special fishplate for securing a stiff joint. The wheel details are shown in Fig. 16.

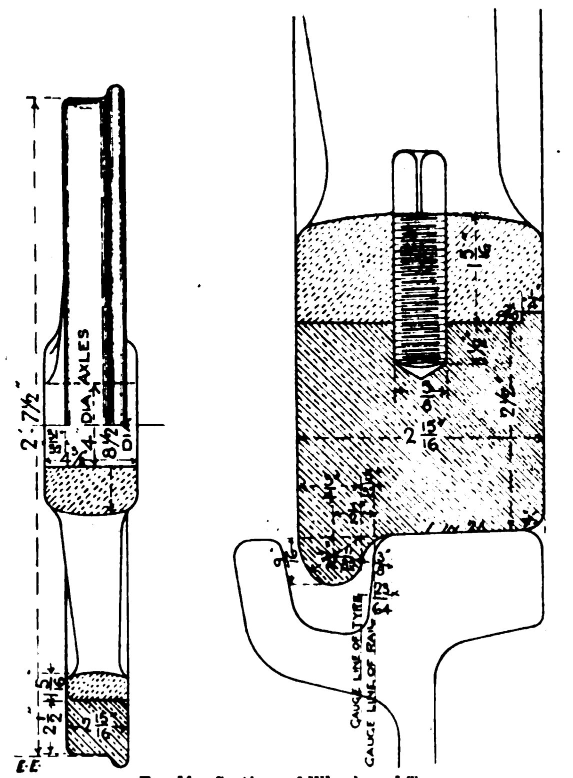

FIG. 16.—Sections of Wheels and Tyres.

It will be seen from the above that Derby will in the near future have a complete system of electric tramways, which is much needed in the town. The introduction of these will help the electricity supply in many ways, and hasten the conversion of the central portions of the supply to the direct-current system. We have to thank Mr. T. P. Wilmshurst and Mr. T. Knatchbull-Hugessen, the mains superintendent, for their kindness in showing us the works on Monday last.

WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

(Continued from page 203.)

Wireless Fire-Alarm.—The importance of automatic fire-alarm systems, especially in centres of population, is obvious. That this importance is recognised is evident from the high prices at which shares in some companies owning patents for apparatus of this kind stand. But an ordinary fire-alarm fails to indicate exactly the position of the fire. That of M. Emile Guarini, using the known laws of ether-wave signalling, accomplishes this very important function, at the same time being automatic.

The principle of M. Guarini's system is that of most automatic fire-alarms, in that a mercurial thermometer acts as the basis of the alarm. Two platinum contacts fused into the glass walls of the thermometer tube are in a circuit including a battery and relay. The circuit is completed by the expansion of the mercury in the thermometer when exposed to the increasing heat of the fire. The circuit may be arranged so that the alarm shall act when the temperature reaches any fixed limit, which, of course, must be above that of any ordinary summer temperature. The

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novelty of M. Guarini's system, however, lies in the fact that communication between the thermometer in the premises protected and the fire station is accomplished by Hertz-wave telegraphy. Thus no connecting wires are necessary, and the distance up to 20 or 30 miles is of little consequence. The alarm circuit includes a battery and relay, the armature of which acts as a detent, preventing, under normal circumstances, a contact wheel driven by clockwork from acting. When the circuit is completed, through the expansion of the mercury, the armature of

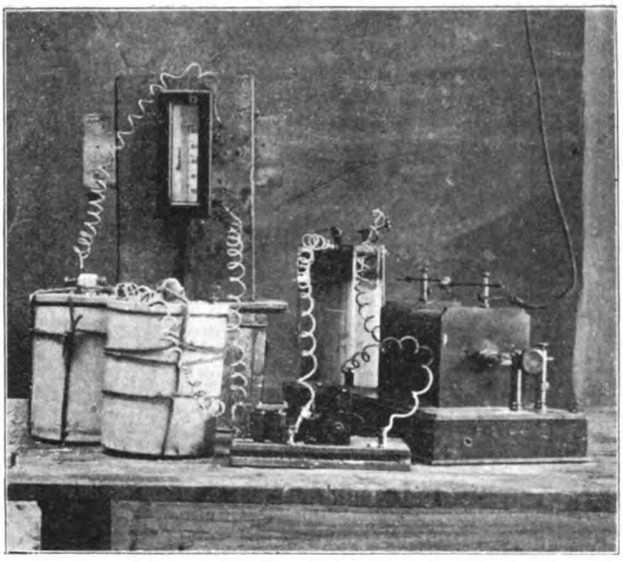

FIG. 77.—Guarini Wireless Fire-Alarm Transmitter.

the relay is attracted; this wheel is released, and the latter revolving makes a series of contacts with a fixed brush which is connected through a battery with the primary of an induction coil transmitter. The induction coil secondary is connected with the usual oscillating circuit and aerial with earth connection. The transmitting apparatus is shown in Fig. 77. The apparatus, it will be seen, are well protected, so that the alarm may have a considerable time in which to act before the temperature is so high as to destroy the transmitter itself. The receiver is shown in Fig. 78, which has the usual coherer battery, Morse

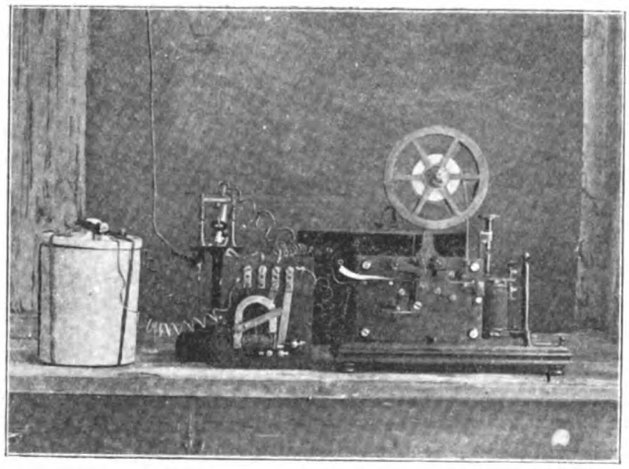

FIG. 78.—Guarini Fire-Alarm Receiver.

printer, etc. The first incidence of the ether waves rendering the coherer conducting, closes a circuit including a call bell. The contacts on the wheel of the transmitter determine the signals, and thus not only an alarm is given, but the name and address of the premises or even the *room* protected by a given instrument are repeated again and again and registered by the receiver. The same receiver can be made to serve for different thermometers placed in distinct buildings or in different rooms of the same building.

This up-to-date application of wireless signalling appeals to all who wish to avail themselves of the most recent advantages resulting from scientific research. As fires are more numerous and more dangerous by night than by day, it is as well to remember also that wireless signalling can be carried on with more certainty at night than in the daytime, and over longer distances.

THE NEW GERMAN SYSTEM—"TELEFUNKEN."

This system of wireless telegraphy arises from the amalgamation of the two systems already described—the "Braun-Siemens" and the "Slaby-Arco"—the one owned by the Gesellschaft für drahtlose Telegraphie, and the other by the Allgemeine Electricitäts-Gesellschaft. This fusion of systems took place in the summer of 1903, the apparatus of the new system being constructed in the workshop of the two companies, but for alterations and repairs required on short notice, and for the production and *testing* of new models, a special workshop employing about 100 carefully trained workmen and assistants has been established. For outdoor experiments with aerial conductors, and in relation to syntonising and carrying distance tests, six stations in and around Berlin have been established.

The two systems have over 20 patents in Germany alone. Amongst these may be mentioned that of 1898 for the transmitter arrangement, in which an oscillation circuit with condensers and a spark-gap with a large amount of energy excites the aerial conductor slightly deadened to self-oscillations. A similar arrangement for the receiver was patented in 1901, consisting of a closed oscillating circuit, which by a clear and pronounced self-period renders the receiving apparatus sensitive to a definite transmitter frequency only, thus eliminating to some extent disturbances emanating from foreign transmitters. A patent reserving to the company the resonance arrangements of four oscillation circuits of transmitter and receiver for certain modes of mounting has been followed by others, granted or applied for, in connection with transmitter arrangements for reducing loss by deadening in the spark-gap—the first successful attempt, it is claimed, made by any company to deal with this hitherto chief cause of loss of energy. The patent electrolytic wave-detector or coherer (Schloemilch) already referred to (see p 630 *ante*) is, no doubt, one of the chief sources of success. It is claimed to be the simplest and most reliable receiver yet produced.

The fact that 250 stations on this system are (according to information supplied to us from Berlin) now working, and that the number is rapidly increasing, shows the importance of the system. The annual cost of working in warships amounts, we are told, to about £20 (we presume this means £20 per ship). A great feature of this system is the portable station (see p. 79, July 15, 1904). Concerning the reliability of these stations and their use in war, an officer of the general's staff, referring to the manœuvres in an article in the *Militär-Woehenblatt* of November, 1902, says: "The telegraphists employed the Braun-Siemens system of spark telegraphy, which worked exceedingly well. The transportable station was daily in great requisition: it transmitted orders and reports between the general in command of the fifth army corps and the cavalry division. . . . With the Morse printer the stations worked reliably at a distance of two days' march, with other operators at a distance of three or four days' march."

Distance of Signalling. — The distance of successful signalling is determined by the size of the aerial conductor net and the magnitude of the source of electric energy necessary for radiation into the ether. As early as 1902 some experiments by the company were made from the Oberspree works of the Allgemeine Elektricitäts-Gesellschaft. Four chimney stacks, each 70m. (229½ft.) high, were used to support a square aerial net consisting of about 100 wires running down in funnel shape to the generator. An alternating-current supply of about 15 kw. was taken from the engine-room. This current converted to a pressure of about 50,000 volts supplied the exciting system. The enormous oscillations with a frequency of about 900,000 per second excited the aerial net. On the very first day of the reconstructed trials legible messages were transmitted to Karlskronain, Sweden, 450 km. (about 281 miles), the receiving wires being only 35m. (82ft.) high. The company now guarantee communications over distances

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of upwards of 1,000 km. (625 miles). Especially in summer it is, however, a well-known fact that the distance of successful signalling varies much with the state of the atmosphere. Hence a large *factor of security* is necessary to ensure successful communication at all times. Thus to cover successfully a distance of 100 miles under all conditions, it may be necessary to utilise energy sufficient to cover 300 miles under favourable conditions.

The Province of Wireless Telegraphy.—The owners of this system have made many experiments, and give it as their opinion that in the immediate future neither absolute exemption from disturbance nor complete secrecy—at least for comparatively long distances—is to be expected. Even if this be true—and it is disputed by some authorities—wireless telegraphy has in numberless cases already done excellent work. The first primitive contrivances of wireless apparatus were sufficient, and various navies introduced them on their ships. Now, however, an important problem presents itself. A company supplying such apparatus as are used on board, say, the ships of a large navy, is required to make the range of all the instruments as nearly alike as possible; in other words, they are all to be as nearly alike as possible in the time period and wave-length adopted, so that intercommunication may be easy and interference from outside workers, to some extent, at least, secured. To do this a wave-meter becomes a necessity, and this the system here referred to supplies. This apparatus has already been described in these articles, and by its use a station may be erected in any part of the world with apparatus suitable to receive messages from any other given station. Further, if it were desirable, this apparatus could be used to determine the wave-length employed by any other rival station, or station in the hands of an enemy. The necessary alteration being made in the receiving circuit of the station supplied with the wave-meter, the messages from the rival or enemy could easily be read if dependence were placed merely on the security given by resonance effects. Of course, a code might be employed to get over this difficulty, but apart from this suppositious case the utility of the wave-meter is evident.

This very weakness of wireless telegraphy—viz., the fact that it is necessary to radiate into space, and hence all within a given distance may read who care to suit their stations to the radiations—proves, in some cases at least, its most desirable feature. In army work, for instance, the fact that a telegram may be *simultaneously read by many receivers*, is of the greatest value, as the orders of a commanding officer can thus be received *simultaneously* at many quarters, and combined movements of large bodies of troops in scattered positions may thus be made with the greatest precision. This feature has been fully worked out in Germany, and the excellent portable sets there used testify to the ingenuity displayed in taking advantage of the above peculiarity of wireless signalling. Light military wagons have been constructed to carry not only the whole apparatus of a station, but also the necessary supply of current, kites or balloons being used to carry the aerial wires. The use of wireless signalling to and from railway trains in motion has been advanced by this company. With horizontal aerials on the trains and the ordinary telegraph wires on the line the military railway from Berlin to Zossen has been equipped for wireless telegraphing, and it has remained in uninterrupted use since the close of 1903.

The use of the system in the Imperial and commercial navy is very striking, the shores of the North Sea and Baltic being netted by an unbroken series of stations belonging to the German navy. *All* telegrams are taken up and sent off within a range of 150 km. (93⅔ miles) at the low tariff of 9½d. per 10 words, irrespective of the nationality of the dispatching vessel or of the system employed on it. The shores of the United Kingdom are surrounded by many similar stations, but we may have some disquietude as to whether these stations will soon be under State control, and whether State resources will be used to further commercial enterprise as in Germany.

There is another little disquieting statement that one may mention. The owners of this system in their pamphlet, now in the press in Germany, say that "On Sept. 26, 1903, their Lloyd-Hall station at Bremerhaven exchanged telegrams with the Marconi station on the fast steamer 'Kronprinz Wilhelm,' 257 km. (161 miles) away." They also say, "In like manner we can catch up, on the North Sea coast, telegrams which the Marconi apparatus at Poldhu strives to fling across the Atlantic. Similarly, we can force the Marconi receiver at Poldhu to take up our telegrams together with the messages coming from America, so that when the two arrive simultaneously . . ." The writer desires to avoid controversial matters, so prefers not to give the remainder of the sentence, and distinctly desires to state that he has no knowledge of the truth or otherwise of the statement. The first part of the pamphlet ends with the pregnant words, "all we need is to work with a like wave." The disquieting part of this matter is that as our navy is equipped with Marconi apparatus, one cannot help wondering whether our German friends are as successful in connection with the reception of our naval messages as they say they are of the messages referred to, and whether a code would be of much use in time of war.

(To be continued.)

PRESSURE DROP IN ALTERNATORS.

BY WILLIAM CRAMP.

The Heyland diagram for polyphase motors shows clearly all the effects observed when one field produces upon closed conducting circuits by its rotation a second rotating field. It states that the currents induced in the closed circuits by the rotation of the first field follow what is now known as "the semi-circle law"—*i.e.*, their values are given by the length of lines drawn from one extremity of a diameter of a semi-circle to the circumference.

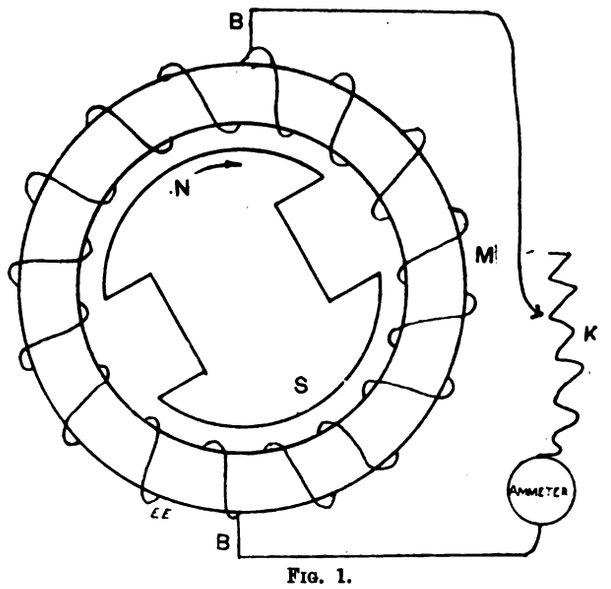

FIG. 1.

Now, an alternator consists of a series of rotating fields and a number of closed circuits upon which these fields act. One of the simplest forms of alternator is that shown in Fig. 1, where N S is a revolving permanent field, B B a ring armature connected to the external circuit, K, at the points B B. B B are, therefore, not brushes—*i.e.*, there is relative motion between them and the field N S, and they are fixed with respect to the windings. We shall assume that the distribution of the field set up by N S is sinusoidal around the armature, B B.

Now if N S revolve at a uniform speed in a direction, say clockwise, it will set up in the coils of the ring and in the external circuit an alternating current, which current will in turn set up an alternating field along the line B B. This field may, by the method of Prof. Ferraris,* be resolved into two equal magnetic fields, rotating about the armature in opposite directions, each field of half the maximum strength of the resultant or actual field. These two fields pass one another on the line B B. The reaction of one of these—viz., the one which rotates in the

* Galileo Ferraris, *The Electrician*, p. 110, 1894.

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same direction as the field N S—may, by the laws of the Heyland diagram, be easily taken into account. The reaction of the other may be considered as follows: Imagine the two similar component rotating fields, I. and II., starting from B (Fig. 2) and rotating with equal velocity about the armature, C, which, for the sake of simplicity in this figure, is drawn with a simple drum winding, the obvious equivalent diagrammatically of the ring armature in Fig. 1. The field II. revolves clockwise—*i.e.*, in the same direction as the original field, N S. Suppose that at the moment which we are considering the sense of this field is north at N. The sense of field I. is, therefore, north at N_1. As field II. proceeds in the direction of the arrow head it will produce upon reaching the conductor, A, a current in the

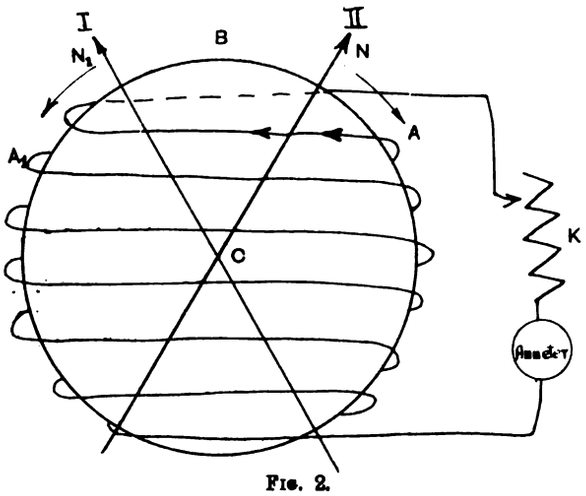

FIG. 2.

direction shown. Field I., by this time arrived at A_1, will be found by Fleming's hand rule to be producing a current *in the same direction in the same coil.* That is, though each field exercises upon the armature a tendency to turn (or torque) in an opposite direction to its fellow, each produces a current in direction and time about the armature, C, exactly similar. But the reaction upon the field N S is produced or transmitted by means of the current in the armature coils; thus it is clear that, so far as reaction upon the field N S is concerned, the result of field II. is just to double the influence of field I.—that is to say, both fields produced by N S may have their reaction upon N S represented by a similar constant field rotating in the same direction as N S.

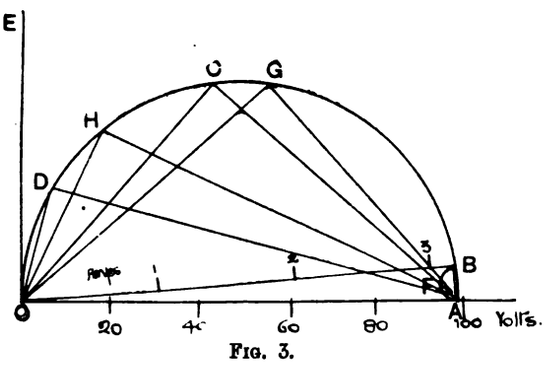

FIG. 3.

The problem, therefore, is exactly that dealt with by the Heyland diagram, for, by reference to Fig. 1, it will be seen that the E.M.F. produced in either half of the ring is a maximum when N arrives at M. If there is very little self-induction in the circuit, the current will at the same instant be a maximum, but there will be no field (or practically none) along the line B B. This is only possible when the resistance of the circuit is extremely large, and the current, therefore, practically zero, thus corresponding to the starting point, O, of the semi-circle diagram (Fig. 3), where O E represents the alternator E.M.F., and lines from O to the semi-circle give the alternator current. The other extreme position—*i.e*, when the alternator current is equal to O A—though it can never be realised in practice, corresponds theoretically to the condition when in Fig. 1 the lag of current behind the E.M.F. is 90deg., so that, though the E.M.F. is still a maximum when N arrives at M, the current is a maximum when N arrives at B. Under these conditions the resistance of the circuit is zero, the current is entirely a magnetising (rather a *de*-magnetising) current, and since it is as great as it can ever be, it must be just balancing the field N S—*i..e*, the ampere-turns of the armature when the armature current is a maximum are exactly equal to the field ampere-turns.

It must be well understood that the Heyland diagram only answers to those cases in which the coefficient of self-induction of the circuit considered is practically constant, a state of affairs usually existing in polyphase motors because the magnetic densities employed are relatively low, and thus every increase of current produces a corresponding increase of armature field. This, however, is not the case with single-phase alternators; the induction in the teeth of the armature is frequently high, as also that in the pole-faces, and it becomes necessary sometimes to take this into consideration in the diagram. First of all we will show by a small test case that the alternator follows the law given above if the saturations are low. We must bear in mind that the resistance to which the diagram refers is the *total resistance in the circuit*, the E.M.F., the *total E.M.F.*, generated by the alternator. The table below gives details of a test of a small *Crypto* alternator (built for experimental work and kindly put at my service by the Crypto Works Company, 29, Clerkenwell-road, E.C.) run at a constant speed of 2,500 revolutions per minute, and with a constant exciting current of 0·7 ampere, this exciting current being selected as showing all the points of the construction before saturation sets in.

READINGS OF ALTERNATOR.

Exciting current	0·7 amps.
Short-circuit current	3·15 ,,
Volts, open circuit	99
Load, 93 volts	0 8 ,,
86 ,,	1·35 ,,
68 ,,	2·05 ,,
60 ,,	2·35 ,,

We proceed to set out the readings as follows: Choose a scale for the voltage so that the line O A (Fig. 3) represents the open-circuit reading. Now, on O A describe a semi-circle O D A, then if the *load* is non-inductive, as it was in this case, O D, O C, etc., are values of the current in the circuit corresponding to A D, A C, etc., which represent the product of current into the total resistances of the circuit, which is here $R_a + R_x$ = resistance of armature + external resistance. If, as in this case, the alternator is to be used upon a non-inductive load, and with normal excitation the short-circuit current is not too large for the armature winding, and the magnetic saturation does not rise to high values in the alternator, we can predict the performance of the alternator on varying loads with only the open-circuit and short-circuit readings. For having set out the semi-circle upon O A as above, we calibrate the current line as follows: the short-circuit current is 3·15 amperes and the resistance of the armature is 2·4 ohms, therefore on short-circuit the C R drop in the circuit is 7·56 volts. To the same scale of volts to which O A is drawn, take a length equal to 7·56, and from the point A cut the semi-circle in B, then O B represents 3·15 amperes, so that the current scale is fixed. For any current, then O C, the external voltage, is A C – [O C . R_a].

Now, since the C R drop in the armature is proportional to the current, and always in phase with or forming a portion of such lines as A C, A D, and since it has its maximum value when the current is a maximum, it follows that we may show the C R_a drop corresponding to any current represented by O C by describing a semi-circle upon A B, when A F (that portion of A C which is cut off by the semi-circle A F B) is seen to represent the C R_a drop corresponding to the current O C. Thus, C F is the actual terminal voltage corresponding to current O C, and so on. For the particular alternator given above I have plotted these readings by ordinary rectangular co-ordinates, and have marked by crosses on the same diagram the theoretical readings, while dots give the actual readings of the alternator taken upon load as given above. The letters in the two diagrams correspond (Figs. 3 and 4).

So much for the case of non-inductive load. In predicting the fall of pressure upon an inductive load, we have

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to remember that the densities used in alternate-current apparatus, such as transformers and induction motors, are low, resulting in the coefficient of self-induction being constant over working loads. We have then simply to consider a circuit made up of apparatus which increases the self-induction of the original circuit by a definite amount. This is only equivalent to multiplying the armature leakage by a definite amount, and, therefore, it is clear that the current and voltage in the total circuit will follow the same general law. The only difference is that now to get the actual short-circuit current, we must obtain that current which would flow when the *resistance* of the inductive apparatus connected to the alternator is reduced to a minimum.

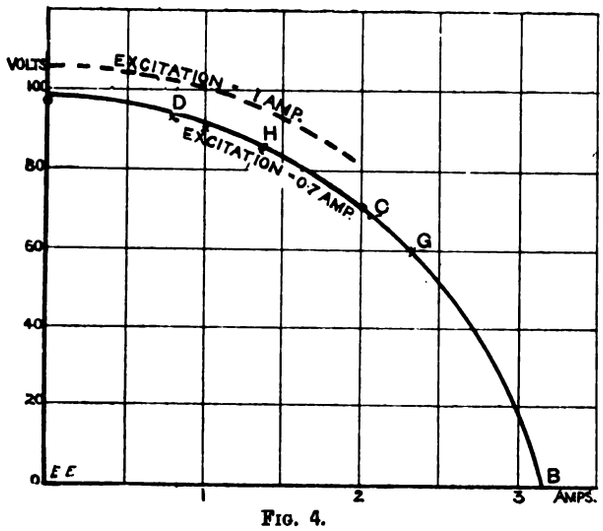

FIG. 4.

The connection between current and voltage in such an apparatus as a short-circuited transformers is (as in the case of an alternator) nearly a straight line until saturation sets in. We may, therefore, obtain such a curve for the particular inductive load by finding one or two points upon the line and producing it until we obtain the current corresponding to the open-circuit voltage of the alternator. We are then able to compare the self-induction of the alternator with that of its load, taking care not to omit to get the absolute short-circuit current for the load—*i.e.*, that which corresponds to O A in Fig. 3—by finding O B from the short-circuit curve, measuring the resistance of the apparatus, and setting out

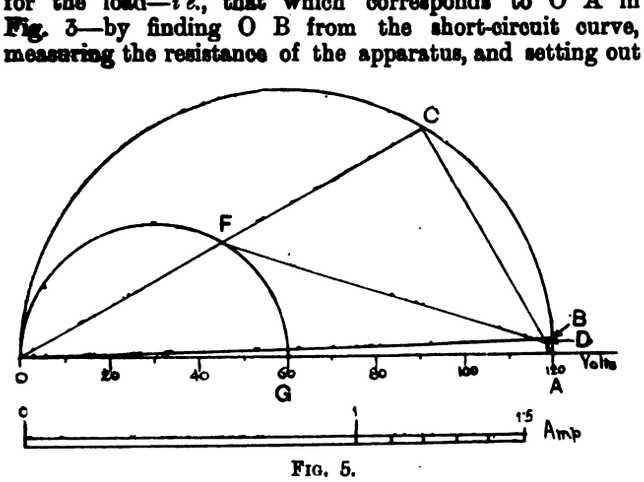

FIG. 5.

B A to represent the C R drop. An actual case will, perhaps, make this more clear. A transformer was connected to the alternator used above, and the exciting current of the alternator was raised until the voltage at the terminals of the primary was 120, while the secondary was short-circuited by a negligible resistance. The current was then found to be 3·2 amperes in the primary circuit, and the equivalent resistance of the apparatus was 0·6 ohm. A figure was then set out like Fig. 3: O B = 3·2, B A = ·6 × 3·2, O A = 120. It was then found that O A to the ampere scale was also practically 3·2. Upon altering the excitation of the alternator so that its open-circuit voltage was 120, and then short-circuiting it, the absolute short-circuit current corresponding to O A was also found to be 3·2 amperes. It follows that when with this latter excitation the alternator is connected to the transformer, and the secondary of the transformer is short-circuited, the absolute short-circuit current through the whole circuit would be 1·6 amperes, and the voltage at the alternator terminals 60.

Suppose, now, the secondary of the transformer is closed by a variable resistance, or, what is the same thing, an apparatus which by motion produces an E.M.F. tending to reduce the supply current (such as an induction motor). Then, as we have already said, the whole circuit will follow a semi-circle law, and we may draw a diagram like Fig. 3 straight away, as follows: Make O B = 120 volts to scale; upon O A describe a semi-circle, O C A (Fig. 5). Draw A B = R_c . C_s to the same scale in volts to which O A is drawn. (R_c = resistance of circuit, C_s = current on short-circuit.) Join O B, and calibrate in amperes, so that O A = 1·6 amperes. Take now on the semi-circle any point C, and join O C, C A. Then O C is the current in the circuit corresponding to a resistance (or energy) voltage C A. At A set out as before a semi-circle to give the C R_c drop in the alternator. Then C D is the voltage to drive the current O C against the resistance (or E.M.F.'s) in the rest of the circuit. Similarly, since $\overline{OC} + \overline{CA} = \overline{OA}$ = total voltage generated, O C = the total volts absorbed in overcoming the self-induction of the circuit = C. $(L_1 + L_2)\,p$. [Where $p = 2\pi \times$ frequency, f, and L_1 = coefficient of self-induction of alternator, L_2 = coefficient of self-induction of the load.] But $L_1 : L_2 =$

$$\frac{1}{\text{absolute short-circuit current of alternator}} : \frac{1}{\text{absolute short-circuit current of load}}$$

Divide O C then at F, so that O F : F C as L_1 is to L_2, and join F D. Then C F = O C × 2 π f L_2, and therefore the pressure at the terminals of the alternator is = F D volts.

Since the ratio $\frac{O\,F}{F\,C}$ is constant, and C moves on a semi-circle, F also moves on a semi-circle, having its chord along O A, O and F being points on the semi-circle. This has been shown in the figure, and completes the diagram for inductive load. O G is to G A as L_1 is to L_2. We, therefore, have the following rule for the diagram of inductive circuits: Divide the line O A, whose length has been already found, into two parts, O G, G A, so that O G is to G A as the absolute short-circuit current of the load is to the absolute short-circuit current of the alternator under similar conditions of P.D., as already explained. Then the values of the current are given by all such lines as O C, while the terminal volts are given by all such lines as F D. It is obvious that if we make the line O A to represent the short-circuit current of the alternator (instead of short-circuit current of load and alternator), we get C F, representing current in the circuit to the scale of O A instead of O C, as above, F D still representing the terminal voltage.

Two points remain to be discussed: (1) how to get the more important curve of *exciting current against load* for constant terminal voltage; (2) what is the effect of saturation upon the method employed. The second point influences the first, but its effect is easily seen.

To get the *load excitation* curve from these diagrams, we must draw a number of diagrams like Fig. 3 at different voltages, preferably upon the same base line. The open-circuit voltages are best taken from a magnetisation characteristic, the short-circuit readings from a short-circuit curve. It is not difficult then to prick off from the various semi-circles corresponding to the different exciting currents the current lines corresponding to a definite voltage, and these may then be plotted in the ordinary way. In Fig. 4 part of a second load curve has been drawn, corresponding to an exciting current of one ampere. If we desire to find the characteristic for constant voltage and varying load—*i.e.*, exciting current plotted against varying load—we get two points on the curve required from Fig. 4. As a rule, in practice one only requires two or three such curves, for all that is really essential is to know the exciting current corresponding to open-circuit voltage, and that corresponding to the same voltage at full load.

The effect of saturation is to lower the impedance of the circuit in which the saturation occurs, in consequence of

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the fact that the open-circuit voltage curve turns over quickly, due to saturation, the short-circuit curve also turns over somewhat. This may be allowed for in the diagrams by drawing O A (Fig. 3) first equal to the short-circuit current which would flow if the short-circuit curve were a straight line, and then setting out O A′ equal to the actual short-circuit current. A curve may now be drawn, starting at O and finishing at A′, which partakes largely in its first portion of the form of the semi-circle on O A. Naturally the semi-circle on O G in Fig. 5 will follow the same sort of shape. Though this process may be carried out with some success if necessary, I do not lay great stress on it, as I have found that within the working range of most alternators the impedance is practically constant. It will be seen that the curves shown above are taken with small currents, and it would be interesting to see results taken from larger alternators. At the same time, care has been taken to check the method carefully, and I have to thank Messrs. Pitkin and White for calibrating specially a low-reading ammeter.

The method here detailed enables the performance of an alternator to be predicted graphically when the following curves have been taken, neither of which necessitates the use of large power: (1) open-circuit characteristic; (2) short-circuit characteristic. Besides this we must know the resistance of the full-load circuit and its probable power factor, and the resistance of the alternator armature.

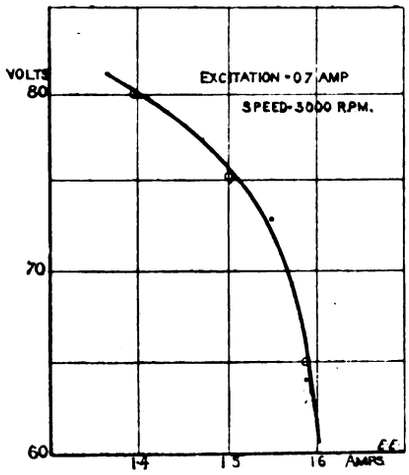

FIG. 6.

It may be noted, in connection with what has gone before, that since the circuits considered have been simple circuits, consisting of various self-inductive coils and resistances, with a definite sine wave of E.M.F. producing a definite current through them, the same sort of diagram would be applicable to all alternate-current circuits That is, that as the foregoing applies to an alternator, it will, with some modifications, apply also to a synchronous motor, and hence to any sort of alternate-current motor driven by an alternator.

In connection with the prediction of alternator characteristics, it is sometimes of interest to be able to foretell by simple geometric construction what will happen if, with a given load, the frequency is varied, the exciting current meanwhile remaining constant. Perhaps the simplest way to develop the construction is to put the well-known formula for alternate-current circuits in terms of the alternator speed. We have

$$C = \frac{E}{\sqrt{R^2 + 4\pi^2 L^2 f^2}},$$

where C = R.M.S. current in amperes;
E = R.M.S. E.M.F. in volts;
R = total resistance of the circuit in ohms;
L = coefficient of self-induction of the circuit in henries; and
f is the periodicity in cycles per second.

In the case of our alternator, all the above quantities refer, of course, to the complete circuit, so that E is the E.M.F. set up by the alternator itself. This is proportional to the speed so long as the excitation remains constant. In the denominator everything is constant except f, which varies directly as the speed, so that we might write

$$C \propto \frac{S}{\sqrt{R^2 + S^2}},$$

where S is the speed of the alternator. Set off a line then as O B in Fig. 7, and divide it up to represent the speed, obviously to another scale it may represent the E.M.F. developed by the alternator.

From the point O, and at right angles to O B, draw O A to a convenient scale to represent the resistance of the circuit in ohms. The length of this line will, of course, be constant, as we are supposing the alternator running on a constant load. Join A B, then A B is equal to $\sqrt{R^2 + S^2}$, and the current corresponding to speed S and resistance R is given by $\frac{S}{\sqrt{R^2 + S^2}}$ (*i.e.*, sin ϕ), ϕ being angle O A B.

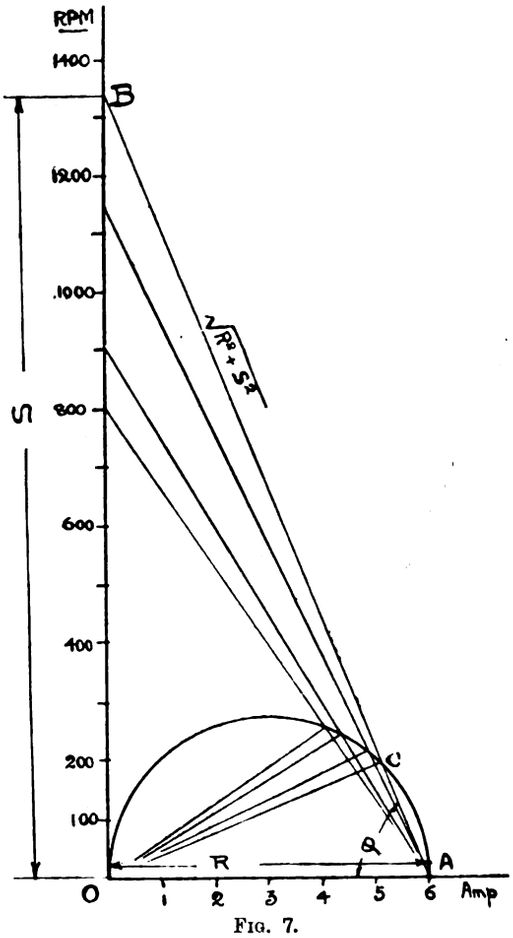

FIG. 7.

In order to get this sine in a more convenient form, from O upon A B let fall the perpendicular O C, then $\frac{O\,C}{O\,A}$ = sin ϕ. But O A is constant, therefore O C $\propto$ sin ϕ—*i.e.*, O C may be calibrated to give values of the current for the various speeds on O B. It will be seen that since O A is constant and O C A always a right angle, as ϕ varies the point C will move upon a semi-circle described upon O A, as shown in the figure.

We will now consider the two limiting cases of the diagram, which are (1) when C coincides with O; (2) when C coincides with A. In the former case B will coincide with O and, therefore, the speed is zero—*i.e.*, the alternator is at rest. In the latter case A B will be at right angles to O A; O A will be the current in the circuit and A B will be parallel to O B, so that the speed is infinite, from which it follows that no matter how fast the alternator run, there is a limit to the current in the circuit. This shows clearly that above a certain speed (say when the angle C O B is about 80deg.) the current in the circuit is practically constant, for O C is almost equal to O A at that time, and the length of O B, which represents the speed, changes from O B to an infinite length, while the current only changes

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from O C to O A. Now, the angle of lag of the current behind the E.M.F. is an angle whose tangent $= \frac{2\pi f L}{R}$ which $\propto \frac{S}{R}$. Clearly from the diagram this angle is ϕ.

We will now take a case to show how near this construction comes to actual practice. The Crypto alternator mentioned above was run with a constant resistance in circuit and a constant excitation in the field circuit of 1 5 amperes. Fig. 7 has been calibrated to show these readings set out, and it will be found from careful measurement that the agreement with the diagram is very close. The method used in setting out was as follows: It was found that the armature current only rose 0 1 of an ampere between a speed of 1,340 and 2,000; higher readings revealed the fact that the maximum current it could possibly give would be about six amperes. O A was then drawn to scale to represent six amperes, and on O A the semi-circle was described. To this scale a length was taken equal to 5·6, and from the point O the semi-circle was cut at C. A C was joined and the line produced until it cut O B at B. This point was called 1,340, and the distance between B and O divided off as shown. Upon then drawing in lines from speeds 1,444, 904, 796 to point A, and joining the intersections of these lines with the semi-circle to point O, the readings in amperes measured from O were exact to those found from actual experiment.

The above method of setting out the diagram, though it checks the method well, is not to be recommended for constant use. It would be better, knowing the open-circuit E.M.F. corresponding to any given speed and the current corresponding to the same speed, and the total resistance in the circuit, to set out the diagram by making O A equal to this resistance, O C equal to the current, and the intersection of A C and O B equal to the E.M.F. and speed. From this one reading O A and O B may be calculated. Thus, to obtain this diagram it is only necessary to take one experimental reading on any known load, and the corresponding reading on open circuit, and the construction is valuable to the designer as giving him a clear idea of what will be the worth of using an alternator intended for one periodicity for a periodicity slightly higher or lower.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

III.—On College Life.

My Dear Young 'Un.—You do not start your last letter very brilliantly. After informing me that you have entered College, you ask me on what subject you should specialise; as if a youth your age could afford to neglect anything! Specialisation at an early stage of development is a big mistake. Devote the first 10 years in your profession to getting an accurate general knowledge of it. There will be time enough to blossom out as a specialist when you have formed the necessary supporting-stem of general practice.

If you ask me what, in my opinion, is the fundamental study of all, I should pick mathematics. I am aware that the reading of this will give you a cold shudder, because you are constitutionally inaccurate. Maths. are the finest aid to accurate habits of thought I know of. Even if a man never has to use a differential in the whole of his engineering practice, the precision of thought acquired by the study will extend itself to other spheres of usefulness and make him a more valuable engineer. An inaccurate man is no good in our work. The days are gone when you could mark off the rivet holes in an iron plate by salivating on it Don't get away with the idea that mathematics are dry-as-dust. The further you get, the better you will see that high mathematics is imagination of the finest order, kept sane by science. Scientific discovery has been a race between the experimentalist and the mathematician, and often times the latter has come in first.

Next, build up your general physics. The electrical engineer who doesn't know a bit about heat, light, and mechanics is like a bird with one wing. If you can get a course of physical chemistry, hang into it, Electro-chemistry is the coming thing in our line

I have noticed that the majority of young fellows I have had to deal with cannot make a decent dimensioned sketch of a machine part without perspiring over it. Learn to handle the tee-square and compasses till your fingers itch for them. Make a practice of expressing your engineering ideas by firmly-defined sketches on the back of the nearest envelope. Learn to "graph" a curve instinctively—the "graph" is the engineer's shorthand. Carry a slide-rule in your breast-pocket, and learn how to use it without chancing the decimal point.

Having thus cleared a small space in the forest of your ignorance, commence to till the soil by going for general electro-technics. Again avoid specialisation. You may be going to become Marconi's chief assistant, but don't omit to learn the elements of dynamo design. You may turn out to be an electro-chemist, but study telephony just the same. At the same time, you should be laying a broad basis of knowledge by getting hold of the theory of heat engines (if thou understandest the temperature-entropy diagram, blessed art thou among men), hydraulics, strength of materials—they will all come in useful later on.

And amid all this stress of study, don't forget your *self*. You are not sent to College to obtain certain acquirements (things plastered on), but to get an education. Don't assume a superior smile when I remind you that *e duco* means to *draw out*. An engineering education is the development of the gift to make things go that is in you. If you only spend certain hours per day in cribbing notes of other men's thoughts, you will merely become a nasty little prig with a swelled head. Think for yourself. If you don't see a thing first off, stick to it till you *do* see it or fall in a faint.

One word about examinations. I am rapidly coming to the opinion that they are the Works of the Devil. It is better for a man that he should know one thing thoroughly than that he should slur over twenty things sufficiently well to write pretty paragraphs about them on the examiner's foolscap. The man with the carpet-bag head very often finds that he has left the clasp unfastened when he wants something he has bagged. I have known youths who could walk through an exam. on one leg who had to be licked for a year before they assumed practical shape.

Don't be a clever ass in the classroom. You may take it as an axiom that the man who is teaching you is human. Therefore, when you find that he has said on the blackboard that two and six make nine, don't think it is the time of your life because you have found the mistake, and don't lay yourself out to be humorous. You lose caste if you don't behave like a gentleman. I once knew a man who left a good job to become a college lecturer. He was up to his work, but he made the mistake of not having the skin of a pachyderm. The students found this out, and considered it funny. The lecturer therefore got nervous and depressed, and made unnecessary errors. Finally, he emulated the worm by turning. He told them that if he had them in a works behaving like that he would fire them out. As it was, they had paid their money and were entitled to their sport. But as he wasn't going to be the baited bull, he had resigned. Then the students considered him a bigger mug than ever. But they overlooked the fact that, being fresh from actual practice, he could have taught a class of gentlemen something worth knowing.

If you really want to be polite, laugh at the Professor's jokes. The professorial humour is like the judicial joke—it wants seeing. Sometimes it takes half an hour to see it; sometimes the vision never comes. But don't wait till then. Laugh vigorously when the Professor smiles hesitatingly. He will like you better for it, and will possibly spend 10 minutes with you after the lecture to clear up an obscure point.

Finally, when College life is done, and you are taking the class prize in the senior section, remember that you have only just begun. The time has come when you must forget you ever wore a top hat, when the dungaree suit will cover a multitude of sins, when a clean collar (always wear a clean collar—it is the emblem of a gentleman) will be the only relic of the past days. It is a long, high dive from the College to the Workshop. If you don't strip for it, and dive cleanly with a deep plunge, you will make a beastly splash and hurt yourself.—Yours, The Old 'Un.

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SINKING FUNDS—HOW DEALT WITH?

The finance of local authorities differs from the finance of individuals and companies in many directions. The terms used in these financial operations differ, although the results may be somewhat analogous. For some years we have had heated discussions as to what constitutes depreciation, in which we have taken a somewhat prominent part, with the result that our views have generally been accepted. It has long since seemed to us desirable that discussion was necessary on the question of sinking and analogous funds, especially as to the realities of these funds and the methods of dealing with them. No doubt once we have started the subject we shall have the usual splitting of hairs and straining at definitions and interpretations. Broad principles, or principles of any kind, are too often ignored by interested controversialists, whose energy is taken up in detecting archaisms or grammatical peculiarities. At present we are not troubling about minor details or differences, but only with the general question. A local authority obtains capital under compulsory legal disabilities of repaying that capital by instalments over a period of time determined by a Government department, and depending upon the nature of the work for the doing of which the capital is required. Hence the capital account of a local authority is a decreasing quantity, vanishing altogether in the course of so many years. The money set aside for the paying of the instalments of capital is usually termed the "sinking fund." We should say that companies have a fund with a more or less similar object and call it "reserve." Our point to-day is how the sinking fund or reserve is dealt with. Of course, if the instalments of the sinking fund are used at once to pay off a certain amount of capital, there is nothing to be said. That is the object for which the fund is created, and when so used is converted to its proper purpose. But financial operations cannot always be conducted in so simple a manner. Investors often require investments of a somewhat permanent character, hence the instalments of the sinking fund are allowed to accumulate till the period arrives when capital can be extinguished. We hold as a fundamental axiom that sinking fund or reserve should always be liquid—that is, subject to no fluctuations in value and realisable at the moment. If equivalent capital cannot be extinguished at once—and the interest paid on capital is greater than the interest obtainable on the sinking fund under these conditions—then the sinking fund is not what it purports or is intended to be. The line in many balance-sheets, "SINKING FUND—*Investments*," may be very misleading. Under the fundamental axiom just enunciated, a sinking fund should not be invested in any business, for the result of no business is certain. Unfortunately, it is becoming more common to invest the sinking fund in extensions of the original undertaking. This we hold to be a mistake of the highest order. The success achieved by investments in commercial undertakings may give a far better result than by dealing with them in any other manner. But that is another question. The fund is prescribed for a certain operation, and it should be an absolute certainty to be always available to be so used. All commercial undertakings are risky, and we say sinking funds should not be risked. If our reading of this matter is correct, a local authority, instead of paying from 2½ to 3½ per cent. on its outstanding capital, may be really paying 20 or 30 per cent. We are not going to attempt to give the exact legal position with regard to the accumulation and investing of sinking funds. Some time ago there was a controversy as to which of two ways was the better for paying the instalment, but the accumulating and

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investing is a third way, and we think the worst of the three. The exact use of the reserve of a company is hardly to be defined. It has many valuable uses, all of which are good and legitimate. The one use, however, to which we object is that in which it is treated as capital for extension purposes. A company having £3,000 or £3,000,000 capital, with reserve £1,000 or £1,000,000 respectively, uses this reserve to capitalise a company needing £4,000 or £4,000,000. It is then not liquid, but liable to any and all the fluctuations, losses, or gains of commercial enterprise, and thus has its own risks, which, in the nature of affairs, it is not intended to have. It becomes not really reserve, but an undistributed amount by the grace of the shareholders utilised for capital to improve their concern. It is not available in bankruptcy.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY AT GLASGOW.

SIR,—The paragraph appended to my letter in your last issue shows how difficult it is for a writer not thoroughly familiar with the subject of telephony to be consistent in dealing with telephone questions.

For example, "The Writer on Telephony" (with my statement before him that my argument at Glasgow in 1897 was that the proposed scheme provided too little plant in proportion to working subscribers) says, first, that I am convinced against my will; and then that I hit the goal, though by accident, not by intention. Apart from the fact that goals count, whether made accidentally or otherwise, there seems to be some confusion of thought here.

The "W. O. T." says that I "will not, perhaps cannot, see that there is absolutely no connection between estimates for one thing and costs for another." This is hardly polite, but again it proceeds from confusion of thought and lack of understanding of the subject. The estimate of 1897 was for a "Glasgow municipal exchange" to serve the Glasgow Post Office telephone area. The size of the area has not changed since, though the size of the system has. The arguments made in support of the estimate in 1897, however, were to the effect that the cost per subscriber would not grow materially even if the system grew to 20,000 or 25,000 subscribers, and undoubtedly that was the belief of those interested in the estimate. Apparently what is running in the mind of "W. O. T." is that the estimate was put forward with some such argument as the following: This is an estimate for an exchange of 5,200 subscribers in Glasgow and the neighbourhood, but they must be exactly the subscribers we have picked out, and they must come exactly where we have put our little dots on the maps, and they must number exactly 5,200. Then it will cost £97,833. 3s. 8d., or £18. 16s. 3d. per subscriber. But if we do not get exactly the 5,200 subscribers we have chosen, if they do not come exactly on our little dots, but choose other little dots for themselves, and if they should by any chance exceed 5,200, then the cost will be something quite different—it may be £25, £30, or even £35 per subscriber.

But the estimate was not put forward in that way at all. It was supposed to afford the Glasgow Corporation a reliable guide to the cost per subscriber of telephoning the Glasgow area. The Glasgow area is the same to-day as it was in 1897. It is because the cost of telephoning a large area was not understood in 1897 by the framer of the estimate, that the actual cost per subscriber's line in 1904 is nearly double the estimated cost.

The simple problem set by "W. O. T." is not so simple as it appears, and "W. O. T." will pardon me for saying that he makes it still less simple by confusion of terms and by confusion of expression. He starts by referring to capital cost per *instrument*, and then wants to double the number of *subscribers*. The instrument and the subscriber are two different units; as different, for example, as the lamp and the consumer in electric lighting supply. An instrument may represent a complete subscriber's line, with all the line material and exchange plant that that implies, or it may represent simply a telephone set with a few yards of inside wiring. It may represent several combinations of instrument and line material in between those extremes. The average cost per instrument, then, will depend on the proportion of the different classes of instruments in the system. For example, suppose a system of 1,000 subscribers' lines which has cost £20,000; the average capital cost per subscriber is £20; 200 of the subscribers take inside extension instruments, which cost £3. 10s. each to instal; the total cost then becomes £20,700, and the average cost per instrument £17. 5s. Suppose 400 subscribers take extension instruments, then there is total capital £21,400 and total instruments 1,400; average cost per instrument, £15. 6s. If all the subscribers took extension instruments, the average cost per instrument would be £11. 15s.

This little example shows that you must start fair by estimating according to the unit you are going to adopt throughout. If you estimate by subscribers' lines, you should stick to subscribers' lines, and value the extra instruments in your system at what they cost. If you adopt the instrument as the unit in estimating, you must allow in the estimate, at their proper cost, for a certain proportion of each of the different classes of instruments you are likely to be called upon to provide. In the original Glasgow estimate the cost of the instrument, completely fitted, was put at £3. 14s. If, say, 10 per cent. of extension instruments had been allowed for, there would have been added to the estimate 520 instruments at £3. 14s., or £1,924. The total estimate would have been £99,757, and the average estimated cost per instrument £17. 8s.

As a matter of fact, the Glasgow estimate took the subscriber's line as the unit, not the instrument Indeed, the report of the Glasgow enquiry shows that extension and private instruments were looked upon as a sort of by-product which would bring in extra revenue without requiring extra expenditure of capital. Now that the system has been built, and the results have soared far above all estimates, the instrument is used as the unit in order to arrive at an average figure which comes somewhere near the estimated figure. A single item in the Glasgow statistics shows how artificial this figure really is. The average cost per instrument is put at £28. 2s. 6d. The statistics show that there are 1,081 inside extension instruments. The capital account shows that the total subscribers' and public instruments stand on the books at £50,020, which, for 11,405 instruments, is an average of £4. 7s. per instrument. Therefore, these 1,081 inside extension instruments really stand at £4. 7s. each, or a total of £4,702. 7s. Is it not manifestly absurd to represent them as standing at £28. 2s. 6d. each, or a total of £30,403? And, lest "W. O. T." be misled by a certain ingenious theory of the relation between inside extensions and spare lines, let me point out that an inside extension station is merely an extra facility which can be added or taken away without any regard to spare lines. An inside extension station has no more relation to a spare line than my back drawing-room has to an empty house in the next street.

I trust this little dissertation on lines, instruments, and telephone estimates will be of interest to "W. O. T." and to others of your readers. The subject is of sufficient importance to warrant it being made clear. I now return to "W. O. T.'s" little problem, but I should like to say that the conditions he premises do not apply to the original subject of discussion. The Glasgow area has not only not doubled in radius, but it has not increased by a single square inch between 1897 and the present date. Therefore there is no x about the Glasgow area. The estimate was for a service in the Glasgow Post Office telephone area, which has remained unchanged. The contrast between the results and the estimate is certainly largely due to the effect of the area, but the difference has arisen because of the underlying error in the estimate, which did not give due weight to the effect of area, not, as "W. O. T." seems to suppose, because there has been an increase of the area. This was part of my original criticism of the estimate—that it did not reckon with the effect, in

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plant required per subscriber, of offering service at a low flat rate over such a large area. As to the problem, of course it is "a fundamental fact" that a controlling factor in determining the size of a telephone plant is area. To put it more correctly, there are three controlling factors—area, traffic, and number of subscribers; to which might be added a fourth, density of distribution of subscribers; and a fifth, rate of growth. It is because these factors were not sufficiently considered in framing the Glasgow estimate of 1897 that that estimate has proved so delusive.

Let me tell "W. O. T." that you cannot proceed with estimates for telephoning great cities by *x*'s and *y*'s. It is the belief that you can which has produced so much confusion. You must study the actual conditions of each individual case, and you must lay out your system and calculate your costs according to those conditions. The conditions vary widely, hardly any two places having identical characteristics from a telephonic point of view. Taking "W. O. T.'s" theoretical problem, if you have a system serving a given area, and you quadruple that area by taking in, as "W. O. T." suggests, double the radius, the average capital cost per subscriber for a uniform flat-rate service will certainly be increased. It will not necessarily be doubled, but its relation to the average capital cost in the smaller area, quality of plant being the same, will be governed largely by the factors above mentioned—the traffic, the number of subscribers obtained, the density of distribution of those subscribers, and the rate of growth to be provided for; while, of course, the local conditions as regards cost of executing work will have their bearing.

I do not wish to add to the length of this letter, which has almost become an essay, by biographical details, as I am essentially a modest man. But "W. O. T."—no doubt an experienced telephonist himself—is good enough publicly to question my experience. I did not put up the first telephones in London. In fact, during the embryonic stage of telephony, the period of overhead single wires, crude apparatus, and rule-of-thumb methods, I had little connection with the telephone industry, although I did some telephone work even then, as your pages, Sir, have recorded in bygone days. But since 1899, or shortly after the time when telephone work began to assume a scientific aspect, I have been intimately connected with telephony, and 13 out of those 15 years I have spent as a worker—a humble worker, it is true, but, nevertheless, an attentive observer—in the system which has grown to be the largest telephone system in the world, and is to-day the best equipped and most efficient telephone system in the world. In those 13 years there have been many changes, many problems, a vast quantity of work executed. I submit that one of average intelligence cannot have spent all that time in close touch with such conditions without acquiring a certain amount of experience applicable to telephone questions of all kinds. New York is the Mecca of telephone engineers from all over the world—from Austria-Hungary to Japan. If "W. O. T." really wants to learn something about telephone work, I should advise him to join the Institution tour and to spend all his time in the telephone buildings of the towns visited. It will be an interesting experience for him.

As a further note on my own limited experience, I may say that I have on several occasions visited the principal European countries with the express object of inspecting the telephone systems, and that there is hardly a capital in Europe, from Christiania to Lisbon or from Amsterdam to Budapest, where I have not inspected the telephone system and gathered information regarding telephonic conditions generally. Whether I have much experience of my own or not, I have certainly gathered a goodly stock of that of others. They say that is how wise men learn.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, S.W., Aug. 5, 1904.

Many thanks, Mr. Editor, for permitting me to see and to reply to Mr. Webb's letter at once. I am sorry to disagree with Mr. Webb, and I have no intention nor desire to be unpolite; rather the contrary, and especially with Mr. Webb, whose energy and abilities I admire. But—and 'tis a big but—my forte, if I have one at all, is plain speaking. I think Mr. Webb in this controversy is wrong; utterly, irretrievably wrong. He is not controversial; he is simply calling a man a liar. That is plain to the point, and intentionally so. Misconception, or ignorance, may be the excuse. These charges are so easy to make, so difficult to refute. Mr. Webb attributed these things to me. I do not object, though I deny the soft impeachment that I lack intelligence, have confusion of thought, or do not understand the subject. In a nutshell, Mr. Webb's criticisms are all based upon an assumption that an 1897 estimate of Mr. Bennett's was an estimate for the work he (Mr. Bennett) has done at Glasgow. It was not. Mr. Bennett emphatically denies it. The two had no connection with each other, and therefore comparisons arising out of figures of estimate and figures of actual cost, etc., are absolutely misleading. Here is what Mr. Bennett says, and I for one accept the statement as the truth, the whole truth, and nothing but the truth:

> The 1897 estimate was made for a special purpose. The Telephone Committee said: "We want you to give us estimates showing what the existing telephone system in Glasgow ought to have cost the National Telephone Company." I took it from the Telephone Company's list that there were practically 5,000 subscribers in the city, and to meet the requirements of the Telephone Committee I prepared an estimate for 5,000 lines: but at the enquiry I said, "If the Town Council proceed with the scheme and entrust me with the work, I shall not recommend a system of 5,000; the present estimate is simply to show the Commissioners what the 5,000 ought to cost. I shall go in for a very much larger scheme." When the time came the Council decided to go in for a very much larger scheme, and called for an estimate, which was, of course, considerably higher. Now, the articles which appear in the *Electric Review*, *Engineering*, and so on, attacking corporation telephones, invariably take the first estimate—the one for 5,000—which was made as a comparative one with the company's system, and compare it with what we have spent on the later and larger scheme. It has been pointed out many times that that is most unfair, and is not to the purpose at all, but they go on doing it all the same. Then Mr. Webb says that even the last estimate has been exceeded. That is true, and for this reason, that the Telephone Committee said to me, some time after we had started, "Take your underground lines out to the suburbs; distribute underground in the city; look well ahead, and avoid reopening of streets; don't be afraid to spend money." As the estimates had only provided for overhead distribution in the city and to the suburbs, the extra expenditure is accounted for by the change of plant which was demanded by the committee, and by the spare plant provided. It is no more reasonable to hold me to the original estimate, than to expect a tramway engineer to lay down a double line or track at the cost estimated for a single line.—"*Corporation Telephones, etc., with full discussion. Vide pp.* 58-59.

All I have written has been written upon the understanding that what Mr. Bennett has said is true. Just a word or two about the expressions in my tag of last week. Mr. Webb misinterprets slightly "a man convinced, etc.," referred to the acceptance by Mr. Webb of the term "academic," as did the word "goal." I agree Mr. Webb has had practical experience, but think that Mr. Bennett's practical experience is much greater, hence prefer the greater to the less. That means no disparagement to Mr. Webb, for sooner or later youth must tell as against age. The "old un's" sometimes stereotype their experience, won't and can't go with the times, and then the younger push them aside. It is just possible that Mr. Bennett may be held to be one of the stereotypists. As yet I imagine he has not entered that category, but is wide enough awake to accept improvements. Here is the point where I think Mr. Webb and other energetic men with him are doing good work. It is good for them to discuss whether the system adopted by Mr. Bennett is antiquated and less efficient than another, and for us to have his reply. Stick to such criticism and I shall praise, not blame. My objection is that when a man makes a plain, straightforward, considered statement, it is not believed, and hence a scarecrow is set up to be knocked down. If that kind of thing pleases Mr. Webb, it does not please me, and I say so. I agree the units "instruments" and "subscribers" are not the same, but Mr. Webb can take which he chooses. He evidently agrees with me, that area of which the units are spread, not the units, determine largely (I agree not wholly) the cost of trenching, ducts, etc. I never intended to imply that *x*'s and *y*'s would enable you to estimate. I gave a simple

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problem to indicate that x and y were not necessarily multiples of each other. It was Mr. Webb who rather suggested they ought to be, by hinting there was something abnormal in length of wires, trenching, and ducts, not proceeding in proportionate multiple as did the units. I have no objection to fight out telephonic questions, but until men's words are honourably accepted what is the use?—W. O. T.

ARTIFICIAL LOADS.

SIR,—In his zeal to emphasise the importance of certain articles and discussions which occurred at periods ranging from "some years ago" to "2½ years ago," the critic yclept "Yrreb" has, I venture to suggest, viewed the article on "Artificial Loads," appearing in your issue of the 22nd ult., from a somewhat prejudiced standpoint.

So far as I can see, the article claims no originality, but is a very useful summary of methods in use for obtaining an artificial load, with the description of a conveniently compact apparatus for this purpose. The whole question is begged in the critic's phrase, "with ample electrode surface." There is not much room to spare in many stations for auxiliary plant of this kind, and any data giving the minimum bulk necessary are very welcome. Mr. F. W. Davies points out the desirability of doing without acids or alkalies to reduce the resistance of the water, and emphasises the alternative method—a rapid changing of the water.

The jest which is attempted regarding the length of test run is futile, as the critic will see on a more careful perusal of the article. A permanent water resistance should have some approximation to constancy. Nothing is more aggravating than to waste steam while "playing about" with the load. My own experience has been that not only does the resistance of canal water vary with the period of the year, but fluctuates largely during a test. Repeatedly the load in an engine under test fell at one instant to almost half value, at another time a heavy excess load being thrown on the engine, owing possibly to a film of oil carried into the tank with such water. How can accurate cards be taken under such conditions?

If the insulation of an alternator or dynamo cannot stand the earthing of one pole, how will it go on when an "earth" develops on the cables? No supply company will give an undertaking to their contractors that "earths" will not occur. Added to this is the risk to human life in working with unearthed apparatus (particularly with bubbling water) at high potentials.

Your critic does good by drawing attention to previous notes on the same subject, but the tone of his letter suggests that the last word on artificial loads was long ago said. It is humiliating, therefore, to have to say that busy engineers, unable to find time for research, are always glad to have practical ideas brought anew to their notice.—Yours, etc.,

A.M.I.C.E.

SIR,—With reference to "Yrreb's" criticism of my article in your issue of July 22, I do not, of course, claim originality for the testing tank described; such methods are, I am aware, in common use. It was included in the article because, having been thoroughly successful, the dimensions and general design might be of use to others interested in the subject. I would remind "Yrreb" that, perhaps, all are not so well up in testing tanks as he, and that the publication of successful designs is the only method of forwarding general knowledge. I cannot at all agree that it is not always advisable to earth the outer tank—that is, when machines of 500 volts and over are being tested. The precaution is obvious and necessary, considering that the lives of the attendants are at stake. Besides, in practice a 500-volt direct-current machine, or high-tension single-phase alternator, will run with its negative or outer earthed; therefore, what is the harm in testing it under its proper running conditions? Such a proceeding obviously reduces the insulation resistance, but only to the amount that the machine will be required to work at in practice, and if it is going to fail, it is surely better that this should happen on test than when in regular commission. Regarding the question as to how long I would run a test, "Yrreb" has completely misunderstood me; my remarks were solely applied to station work. It is surely possible either in a testing shop or central station that two similar machines may have to be tested at different seasons of the year, in which case, from the causes stated, an arrangement fitted *in* a canal, although suitable, say, in summer, may be absolutely useless in the winter, and *vice versâ*. Canals doubtless do vary in this respect, but a word of warning may cause preliminary tests to be made before installing a permanent arrangement, and so, in a bad case, save money and trouble in subsequent alterations. In any case, from my experience of various canal waters, I do not like them, and have known the conductivity of a tank fed with such to alter considerably in a few minutes owing to a local stream of impurities having found its way in.

I am in accordance with "Yrreb" as regarding the use of chemicals, and in my article distinctly state that it is best to do without them. I, however, recognise that it is possible occasion may arise when a small addition might be of great service in getting, say, the last few amperes of the load, and in such a case I advocate the use of salt or soda over sulphuric acid. We cannot always have perfect apparatus, and sometimes this sort of thing is necessary. In anything but the smallest quantities, say for the above purpose, the use of chemicals is a mistake.—Yours, etc.,

F. H. DAVIES.

RE BELT CALCULATIONS.

SIR,—Referring to the questions which appeared in the *Electrical Engineer* for July 29, 1904, regarding some method for determining the best or proper length of belt drive in cases where the driving and driven pulleys are of different diameters, I beg to say that a good method is to add together both the pulley diameters and multiply the sum by the ratio of the two diameters, when the result will give the most useful length of drive for any reasonable ratios. For example, take a case where a 3ft. diameter pulley is driving a 1ft. diameter pulley. Then by the rule $(3+1)\times 3=12$, which, measured in feet, will be the distance required between the two shaft centres. Taking two more pulleys of 5ft. and 2ft. diameters respectively, then $(5+2)\times 2{\cdot}5=17\frac{1}{2}$ft. distance from centre to centre; or, again, a 3ft. diameter pulley driving one 11ft. diameter, then $(3+11)\times 3{\cdot}7=51{\cdot}8$ft. approximately. It will be seen on working out that by using this method both the angle of belt, which is about 10deg., and the arcs of contact are fairly constant for any reasonable ratios of pulley diameters. It can also be shown that anything above these lengths is simply a waste of leather.

With reference to the question by "N. L. G." *re* belt thickness, I may say that, generally speaking, it is only in cases where a belt is running on a pulley of small diameter that the question of thickness of leather need be considered. A rule I have always used is as follows: take $\frac{1}{16}$ of the square root of the diameter of the pulley in inches, and the result will be the most serviceable thickness of leather to employ for small pulleys.

For example, take a 2in. diameter pulley, then $(\frac{1}{16}\sqrt{2})$ inches $=\frac{3}{32}$in. thickness. Take another pulley, 4in. diameter, then $(\frac{1}{16}\sqrt{4})$ inches $=\frac{1}{8}$in. thickness; or a 6in. diameter pulley, then $(\frac{1}{16}\sqrt{6})$ inches $=\frac{3}{32}$in. thickness; again, a 9in. diameter pulley, then $(\frac{1}{16}\sqrt{9})$ inches $=\frac{3}{16}$in. thickness; again, a 16in. diameter pulley, then $(\frac{1}{16}\sqrt{16})$ inches $=\frac{1}{4}$in. thickness. This rule is only needed for diameters less than 24in.; above this any thickness of leather may be employed. Both these rules are original, and will be found useful and thoroughly consistent with good practice. Yours, etc.,

THE WRITER OF THE ARTICLE.

P.S.—Another way of stating this would be to take a pulley, say, 9in. diameter. Then by the rule the $\sqrt{9}=3$, and this should be understood as being $\frac{3}{16}$in., which would be the proper thickness of leather for that pulley.

"THE OLD UN'S" ADVICE.

SIR,—I have enjoyed reading the letters of your humorous contributor immensely, and hope "The Old Un" will take my remarks in the spirit in which they are

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written. It seems to me that working, in order to become acquainted with the practical side of engineering, is one of the ways not likely to recompense "a young one." As far as my experience goes, it is the "paper engineer" who rules the roost, who gets *all* the honour and *most* of the dollars. Let the aspirant to success as an engineer throw work, like physic, to the dogs; let him rather go in for study, and make as many influential friends as possible. Learn not so much how to *do* things as how to *talk* about doing them. Theory and practice are both good, but the better of the two is theory.—Yours, etc., M. M.

ELECTRIC TRAMWAYS IN THE EAST.

It is satisfactory to learn that, despite the keen competition which exists in the East for electrical work, at least one English firm is able to secure large and inclusive contracts for electric tramways and lighting. Following up previous successes, Messrs. Dick, Kerr, and Co., Limited, have recently obtained a contract for electric tramway plant and material for Bangkok tramways, owned by the Siamese Tramways Company, Limited. The contract includes power-house equipment, which consists of three 200-kw. 500-volt direct-current generators coupled direct to three Browett-Lindley vertical compound engines, and the usual accessories, including surface condensers, pumps, etc. There are also 40 single-motor equipments of the firm's 25B type mounted on Brill 21E trucks, and the whole of the rails, fishplates, tiebars for the line, which has a total length of 13½ miles.

Of the other contracts which Dick, Kerr, and Co. are carrying out, the Mandalay tramways have just recently been successfully opened by the Lieutenant-Governor of Burma, Sir Hugh Barnes, K.C.S.I., K.C.V.O., and the system is now in operation. We shall shortly be publishing full details of these tramways; in the meantime we would mention the principal features of the system. The total length of the tramways is 12 miles of single track, laid to a gauge of 3ft. 6in. with rails of the girder type weighing 85lb. per yard. The overhead equipment is on the span-wire system, and is of a very neat and rigid design. The rolling-stock consists of 24 single-deck, open, cross-bench cars to accommodate 48 passengers, built for Dick, Kerr, and Co. by the Electric Railway and Tramway Carriage Works, Preston. The cars are mounted on Brill maximum trucks, each car being supplied with a complete electrical equipment, consisting of 25B motors with DB1 form "C" controllers. The power-house equipment consists of three direct-current, compound-wound, 200-kw., 400 revolutions per minute, 500-550-volt generators, direct coupled to three Belliss compound engines. The switchboard is in accordance with the standard traction practice, and consists of four feeder panels, three generator panels, one testing panel, and one panel for motor and lighting circuits.

The electric tramways of Hong Kong are rapidly approaching completion, the contractors again being Messrs. Dick, Kerr, and Co. The total length of single track is 14½ miles, and is laid to a gauge of 3ft. 6in. with girder type rails weighing 86lb. per yard. The overhead line within the city is centre-pole construction, but outside the city boundary is equipped on the side-pole system. The power-house is as nearly as possible in the centre of the system. The plant consists of two direct-current 300-kw. railway generators of the multipolar type, compound-wound, running at a speed of 100 revolutions per minute at 500 volts, direct coupled to the main shaft of two engines built by Yates and Thom. In addition to the two traction sets, two combined sets for arc and incandescent lighting of the depôt have been installed. The switchboard consists of two generator panels, two feeder panels, three lighting panels, one main station panel, and one Board of Trade panel. The boiler-house contains two Babcock and Wilcox watertube boilers and the usual accessories. Twenty-six single-deck cars are provided, 10 being of the combined type, with an enclosed portion in the centre and an open platform with seats at either end, and have a seating capacity for 32 passengers; the remaining 16 cars are of the open cross-bench type, to seat 48 passengers. Each car is mounted on a Brill 21E truck, and is fitted with two standard four-pole series-wound motors of 25 h.p., and at either end of the car is one of the firm's standard DB1 form C controllers. As this is the pioneer system of electric traction in China, it is to be hoped the venture will meet with a well-deserved success, and that electrically-equipped lines will shortly be laid in other parts of the Celestial Empire.

Singapore tramways are in the hands of the same contractors, and are making considerable progress. The power-house contains eight Lancashire boilers, with the usual accessories, including two fuel economisers and four feed pumps, three engines, two of Yates and Thom's horizontal cross-compound condensing type, coupled direct to two of Dick-Kerr's standard 500-kw. 100 r.p.m. 500-volt compound generators. For lighting purposes a 200-kw. plant has been installed, including one direct-current generator of 150 kw. capacity coupled direct to a Willans engine, also a 50-kw. motor-driven generator working off a circuit of 550 volts. A suitable switchboard has been supplied and erected by the contractors. The overhead work has been carried out on the span-wire system. The total length of single track is 27 miles, and is laid to a gauge of 1m., and the form of construction consists of laying girder type rails weighing 95lb. per yard upon a continuous beam of concrete. The rolling-stock consists of 50 cars, 20 single-deck single-truck combination type, with a seating capacity of 32 persons, 16 inside and 16 outside, and 30 open cross-bench type to seat 40 persons. They are mounted on Brill 21E trucks and equipped with 25B motors and DB1 form "C" controller. In addition, there are 33 goods vans mounted on Brill 21G trucks, each with a double-motor equipment, the whole of the rolling-stock being built by the Electric Railway and Tramway Carriage Works, Preston.

Lastly, that most successful tramway owned by the Calcutta Tramways Company is carrying out considerable extensions, and this work has been entrusted to the original contractors—Dick, Kerr, and Co., Limited. This includes an additional 10 open-type motorcars, in all respects the same as those supplied before—*i.e.*, single-deck open-type cars, mounted on Brill 21E trucks, and equipped with two 25A motors, each with a DE1 form C controller. The main station plant is being increased by one of Dick-Kerr's standard three-phase alternators, 500 kw., 25 cycles, 6,000 volts, 94 revolutions per minute, direct coupled to a Yates and Thom horizontal cross-compound engine, and a switchboard built by Dick, Kerr, and Co. There are two sub-stations being erected, in which will be placed a 300-kw. rotary converter, with the necessary transformers and switchgear.

SINGLE-PHASE MOTORS—V. A. FYNN'S PATENT.

The following notes gives a brief description of the latest type of repulsion-induction motors which has been placed on the market. They are supplied by Messrs. Witting, Eborall, and Co., who have sent us the following particulars:

The motors are manufactured under Mr. V. A. Fynn's patents; they are of the commutator type specially designed to give a large starting torque with a comparatively small current consumption, and are specially suitable for lift and crane work. In these motors the rotor has two interconnected windings, the ends of the one being connected to slip-rings, and the ends of the coils of the other to a commutator. The winding of the two-pole machine is given in the accompanying diagram. The stator has simply a standard three-phase winding.

In the larger sizes of motors the brushes on the commutator are connected through a variable resistance which is gradually cut out as the motor starts, and is short-circuited in the running position. In the smaller motors the brushes are permanently short-circuited. The brushes are fixed once for all, and no adjustment for these is necessary. The slip-ring brushes are connected to a resistance exactly similar to the starter of an ordinary three-phase motor. The construction of the motor is such that at starting it operates as a repulsion motor, and at full speed as a synchronous motor; at intermediate speeds the motor works partly as an induction and partly as a repulsion motor. Sparkless running of the brushes is guaranteed

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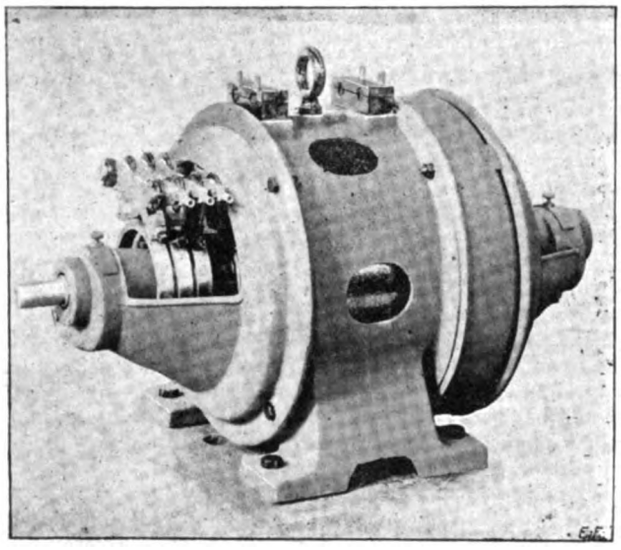
at any speed. A set of curves are here given to show the performance of a 220-volt 50-cycle 4-b.h.p. motor.



Single-Phase Commutator Motor (Fynn's Patent)

With regard to the starting performance generally, the makers guarantee that when starting with a torque equal to that at full load, the starting current will not exceed three-quarters of the full-load current; or when starting

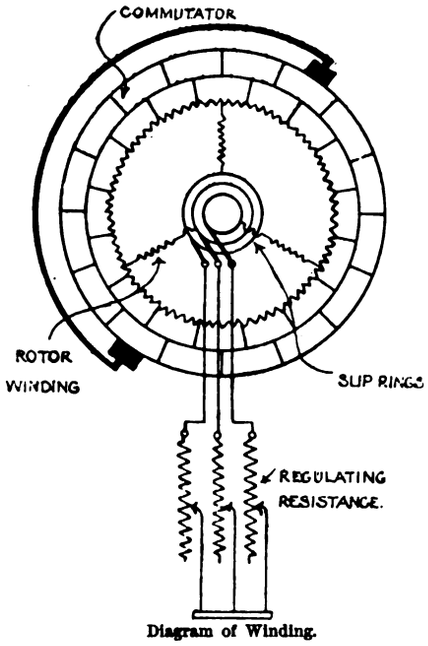
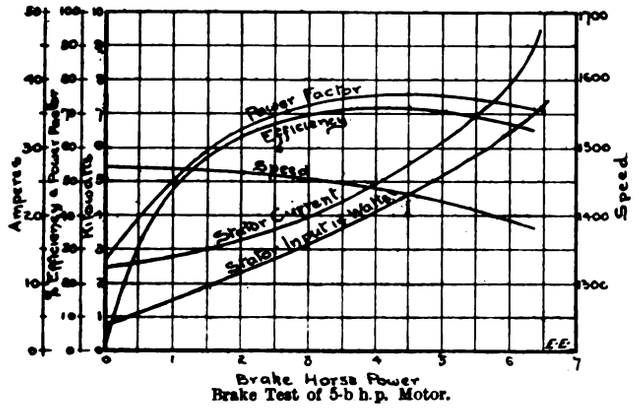


Diagram of Winding.

with a torque equal to twice that at full load, the starting current will not exceed 1½ times the full-load current, it being assumed that the pressure at the terminals on the stator remains constant. Those who have had experience



Brake Test of 5-b.h.p. Motor.

with single-phase motors will realise the excellence of this starting performance.

As stated above, the motors are specially suitable for lifts and hoists, but they can be equally well used in other classes of work; however, where a large starting torque is not specially required, the standard induction motors are usually preferable on account of their lower price, and of the absence of the commutator.

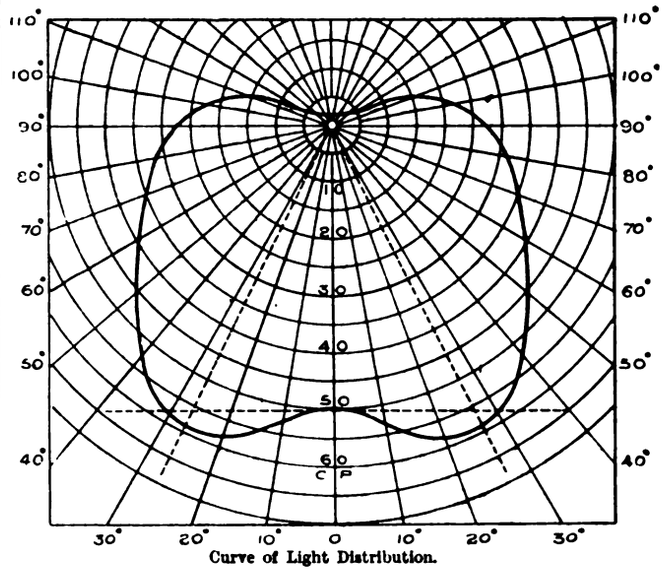
TRADE NOTICES AND NOVELTIES.

The B.T.H. Meridian Lamp.

A lamp to fill the existing gap between the ordinary incandescent lamp and arc lamp should be as simple as the former, and should have an efficiency approaching at least that of the latter. These requirements are met, it is claimed, by the

B.T.-H. Meridian Lamp.

B.T.H. Meridian lamp. This, according to a description for which we are indebted to the British Thomson-Houston Company, Limited, Rugby, is a new type of incandescent filament lamp, having a large spherical globe and translucent prismatic reflector. The lamp is specially designed to give an almost



Curve of Light Distribution.

perfect distribution of light in the lower hemisphere with a comparatively small expenditure of energy. The bulb is obscured, and when the lamp is burning it has the appearance of a globe of soft, brilliant white light. The excellent light distribution in all useful directions is shown in the accompany-

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ing diagram. The maximum candle-power is about 58 at an angle of 30deg. from the vertical, and an average candle-power of about 55 is well maintained over an angle of 60deg. The dotted triangle shows that this peculiar distribution produces a practically uniform illumination of great intensity over a circular field, whose diameter approximates its distance below the lamp. The lamp has been specially designed to give this distribution of light, which makes possible efficient illumination from a source of light above the line of vision—a method of lighting involving the least strain on the eyes. It is, therefore, particularly adapted for ceiling suspension, and is not intended to be used on wall brackets or side fixtures. For drawing offices, libraries, and similar places, the globes should hang about 4ft. or 5ft. above the desks or tables, and for general illumination they should be about 8ft. to 12ft. above the floor, depending upon the reflecting power of the walls and ceiling. The Meridian lamp is specially adapted for show-window, shop, and office lighting, and in general for all kinds of illumination where a downward distribution is desirable. To obtain the best lighting effect in art galleries the source of light should be above and behind the observer. Meridian lamps, either singly or in groups, exactly meet the requirements.

CHESTER TRAMWAYS ACCOUNTS.

The statement of accounts for the period from April 6, 1903, to March 25, 1904, shows a total expenditure on capital account of upwards of £66,000. Appended are abstracts of the revenue account and general balance-sheet.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Power expenses—current from Lighting Committee	1,743	4	8
Traffic expenses—wages, uniforms, etc.	2,296	9	9
General expenses—salaries, rents, rates, etc.	900	19	10
Repairs of permanent way, cars, motors, etc.	391	11	9
	5,332	6	0
Balance carried down	3,584	0	11
	£8,916	6	11

Cr. Income.	£	s.	d.
Traffic cash receipts	8,881	5	6
Conveying parcels	5	17	2
Claims for damage to cars	4	12	2
Advertising on tramway tickets	11	19	2
Sundry receipts	12	12	11
	£8,916	6	11

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—loans on mortgage, less redeemed	67,191	0	0
Sundry creditors	499	11	1
Balance at credit of net revenue account	340	11	2
Sinking fund account, less mortgages redeemed	917	14	0
	£68,948	16	3

Cr. Assets.	£	s.	d.
Capital account—amount expended	66,097	17	11
Sundry debtors	442	5	11
Balance due from treasurer	2,401	2	5
Cash in hand	7	10	0
	£68,948	16	3

PERSONAL.

Mr. M. D. Keith Murray, D.L., has been appointed town clerk of Thurso in room of the late Mr. A. Manson.

At the Rochdale electricity works last week Mr. Fred. H. Rudd, station superintendent, was, on the occasion of his marriage to Miss Annie Crompton, of Bolton, presented with a beautiful barometer mounted in an oak frame suitably inscribed, a case of silver serviette rings, a case of pipes, etc.

APPOINTMENTS VACANT.

Resident Electrical Engineer, St. Marylebone Borough Council. Salary, £600 per annum. Applications by Sept. 5. See advertisement.

Engineer-in-Charge, Southport Corporation. Commencing salary, £2. 5s. per week. Applications by Aug. 22. See advertisement.

Engineer with good knowledge of mechanical and electrical engineering. Salary, £400 to £600. Apply, G M 93, Messrs. Deacon's, 154, Leadenhall-street, London. See advertisement.

Lecturer in Electrical Engineering in the University of Sydney, N.S.W. Salary, £500 per annum. Applications by Sept. 10.

Jointer, for Weymouth and Melcombe Electricity Committee, salary £2 per week; also Fitter-Driver, salary 35s. per week; and a Switchboard Attendant, salary 25s. per week.

BRITISH STANDARDS FOR ELECTRICAL MACHINERY.

The following is the interim report issued by the Engineering Standards Committee dealing with electrical machinery:

In publishing the interim report of the Sub-Committee on Generators, Motors, and Transformers, it will be as well to draw attention to some of the important points which have arisen in carrying out the work entrusted to the sub-committee by the Electrical Plant Committee. The Sub-Committee on Generators, Motors, and Transformers was appointed at a meeting of the Electrical Plant Committee on Dec. 18, 1902, and confirmed by the main committee on Feb. 13, 1903. This interim report was approved by the main committee at their meeting on July 26, 1904. At the earlier meetings it was decided that no attempt should be made to prescribe standard dimensions or shapes which might hamper future development in design, but to confine the recommendations of the sub-committee to such points as would ensure uniformity in nomenclature, outputs, and test conditions. The recommendations which the committee have arrived at with reference to standard pressures, frequencies, outputs, and speeds were prepared after the views of both users and manufacturers had been very carefully considered. Before standard test conditions can be laid down, the safe limit of temperature at which electrical machinery can be allowed to work for lengthened periods of time has, of course, to be determined. A sub-committee under the chairmanship of Dr. Glazebrook was, therefore, formed to experimentally investigate this matter at the National Physical Laboratory, supplemented by tests at the works of those manufacturers who were willing to assist.

The points to be investigated were the following: (1) the maximum temperature to which the insulating materials at present used in the manufacture of electrical apparatus could be exposed for lengthened periods of time without electrical or mechanical deterioration; (2) the permissible rise in temperature deduced from these experiments; (3) the relation between the mean temperature of any coil obtained by measurement of rise in resistance and the maximum temperature at the hottest portion of the same coil.

In addition to these experiments, some of the coils which were tested singly at the National Physical Laboratory were subjected to a second series of tests when mounted on the machines for which they were intended, at the makers' works. The reports of this experimental work are likely to be of very great interest and value to the electrical industry at large, and the committee hope to publish them in full at an early date. It will be of interest to designers to note that the experimental work has made sufficient progress to indicate with considerable certainty that the temperature limits ultimately to be recommended by this sub-committee are likely to be more liberal than those laid down by either the American or German Electrical Standardisation Committees. The experiments have also demonstrated that the temperature of the hottest part of the coils, taken by thermo junction, is no more than 25deg. C. in excess of the mean temperature of the coil, taken by rise in resistance.

The question of settling the standard electrical pressures did not meet with as much difficulty as was anticipated. Care was taken to select those standard pressures which, with the allowable variation of 10 per cent. on either side, would enable nearly all the pressures at present existing to be served by the proposed standard machines. These standard pressures have now been fixed, and it is hoped that *in all future work* they will be universally adopted by engineers who are advising power companies, corporations, supply companies, and others engaged in the distribution of electrical energy, so that in these cases the permissible variations will gradually cease to be necessary.

The standard frequencies proved to be a debatable matter, and after several circular letters had been addressed to and replies received from both users and makers, it was deemed advisable to convene a conference, so that the matter might be thoroughly discussed. This conference was held early in January, and the advisability of adopting two or three

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standard frequencies was fully considered, especially from the point of view of the future developments in power schemes. Strong evidence was brought forward in favour of standardising one frequency only, and the sub-committee after due consideration decided to recommend 50 periods per second as the standard frequency, placing 25 periods per second in a secondary category.

The question of recommending standard lists of motor speeds, which appeared so desirable from the users' point of view, was found to be an extremely difficult one. The sub-committee felt that they could not materially assist manufacturers in reducing the number of patterns to be kept in stock, if a greater number of speeds were retained than those recommended in the standard lists. Happily, one list of speeds—namely, that for prime movers—was practically fixed for the committee by the conditions of the frequency and the number of the poles in the alternators, so that the committee decided to put forward this one list of speeds for the whole of the direct-coupled machinery of both classes.

The Sub-Committee on Generators, Motors, and Transformers are indebted to the Transformer Sub-Committee for the recommendations with reference to alternating-current generators. They have still under consideration the very important subjects of the standardisation of transformers, test conditions, and permissible variations from the adopted standards, and the complete report cannot be published until such time as these investigations are concluded. The committee, however, feel that the interests of the electrical profession will best be served by the early publication of a portion of the information which will ultimately be embodied in the report when complete.

(Signed) R. E. B. CROMPTON,
Chairman of Sub-Committee on Generators, Motors, and Transformers

We have previously published the names of the experts forming this sub-committee, on which the Admiralty, the War Office, the Crown Agents for the Colonies, the National Physical Laboratory, and the Electrical Engineering Plant Manufacturers' Association were specially represented.

PRESSURES AND FREQUENCIES.

The following are the resolutions with reference to British standard pressures and frequencies:

1. Resolved that the standard low pressures for direct and alternating current work, measured at the terminals of the consumer, be

   110, 220, 440, 500 volts.

   Though not included in the above standard pressures, 380 volts shall be considered as the recognised pressure to be maintained between the principal conductors in a three-phase system with neutral wire, the pressure then being 220 volts between the three conductors and the neutral.

2. Resolved that the standard high pressures for alternating-current work, measured at the terminals of the generator, be

   2,200, 3,300, 6,600, 11,000 volts.

3. Resolved that the standard primary pressures for alternating-current transformer work, measured at the primary terminals of the transformer, be

   2,000, 3,000, 6,000, 10,000 volts.

4. Resolved that the standard secondary pressures for alternating-current transformer work, measured at the secondary terminals of the transformer, be

   115, 230, 460, 525 volts at no load.

5. Resolved that the standard direct-current pressure for tramway work, measured at the terminals of the motor, be

   500 volts.

6. Resolved that the standard frequency for alternating-current work be

   50 periods per second.

But where the circumstances of the case demand a lower frequency, a standard of 25 periods per second shall be adopted. N.B.—The above standard pressures are subject to a permissible variation of 10 per cent. on either side, as explained in the introduction.

RATING OF GENERATORS AND MOTORS.

(Except for Traction Motors.)

1. Two ratings shall be recognised by the British Engineering Standards Committee: (*a*) continuous working; (*b*) intermittent working. (*a*) The output of generators and motors for continuous working shall be defined as the output at which they can work continuously for *six hours* and conform to the prescribed tests; (*b*) the output of motors for intermittent working shall be defined as the output at which they can work for one hour and conform to the prescribed tests. N.B.—The duration of test for machines above 250 kw. is still under consideration.

2. Every generator and motor shall carry in a conspicuous position a name plate, giving the output and other particulars enumerated below. In the absence of any statement to the contrary, the output given shall always be understood to mean the output for continuous working under Rating (*a*). Name plates for machines under Class (*b*) shall bear the word "intermittent."

3. The output and full load speed marked on the name plate shall be those taken when the machine is at its normal working temperature, as determined at the close of the test run referred to above.

4. All generators shall have their outputs stated in kilowatts. All motors shall have their outputs stated in brake horse-power.

5. The following information shall be given on the name plates:

Generators.

Direct current	Kw.	Volts.	Amps.	R.P.M.
Alternating current.	Kw.	Volts.	Amps.	Power factor.
	Full load. / Excitation.	Volts. / Amps.	Frequency.	R.P.M.

Motors.

D.C. (continuous working)	B.H.P.	Volts.	R.P.M.
D.C. (intermittent working)	B.H.P. (Intermittent).	Volts.	R.P.M.
A.C. (continuous working)	B.H.P.	Volts. Frequency.	R.P.M. Power factor.
A.C. (intermittent working)	B.H.P. (Intermittent).	Volts. Frequency.	R.P.M. Power factor.

The above applies to combined machines, such as motor generators, boosters, rotary converters, which shall have name plates giving information applying both to input and output.

DIRECT-CURRENT GENERATORS.

6. The list numbers represent the kilowatts which the machine can work at when continuously as a generator. List numbers and speeds of direct-current generators (up to 100 kw.):

List. No.	Standard motor carcase.	Revs per min.	List. No.	Standard motor carcase.	Revs. per min.
6	7½	1,075	32	40	750
8	10	1 000	40	50	675
12	15	900	60	75	625
16	20	850	90	100	575
24	30	800	100	—	500

British standard generators of 100 kw. and above, whether for direct or alternating current work, shall conform to the following list of sizes and speeds recommended for generators to be directly coupled to steam or gas engines:

Kw.	Revolutions per minute—Slow.	Medium.	High.
100	*	250	500
150	*	250	428
200	*	250	375
250	*	250	375
300	94	214	375
400	94	214	375
500	83	214	300
750	83	188	250
1,000	83	188	250

N.B.—The "slow" speeds in the above table are tentative.

ALTERNATING-CURRENT GENERATORS.

7. British standard alternators of any type, in addition to the requirements laid down in previous clauses, in so far as the latter apply, shall conform to the following regulations: (*a*) They shall give an E.M.F. curve which, under all working conditions, shall be as nearly as possible

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a sine wave. (*b*) For exciting the field magnets the standard pressures shall be:

65, 110, or 220 volts.

(*c*) The term "alternator" shall not include an "exciter." The latter, when necessary, shall be separately specified and subject to the regulations for standard direct-current generators. (*d*) The regulation of an alternator shall be defined as the difference between the rated full-load pressure and the no-load pressure with the same speed and excitation. This difference expressed as a percentage of the rated full-load pressure shall be termed the percentage "pressure rise" of the alternator. (*e*) They shall not have a greater percentage pressure rise than 6 per cent. on a non-inductive load and 20 per cent. on an inductive load, the latter being here considered as one having a power factor of 0·8. This pressure rise may be tested on a non-inductive or inductive load according to the requirements of the specification. The figures in (B) and (D) shall not apply to compounded alternators.

MOTORS.

8. All motors for the purposes of tests shall be rated under the following classes: (1) open; (2) protected; (3) ventilated; (4) totally enclosed. (1) and (4) require no definition. (2) A *protected* motor is defined as a motor in which the armature, field coils, and other live parts are protected mechanically from accidental or careless contact, so as not to materially interfere with ventilation. (3) A *ventilated* motor is defined as a motor in which, while ventilation is provided for, access to the armature, field coils, and other live parts is only to be obtained by opening a door in, or removing a portion of, the enclosing case. N.B.—An alternating-current motor (Class 3), in which the slip-rings are outside the protection, shall be considered as coming under Class (2).

LISTS OF MOTORS.

9. The list numbers represents the brake horse-power which the machine can work at when running continuously as a motor, at the standard pressure of 220 volts, up to and including two, (2) brake horse-power, and above that size at the standard pressure of 440 volts.

10. The following are the list numbers of British standard sizes of motors: list numbers (direct-current), ¼, ½, 1, 2, 3, 5, 7½, 10, 15, 20, 30, 40, 50, 75, 100; list numbers (single-phase), 50 ⁓, 1, 2, 3, 5, 7½, 7½A, 10, 10A, 15, 20. 25; list numbers (two and three phase), 50 ⁓, 1, 2, 3, 5, 7½, 7½A, 10, 10A, 15, 20, 25, 30, 40, 50, 50A, 75, 100.

11. List numbers and speeds of motors (up to brake horse-power).

Direct-Current Motors.

List No.	R.P.M. at full load.	List No.	R.P.M. at full load.	List No.	R.P.M. at full load.
¼	1,600	5	1,000	30	750
½	1,400	7½	1,000	40	700
1	1,400	10	900	50	650
2	1,100	15	850	75	600
3	1,100	20	800	100	550

Alternating-Current Induction Motors.

Single-phase, 50 ⁓.

List No.	R.P.M. at no load.	List No.	R.P.M. at no load.	List No.	R.P.M. at no load.
1	1,500	7½	1,500	15	1,000
2	1,500	7½A	1,000	20	1,000
3	1,500	10	1,500	25	750
5	1,500	10A	1,000		

Two and three phase, 50 ⁓.

List No.	R.P.M. at no load.	List No.	R.P.M. at no load.	List No.	R.P.M. at no load.
1	1,500	10	1,500	40	750
2	1,500	10A	1,000	50	750
3	1,500	15	1,000	50A	600
5	1,500	20	1,000	75	600
7½	1,500	25	750	100	500
7½A	1,000	30	750		

The figures referring to alternating-current motors give the no-load or synchronous speeds; allowance should, therefore, be made for a reduction in speed at full load of from about 7½ per cent. in the smallest motors to 2½ per cent. in the largest motors.

LEGAL INTELLIGENCE.

MANCHESTER TRAMWAYS PURCHASE.

In the King's Bench Division on Monday Mr. Justice Bigham gave judgment in the special case arising out of the arbitration proceedings connected with the acquisition by the Manchester Corporation of the Manchester Carriage and Tramways Company's undertaking. A question in the case was whether the Corporation were bound to take the depôt at Ashton-under-Lyne, and another point was whether the Carriage Company had a proper title to the depôt.

Mr. Moulton, K.C., for the company, contended that the depôt was the company's property, and not that of the Corporation of Ashton-under-Lyne.

His Lordship said he thought the Corporation must take the Ashton depôt and its contents, they being suitable for the undertaking which had been acquired. Of course, if the company were not in a position to make out their title to the property in question, they would not get the money. He further thought that the value of the undertaking included not only the cost of obtaining parliamentary powers to construct the tramways, but also the cost of the powers to maintain and work it, this being properly part of the cost of construction. But the cost of the company's opposition to private Bills in Parliament which threatened to interfere with the working of the undertaking, ascertained by the arbitrator to be £120, ought not, he thought, to be paid by the Corporation to the company, as it could not be regarded as part of the cost of construction. Judgment must be entered for the company for £13,970, £8,750, and £3,107—the Corporation to pay the company's costs of the proceedings before his lordship.

THE EMPLOYERS' LIABILITY ACT.

In the City of London Court on Tuesday, before his Honour Judge Lumley Smith and a special jury, Charles Howard, of 39, Holmby-street, Albany-road, Camberwell, S.E., claimed £200 from the Electrical Engineering and Maintenance Company, Limited, 5, Eastcheap, for injuries sustained while in their employ. Mr. O'Connor was counsel for plaintiff and Mr. Shakespear for defendant. The action was brought under the Act of 1880. In May last wires were being put up at Snaresbrook, in Essex, and plaintiff alleged that there was negligence on the part of the defendant company in not providing proper ladders, and on the part of their foreman in not seeing that a ladder which was borrowed from Holly Lodge was in good condition. It was a telescopic ladder, and when plaintiff went to raise it with the help of another man named Robinson, the top part came down and broke his arm and caused other injuries to his hand. This was because the locks did not act. Defendants' foreman said Howard had no authority to use the particular ladder, and he could have got one from the asylum, where they had borrowed them from before. Witnesses were called on both sides, and in the end the jury found for plaintiff for £35.

PURLOINING "ENERGY."

At Maidstone Police Court last week Mary Sims was charged with stealing electric current. Prisoner pleaded not guilty.

Mr. Herbert Monckton, who prosecuted on behalf of the Town Council, stated that the house in which the prisoner lived had been wired by the owner, but there was no connection. Suspicion was aroused by the fact that the electric light was seen burning there at night. On examination of the premises it was found that the seal of the wire had been broken and a connection made.

Mr. Hoadley, chief engineer of the electricity department, stated that 82, Boxley-road was wired. He examined the wiring on Friday, and found a temporary connection had been made between the house wiring and the main cut-outs of the Corporation. The cut-outs were unsealed, fuses had been inserted, and the supply was connected throughout the house. He tried several of the lights, and proved that the whole of the wiring was on. No meter was attached. He estimated the amount of electricity consumed at 7s. to 10s. No notice that the light was being used had been received at the electricity works.

Other evidence having been tendered on behalf of the Council, the prisoner made a statement to the effect that the connection was made when she took the house seven weeks ago.

The Bench imposed a fine of 40s., or one month's imprisonment.

COMPANIES' MEETINGS AND REPORTS

CENTRAL LONDON RAILWAY.

The eighteenth ordinary general meeting of this Company was held at the Holborn Restaurant on the 3rd inst., under the chairmanship of Sir Henry Oakley. Particulars of the report were given in our last week's issue.

The **Chairman**, in moving the adoption of the report, said the half-year had been very uneventful. Happily, they had had no serious trouble, hardly a mischance, and the business had gone on with undeviating regularity, and with satisfactory result in the way of profit. The sum of £5,800 had been spent on equipping and strengthening the line, and the new motorcars had cost £7,200, that being almost the completion of the order for the 68 of these cars. They did not anticipate any large capital expenditure of any description, and the completion of the few things they had in hand would be met by £20,000 or £30,000, and that would leave them with £200,000 or £300,000 unspent and practically unraised. They were beginning

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to see the end of the expenditure unless the line was extended, and they had a substantial sum in hand to meet any emergency. It was considered desirable to keep a substantial balance available, as the Royal Commission on London Traffic had not yet reported, and until the Board knew whether the views or recommendations or suggestions in that report would involve expenditure on the part of the Company, it was thought well to keep in hand as much as possible, so that they might be able to deal efficiently with any recommendation which might be made.

Lord Rathmore seconded the motion.

In reply to a question, the **Chairman** said they carried anybody—peer or peasant—for the double journey at single fare up to 7.30 in the morning—it was a sort of reward for getting up early. They did not believe they made a loss on the workmen's fares, but it was very difficult to separate the two classes of fares.

The motion was carried unanimously, and the dividend at the rate of 4 per cent. per annum on the undivided ordinary and preferred ordinary stock was duly carried.

CROMPTON AND CO.

The sixteenth annual general meeting of the above Company was held on Tuesday at Salisbury House, Mr. J. Trotter (chairman of the Company) presiding.

In moving the adoption of the report (particulars of which we published last week), the **Chairman** stated that the results of the year's working had been disappointing. The results at the end of the first half-year did not justify them in recommending any dividend, and at the end of the year it was found that they had merely enough to admit of the payment of 2½ per cent. In the previous year's report the directors indicated that they were hopeful of the bad times having been passed, and that better times were in store. Their reasons for believing that they were likely to do better during the past year were founded on the fact that they had taken steps to obtain the very best technical advice, both at home and abroad, and had for a long time been overhauling their designs, with a view to cheapening and improving the output of their machines. Every step they had taken to cheapen prices, however, had been nullified by a steady drop in the market value of the regular goods made by the electric manufacturers during the year, which, he regretted to say, steadily continued. They had, however, endeavoured as far as possible to put their house in order. The Chairman then alluded in more optimistic terms to the Electric Supply Corporation, which they had launched, and which was preparing to execute a number of large orders. In conclusion, he referred to the special department that had been established for watching over the sales of the Company. That department had, he considered, already justified its existence, and he predicted that the good work it accomplished in bringing the Company into closer contact with London buyers would be of material benefit in the conduct of the business.

The report was adopted without discussion.

CONSOLIDATED ELECTRICAL.

The second ordinary general meeting of this Company was held on Tuesday at River Plate House, London, under the chairmanship of Mr. Herbert Allen.

The **Chairman**, in moving the adoption of the report (particulars of which we published last week), stated that he could not say anything definite about the future, as at present the business was so poor, and they experienced great difficulty in obtaining orders. Their factory at Canonbury was now in a thoroughly efficient condition, and if it could be made to pay it would be continued; if not, the factory would have to stop. They could not continue their manufacturing branch unless there was a revival in trade.

The report was adopted.

GREAT NORTHERN AND CITY RAILWAY.

The report of this Company to June 30 last states that the receipts for the 19 weeks and five days during which the railway had been opened, up to and including June 30, amounted to £19,354. The number of passengers carried during the above period, excluding season-ticket holders, was 2,711,152. The number of season tickets in use at June 30, 1904, was 758. The working of the railway has been in every way satisfactory, but the traffic receipts are, so far, disappointing, owing almost entirely to the fact that the negotiations with the Great Northern Railway for interchange of through booking facilities have not as yet been completed, and the returns, therefore, show practically no traffic, either in ordinary or season tickets, to or from Great Northern suburban stations. The receipts from local traffic are steadily increasing, and when the arrangements with the Great Northern Railway Company are completed, which it is hoped will be very shortly, the revenue will certainly show a more satisfactory result. The station at Highbury was not opened to the public until June 28 last. As was anticipated, it has already been productive of a considerable increase of traffic, although the lifts are not yet working. While the line is carrying a purely local traffic, it has already attained to a number of passengers, allowing for a complete half-year, larger than that carried by the City and South London Railway, over an equal length of line, at the end of nine years' working. Although the successful development of the traffic may take somewhat longer than was anticipated, the contractors are sanguine that the ultimate results of the railway will fully justify its construction, and in this view the Board concur. The agreement for working the railway by the contractors, for three years from its opening, provides that S. Pearson and Son, Limited, shall retain, in respect of such working, 65 per cent. of the gross receipts from all sources, and that the remaining 35 per cent. shall belong and be paid over to the Company. The contractors have guaranteed, while they so work the railway, a minimum interest of 4 per cent. per annum on the "A" shares if the net receipts paid over to the Company be insufficient; and also a minimum interest of 3 per cent. per annum on certain "B" shares. Warrants for interest will be posted on Aug. 15 to the proprietors entitled to the benefit of the said guarantee.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The half-yearly general meeting was held at Hamilton House, Victoria-embankment, Sir Henry Fowler, M.P., presiding.

The report stated that the capital expenditure for the six months ended June 30 last amounted to £717,190, and that the estimate for the current half-year was £900,000. The rent due from the Underground Electric Railways Company of London, Limited, under the terms of the agreement for lease, dated Jan. 13, 1903, up to the close of the period under review, permitted of a dividend at the rate of 4 per cent. per annum, which the Board recommended to be paid. The progress of the works had been most satisfactory. With one exception all the station sites were in the possession of the contractors. With regard to the Holborn-to-Finsbury Park section, the engineer (Mr. A. Ross) reported that at Finsbury Park Station the whole of the shafts, tunnels, and passages were completed ready for the hoists, permanent way, and electrical appliances. At the King's Cross Station the two shafts, the station tunnels, and the passages were completed, and at the Holborn Station the two shafts were sunk to the full depth, and tunnelling was being proceeded with from these in a northerly direction. Possession had not yet been obtained of the site of the Strand Station. Since the commencement of the works good progress had been made generally, and out of an aggregate length of running and station tunnels to be constructed of 12,903 lineal yards, 10,374 had been driven and lined with cast iron.

Lord Farrer seconded the motion for the adoption of the report, which was carried.

CHLORIDE ELECTRICAL STORAGE.

The report for the year ending June 30 shows a trading profit of £17,510. 9s. 1d. After deducting directors' and auditors' fees (to June, 1903), debenture interest, depreciation, provision for bad debts, and interim dividend on preference shares, the available balance for the year is £5,075. 14s. 4d., to which must be added £7,312. 9s. brought forward from last year, making a disposable balance of £12,386. 3s. 4d. The directors propose the payment of a dividend of 6 per cent. on the preference shares for the financial year, less interim dividend already paid, and a dividend of 8 per cent. on the ordinary shares, free of income tax, together amounting to £4,520, and to carry forward the balance, £7,866. 3s. 4d.

NEW COMPANIES REGISTERED.

Weldrivet Boiler and Motor Company, Limited (81,084).—Capital, £12,000. Objects: to acquire the business lately carried on by the Empire Boiler and Engineering Company, Limited, at Ovenden, near Halifax, and to carry on the business of mechanical, electrical, and hydraulic engineers, etc. Registered office: Empire Works, Holmfield, Halifax.

Morris Hawkins Electrical Company, Limited. — Capital, £11,000. Objects: to adopt an agreement with the Morris Aiming Tube and Ammunition Company, Limited, and to carry on the business of electricians, electrical and mechanical engineers, makers of electric tramcars, dynamos, telephones, etc. Registered office: 17, Charing Cross-road, W.C.

Imperial Engineering Supplies Company, Limited.—Capital, £1,500. Object: to carry on the business of suppliers of electrical and engineering fittings and accessories, electric light and power contractors, electrical and mechanical engineers, electricians, etc.

German Laundry Company, Limited. — Capital, £2,000. Object: to acquire the undertaking and assets of the Electric Laundry Company, Limited (incorporated in 1898, now in liquidation). Registered office: 16-26, Rosemont-road, Finchley-road, N.W.

Liens Registered.

Electric Supply Corporation, Limited.—A trust deed, dated July 18, 1904, to secure £50,000 debenture stock, has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees: C. F. Tufnell, Kenley, and J. G. B. Stone, Drapers'-gardens, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Ipswich.—The Electric Lighting Committee will shortly advertise for tenders for addition of boiler.

Pennas de San Pedro (Spain).—The Municipality require tenders for electric lighting for 20 years. Tenders by Aug. 26.

Paris.—The Posts and Telegraph Department, 123, Rue de Grenelle, require tenders for paper-insulated cables (11 lots) by Aug. 15.

Brazil.—The Municipality of Porto Alegro require tenders for erection, etc., of a generating station for electric lighting and tramway purposes by Aug. 15.

Plymouth.—Tenders are invited for electric light installation at the technical school, Plymouth, for the Plymouth Education Authority.

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Tenders to Mr. E. Chandler Cook, secretary, 18, Princess-square, Plymouth, by 12 noon on Aug. 15.

Dublin.—The Lighting Committee of the Corporation of the City of Dublin are prepared to receive tenders for the supply of 500 alternating-current meters, single-phase and three-phase. Tenders to the Chairman, Lighting Committee, 3, Cork-hill, Dublin, by 12 noon on Aug. 23.

Hove (Sussex).—Tenders are invited for the supply, delivery, and laying, in the parish of Aldrington, of low-tension vulcanised-bitumen, dialite, or "leadless" paper cables, conduits, boxes, meters, etc. Tenders by Aug. 30. See advertisement.

Plymouth.—The Corporation invite tenders for (25) steam alternator, etc.; (26) Lancashire boilers, with mechanical stokers; steam, exhaust, and other piping; ejector, condenser, valves, etc. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by Aug 15.

Madrid.—The Directorate-General of Administration ("Ministerio de la Gobernación") require tenders for the supply and upkeep for three years of continuous-current arc lamps, with a minimum of 64 lamp-posts. The total upset price is about £7,762. Local representation is necessary. Tenders by Aug. 24.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Penang.—The Municipal Council of George Town, Penang, invite tenders for the supply and delivery of tramcars, complete with motors, controllers, trolleys, etc. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by 12 noon on Aug. 24.

Leeds.—The Corporation invite tenders for the supply of two 1,000-kw. turbo-alternators, with condensers, exciters, and high and low tension switchgear for same. Forms of tender, etc., can be obtained from Mr. J. B. Hamilton, general manager, Standard-buildings, City-square, Leeds. Tenders to the Town Clerk by 10 a.m. on Aug. 15.

Perth.—The Corporation invite tenders for the construction and equipment of about 4¾ miles of route length of tramways, constructed as single line with passing places—viz.: (1) permanent way and paving, including copper bonding; (2) overhead equipment; (3) cables, ducts, etc.; (4) cars and equipments; (5) car depôt building. Specifications, etc., can be obtained from the Town Clerk. Tenders before noon on Aug. 16.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Manchester.—The Directors of the Manchester Dock and Warehouse Extension Company, Limited, invite tenders for the wiring (for power and light) and electric lighting of five transit sheds (now in course of erection) on the southerly side of dock No. 9, in the county borough of Salford. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Aug. 30.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

RESULTS OF TENDERS.

Hammersmith.—The tender of Davey, Paxman, and Co., for the supply of Economic boilers with combined superheaters, for the sum of £4,899, has been accepted.

Accumulators.—The A.B.P. Accumulator Company, Limited. Stockton-on-Tees. report an order for 230 cells of their standard S4-11 plate type for shipment to Calcutta.

Alford.—The Urban District Council have accepted the tender of the Alford Gas Company, at £184, or £2 per lamp—discount 3¾ per cent.—for lighting the town with gas or other light.

Southwick.—The Electricity Committee have accepted the offer of the British Westinghouse Company to construct a switchboard gallery at the Southwick power station for the sum of £1,291.

Rochdale.—The Electricity Committee have accepted the tender of W. A. Peters and Sons, Townhead, Rochdale, for erection of the buildings in connection with the extension of the engine-room.

Rotherham.—The Corporation have accepted the following tenders: Callender's Cable and Construction Company, London, cables; Reason Manufacturing Company, Brighton, 2½, 5, and 10 amp. meters; Electrical Company, London, 10, 20, 30, and 50 amp. meters.

Bitumen.—Messrs. Rowland Carr and Co. inform us that the order for bitumen, both for Portsmouth and Pembroke Government Dockyards, have been placed with them through Messrs. Johnson and Phillips.

Walsall.—The Electricity Committee have recommended the Town Council to accept the tender of Babcock and Wilcox for supplying one of their water-tube boilers, with fittings, for the sum of £1,060.

Mond-Gas Plant.—Messrs. John Brown and Co., shipbuilders, of Clydebank, N.B., have placed an order with the Power-Gas Corporation, Limited, 39, Victoria-street, London, S.W., for a complete Mond-gas plant of 4,000 h.p. for generating electricity for general use in their shops.

Penrith (Cumberland).—The Urban District Council have accepted the following tenders for (Section A) two oil or gas engines and dynamos; (B) switchboard and boosters; (C) storage battery; (D) mains: Lancashire Dynamo and Motor Company, Manchester, dynamos, gas engines, and gas suction plant; Kelvin and Jas. White, Limited Glasgow, switchboard and boosters; Pflüger Accumulator Works, London, storage battery; British Insulated and Helsby Cables, Limited, Prescot, Lancashire, cables.

Finchley.—The Urban District Council have received the following tenders for the supply and fixing of brackets and all necessary work for adapting light railway centre poles in the Great North-road as columns for incandescent street-lighting by electricity:

W. T. Skelding and Co. (accepted)	£585	12	6
H. Blackwell	586	12	1
Improved Electric Glow Lamp Company	596	18	3
Reason Manufacturing Company	656	7	0

Fulham.—The Council have received the following tenders for two boilers capable of 14,000lb. per hour at the electricity works:

Stirling Boiler Company, Motherwell, N.B. (accepted)	£2,600
Babcock and Wilcox, Renfrew, N.B.	2,680
Richardsons, Westgarth, and Co., West Hartlepool	2,966
R. Hornsby and Sons, Grantham	2,973
B. R. Rowland and Co., Redditch	2,995
Stirling Company (American), Manchester	3,391

The Council have also accepted tenders for the supply of coal as follows: Firmston and Co., Putney, 2,000 tons of Shirebrook double-screened nuts at 12s. 6d. per ton; Carrington, Sells, Dale, and Co., 1,000 tons of "Crynant" Welsh nuts at 14s. 9d. per ton, and 1,000 tons of "Albert" nuts at 11s. 11d. per ton.

Bristol.—The Electrical Committee have received the following tenders:

H.T. switchgear.—Siemens Bros. and Co., Limited, York-mansion, York-street, Westminster (accepted). Also tendered: British Thomson-Houston Company, Limited, Rugby; Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon-street, E.C.; Ferranti Limited, Hollinwood, Lancashire; Johnson and Phillips, Old Charlton, Kent; Cowans Limited, Springfield-lane, Salford, Manchester; British Westinghouse Company, Limited, Norfolk-street, Strand, London, W.C.; Kelvin and James White, Glasgow.

Water-tube boilers.—Babcock and Wilcox, Limited, 30, Farringdon-street, London, E.C. (accepted). Also tendered: Stirling Boiler Company, Limited, Flemington, Motherwell; B. R. Rowland and Co., Limited, Climax Works, Reddish, near Stockport; Edwin Danks and Co., Limited, Oldbury, near Birmingham.

Two 1,000-kw. three-phase extra high-tension turbo-alternators.—Willans and Robinson, Limited, Victoria Works, Rugby; Dick, Kerr, and Co., Limited (accepted). Also tendered: Siemens Bros. and Co., Limited; British Thomson-Houston Company, Limited; Richardsons, Westgarth, and Co., Limited, Hartlepool Engine Works, Hartlepool; British Westinghouse Company, Limited; Brush Electrical Company, Limited, Falcon Works, Loughborough; C. A. Parsons and Co., Heaton Works, Newcastle-on-Tyne; Bruce Peebles and Co., East Pilton, Edinburgh; Mather and Platt, Limited, Salford Ironworks, Manchester.

Two 500-kw. induction-type motor-generators.—Bruce Peebles and Co., Limited (accepted). Also tendered: Vickers, Sons, and Maxim, Limited, River Don Works, Sheffield; International Electric Company, Clun House, Surrey-street, Strand, W.C.; Electric Construction Company, Bushbury, Wolverhampton; Siemens Bros. and Co., Limited; Richardsons, Westgarth, and Co., Limited; General Electric Company, Limited, 71, Queen Victoria-street, E.C.; Crompton and Co, Limited, Salisbury House, London-wall, E.C.; Electrical Company, Limited, 121-125, Charing Cross-road, W.C.; Dick, Kerr, and Co., Limited; Brush Electrical Company, Limited; British Thomson-Houston Company, Limited; Mather and Platt, Limited; British Westinghouse Company, Limited; Phœnix Dynamo Manufacturing Company, Limited, Thornbury Works, Bradford.

E.H.T. cables.—Siemens Bros. and Co., Limited (accepted). Also tendered: British Insulated Wire Company, Limited, Prescot; Western Electric Company, North Woolwich, London; W. F. Dennis and Co., Limited, 49, Queen Victoria-street, London, E.C.; Callenders, Limited, London; St. Helens Cable Company, Limited, Warrington; W. T. Glover and Co., Limited, Trafford Park, Manchester; W. and T. Henley's, London.

E.H.T. transformers.—British Electric Transformer Company, Limited, Hayes, Middlesex (accepted). Also tendered: British Thomson-Houston Company; International Electric Company; Johnson and Phillips; Ferranti Limited; Electrical Construction Company; British Westinghouse Company, Limited; Crompton and Co., Limited; J. Fowler and Co. (Leeds) Limited, Steam Plough Works, Leeds; Burnand Transformer Company, Limited, 6 and 8, Oxford-street, Regent-road, Salford; Dick, Kerr, and Co., Limited; Brush Electrical Company, Limited; Electrical Company, Limited.

E.H.T. switchgear.—Siemens Bros. and Co., Limited (accepted). Also tendered: Johnson and Phillips; Ferranti Limited; Cowans Limited; Dick, Kerr, and Co., Limited; British Thomson-Houston Company, Limited; British Westinghouse Company, Limited; Kelvin and J. White.

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BUSINESS NOTES.

TRACTION.

Glasgow.—The Corporation have decided to fix top covers to 100 cars.

Blackpool.—The receipts on Bank Holiday showed an increase of £220. 15s. over last year.

Ipswich.—It is reported that the Corporation are considering an extension of the tramways to Felixstowe.

Leicester.—The Aylestone section is expected to be opened at the end of this month or the commencement of next.

Middlesbrough, Stockton, etc., Bill.—This measure has been read a third time in the House of Lords and passed.

Sheffield.—Improvements have been effected in the car service by abolishing the termini of certain sections and making through routes.

Hartlepool.—The company have commenced to lay the new tramlines to a junction with the West Hartlepool lines at the borough boundary.

Light Railways.—The Board of Trade have confirmed the Woodbridge and Bawdsey and the Bideford, Westward Ho! and Appledore light railway orders.

Grimsby.—A proposal that the Corporation should confer with the company in order to secure an extension of the tramway, has been referred to committee.

Rochdale.—A sub-committee has been appointed to enter into negotiations with the Heywood Corporation for the construction and working of tramways in the latter town.

Speed Trials.—It is reported that the electric railway speed trials are shortly to be resumed on the Marienfelde-Zozzen track, when it is hoped to attain a speed of 150 miles an hour.

Stepney.—The Borough Council have consented to the London County Council using a 1in. slot, instead of a ⅜in. slot as in the case of the County Council's southern system, for the tramways to be laid in the borough.

Spezia (Italy).—The British vice-consul reports that sanction has now been obtained from the various authorities concerned to the project for an electric car service between Spezia and Portovenere, tapping all the intermediate suburbs and villages.

Electric Traction in Germany.—The twenty-fifth anniversary of the introduction of electric traction into Germany by Messrs. Siemens and Halske will shortly be celebrated in Berlin. Up to Oct. 1, 1903, there were some 3,310 miles of rails in use for electric traffic.

Darlington.—At the last meeting of the Town Council it was stated that an attempt was being made to have the restriction against the use of trailers, which had been imposed upon the Council by the Board of Trade, removed, so that they might be employed if at any time it were thought desirable.

Newport.—It is expected that the laying of the line on Stow-hill will be taken in hand in a few days. Some delay has arisen in connection with the supply of the stone setts, and the borough engineer having reported that the quarry to whom the contract had been awarded is not in a position to deliver the material, the contract has been cancelled.

Light Railways for Burma.—When opening the Mandalay electric tramways, the Lieutenant-Governor remarked that there were several places in Lower Burma where short lines would pay remarkably well. His Honour said he was considering the advisability of offering guaranteed dividends from district funds for such a purpose, as had been done in India.

Brighton.—At the meeting of the Steyning East Rural District Council a letter was read from the Board of Trade in connection with the dispute with the Corporation over the tramlines in Dyke-road, the Board stating that they could not withhold the certificate for the trams to run, as they were advised that the line was safe, but such certificate would not prejudice any legal question.

Liverpool.—As the result of an arrangement between the Corporation and the National Telephone Company, all the wires of the latter have been removed from the streets through which the tramway overhead wires pass. The only telephone wires which now cross those of the tramways are a few Post Office telephone trunk wires, and efforts are being made to secure the removal of these.

Yarmouth.—A memorial, signed by tradesmen and residents, was presented at the meeting of the Town Council against the extension to Queen's-road, an alternative route being suggested on the ground that the one selected would interfere with the fishing industry. The Council decided, however, to adhere to the original route, only six votes being recorded in favour of the amendment.

Bury.—The Corporation have adopted the recommendation of the Tramways Committee that an agreement be entered into with the Salford Corporation for a through service between Bury and Manchester, the agreement to be terminable by six months' notice. The negotiations with the Heywood Corporation are in abeyance, no definite communication having been received from the latter.

Bury.—At the meeting of the Town Council last week it was reported that the section of the tramways to the barracks was almost completed. The lines to Whitefield had been opened for traffic, and within a fortnight the Salford system would be coupled up to the Bury system. Arrangements for through running between these places were expected to be concluded shortly, but there had been some delay in the negotiations with Heywood.

Burton-Ashby-Swadlincote.—The Midland Railway Company have entrusted Messrs. Dick, Kerr, and Co., Limited, with the contract to construct rather over 10 miles of light railway linking up Burton-on-Trent, Ashby-de-la-Zouch, and Swadlincote. The main roads are being followed with the exception of a short length, where sleeper construction will be used. The work will be carried out to the drawings and specifications of Messrs. Chas. H. Gadsby and Co., the company's engineers.

Tilbury and Southend Railway.—At the half-yearly meeting the Chairman stated that the company would soon have electric traction. Arrangements were being rapidly made, and they hoped soon to be able to accommodate the Metropolitan and District Railways by having electric traction on the section of the line between Bow and Barking. It was expected that electric traction would be ready at about the first half of next year, when the Metropolitan and District lines would be ready for it.

Aberdare.—On Monday afternoon an extraordinary general meeting of the District Council was held for the purpose of passing the necessary resolution to enable the Council to promote a Bill for the construction of electric tramways, and also to erect a refuse destructor in the town. The resolution was carried unanimously, and the clerk was instructed to take the necessary steps to carry out the resolution of the Council. The proposed tramway will run from Trecynon to Aberaman, and thence to Cwmaman and probably to Aberowmboy.

Newcastle.—On Saturday last the Corporation trams started through running on to the company's lines. Arrangements are being made for the company's cars to run from North Shields into the city, as far as Stanhope-street, every 16 minutes, either at the end of this week or the beginning of next. The Corporation having been approached by the inhabitants for an extension of the tramways to Throckley Park, communicated with the Newburn Urban District Council to know whether the latter would give the project their support. The Urban Council decided to write the Corporation for details.

Gomersal.—At the meeting of the District Council last week a letter was read from the British Electric Traction Company intimating their intention of proceeding with the reconstruction of the Birstall and Gomersal tramway, under the Spen Valley and Morley Light Railways Order, 1902, and the Dewsbury, Batley, and Birstall Tramways Act, 1903, and enclosing drawings showing the position of the tracks and the mode of construction, and asking for the Council's approval thereto. It was stated that the scheme included an extension of the existing line to Clough Mills. The matter was referred to the Highways Committee for consideration.

Chester.—The following are details of the working of the Corporation trams from April 6, 1903, to March 25 last, the revenue account and balance-sheet of which appear in another column; length of line, double 2 miles 21 chains, single 19 chains—total, 2 miles 40 chains; receipts from passengers, £8,881; total receipts, £8,916; working expenditure, £5,332; car mileage, 260,785; passengers, 2,002,835; number of cars available, 12; average revenue per mile, 8·205d.; average cost (including interest and sinking fund), 7·892d.; average number of cars running daily, 8·7; average fare per passenger, 1·064d.; units of energy used, 239,072; cost of energy (at 1¼d. per unit) per mile, 1·604d.

Huddersfield.—The Corporation tramways report for the year ended March 31 last (from which, in another column, we extract the financial statement) echoes the views of the committee appointed to consider the question of depreciation (which were adopted by the Corporation), and which were to the effect that, under any circumstances, not less than 3 per cent. on the total capital outlay should be set aside annually for this purpose. Rigid economy has been practiced in the conduct of the undertaking, and the Tramways Committee hope that the public will show a greater appreciation of the service, so that the rate-in-aid may be dispensed with in the near future. The total receipts amounted to £65,675, against £56,632 for the preceding 12 months.

Lowestoft.—A report was presented at the last meeting of the Council giving the statement of accounts for the year ended July 21. This showed total working expenses of £7,392. 18s., the gross profit carried forward to profit and loss account being £3,334. 10s. 7d. The traffic receipts amounted to £10,377. 15s., and advertisements brought in £349. 13s. 7d. The profit and loss account showed sinking fund charges, £875. 3s. 9d.; interest on loan, £2,684. 18s. 10d. The amount taken from the borough fund was £145. The cars carried 2,309,857 passengers, a number equal to the population of Lowestoft 77 times; the mileage run was 286,730; total cost per car mile, 9·161.; working cost per car mile, 6·181.; total revenue per car mile, 8·97d.

Chesterfield.—A start was made on Tuesday with the work of constructing the tramway extension. Members of the Tramway Committee met in an informal sort of way to see the work begun. The extension is from Storrs-road, Brampton, at the Baslow-road end, and from the market place to Whittington Moor at the other end of the existing line. The length of the whole will be about 3½ miles. The British Insulated and Helsby Cables, Limited, have the contract for the permanent way, amounting to £41,257. The work will be done in short lengths so as to occasion as little inconvenience as possible, and it is anticipated that the whole work, which includes the electrification of the route, will be finished in three months. Most of the material required has already been delivered.

King's Norton.—The report of the Tramways Committee states that with regard to the extension of tramways to Northfield, they have again approached the City of Birmingham Tramways Company as to the terms upon which the company would work the suggested extension of the tramways to Northfield. They are informed that the company are not prepared to consider any arrangement for the working of the same except on the basis of a 21 years' lease of the Northfield tramway; and, in addition, that they would not be willing to accept such lease unless they were granted at the same time a lease for the like period of the Moseley and King's Heath routes. The lease of tramway No. 3A Pebble Mill (road) from the Corporation of Birmingham to the

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Council has now been executed, and steps are being taken to obtain the approval of the Board of Trade thereto.

Kirkcaldy.—The accounts of the Corporation tramways for the year ending May 15 show traffic receipts £9,934 and total receipts £10,189. Traffic expenses amounted to £3,163; maintenance and repairs, £315; rents, rates, taxes, and insurance, £439; management expenses, £823; and cost of energy, £2,880, while £40 was allocated to depreciation. This leaves a surplus of £7,663, from which has to be deducted £2,012 for interest, £211 contribution to sinking fund (cost of Bill), and £259 contribution to sinking fund (cost of works). There remains a net balance of £50, which has been carried forward. Details of the year's working are as follows: miles run, 301,779; passengers carried, 2,770,936; units of energy (at 1¾d. per unit), 395,071; population last census, 34,063; number of times population carried, 81·3; units of energy per car mile, 1·309; passengers carried per mile, 9·1; average traffic receipts per passenger, ·86d.; total operating expenses per car mile, 5·7d.; total cost per car mile, 8·06d.

Ashton.—The Town Council have confirmed the following recommendation of the Tramways Committee in regard to the negotiations with the Joint Tramways Board for Stalybridge, Hyde, Mossley, and Dukinfield for inter-running over the various sections of the lines of the two authorities: "To accept ½d. for each passenger picked up or brought into Ashton on all routes, the Corporation to pay the Board the net working expenses at an agreed sum per mile when running in Ashton. The Corporation of Ashton to construct the Scotland-street line from the county bridge to the Pitt and Nelson Hotel, and bear all costs and expenses in connection therewith. The Board to join up their King-street (Dukinfield) lines to the Ashton tramways forthwith. The same terms to apply for the power of running into Stalybridge and Dukinfield by Ashton as were offered to the Joint Board for running into Ashton. Failing acceptance of these terms the matter to be submitted to arbitration, the arbitrator to be appointed by an independent party."

Lancashire and Yorkshire Railway.—Speaking of the electrification of the Liverpool and Southport Railway at the general meeting of the company, the Chairman stated that from the beginning of April up to the present time the number of electric trains run between Liverpool and Southport, and Liverpool and Hall-road, had been gradually increased from 25 up to 110 trains per day, and more trains were being put on to displace the steam-trains as the machinery was handed over by the contractors. The directors hoped that before long the full service of trains would be run. Considering the magnitude of the change and the new problems to be faced which had not hitherto been dealt with by any other railway company, the initial troubles had not been as great as might have been expected, and though there had been some delays to trains, the causes of those delays had been tackled one by one and eliminated. The general public had shown its appreciation of the more rapid and more frequent service by travelling in much greater numbers over the railway.

Wolverhampton.—Colonel Von Donop, on behalf of the Board of Trade, inspected the new tramway line from Wolverhampton to Bushbury on Wednesday. A party, including the inspector, Alderman Mander (chairman of the Tramway Committee), Alderman Craddock (vice-chairman), Mr. Brown (the inventor of the system), Mr. H. Kendrick (assistant town clerk), Messrs. Shawfield (electrical engineer), Luntley (tramway manager), Beaumont (deputy borough surveyor), and several other members and officials of the Corporation, entered a special car at Lichfield-street. The car travelled to the terminus without any untoward incident, and everything appeared to be satisfactory. At the bridges near the Great Western Railway works a careful inspection was made to note the distance between the passengers' heads and the structures. Here the tall men were much in requisition, but the margin was found to be sufficient, even when tall hats were worn. The length of the section is 1¾ miles. The service is expected to be opened to-morrow. It is proposed to charge a fare of 1½d. A contract has been entered into for the construction of the Wednesfield-road extension.

Bradford.—The detailed accounts of the Corporation tramway undertaking for the year ended March 31 show that the total receipts amounted to £198,437. On the debit side, salaries and wages accounted for £44,751; generating costs, £33,675; maintenance of cars and buildings, £29,212; maintenance of permanent way, £7,719; maintenance of overhead equipment, £3,301; rent, insurance, etc., £7,820; and compensation, etc., £3,762; while interest and sinking fund absorbed £46,105, the aggregate outgoings amounting to £184,037. This leaves a net profit of £13,399, of which £10,482 is put to balance of surrender value of unexpired leases account, while £2,916 is carried to depreciation account. At the meeting of the Tramways Committee it was asked that a proper balance-sheet should be provided, as distinct from a trading account, for the 12 months, and that the capital expenditure on the permanent way and the overhead equipment should be shown. The capital expenditure on various items since 1902 was also asked for, and it was stated that this information would be forthcoming at a later meeting.

Burton-on-Trent.—The borough electrical engineer, Mr. P. J. Pringle, has favoured us with a preliminary return of the tramways for the first year, which terminated on the 8th inst.: traffic receipts, first eight months, £11,586. 8s. 8d.; last four months, £6,430. 1s. 2d.; total for 12 months, £18,C16. 9s. 10d.; advertising, £308. 7s. 6d., £147. 4s. 2d., £455. 11s. 8d.; miscellaneous £49. 0s. 6d., £6. 19s. 9d., £56. 0s. 3d.; total receipts, £18,528. 1s. 10d.; car mileage, 282 378, 151,361, 433,739; traffic receipts per car mile, 9 84d., 10 20d., 9·97d.; total receipts per car mile, 10·14d., 10·44d., 10·25d.; passengers per car mile, 9·08, 9·39, 9·19; total passengers, 2,566,134, 1,421,766, 3,987,900; traffic receipts per passenger, 1·084d., 1·085d., 1·084d.; total units, 362,827, 196,170. 558,997; units consumed for driving cars, 347,156, 193,035, 540,191; total units per car mile, 1·28, 1·29, 1·28; number of times population carried, 49·3, 27·4, 76·7. The receipts at the time of August Bank Holiday were exceedingly good, and were as follows: Saturday, £104. 0s. 11d.; Sunday. £51. 15s. 4d.; Monday, £125. 3s. 10d.; Tuesday, £64—total, £344. 13s. 11d. These receipts were a record, the previous best being Whit Monday (£112. 1s. 9d.) and the previous August Bank Holiday, which was the opening day (£95. 0s. 9d.). The receipts for Tuesday are a record taking for this day, with the exception of the first day after the opening, when the takings amounted to £73. 0s. 8d. The net surplus on the 12 months' working is approximately £2,000.

North-Eastern Railway.—The report that the company had decided to electrify their line from Newcastle to Shields and from Newcastle to Darlington, has been officially contradicted. It is stated that no such scheme will be entertained until the company have had an extended experience of the working of the Tyneside line. The company have inaugurated a service of electric auto-cars between Scarborough and Filey. The car is of the ordinary bogie saloon type, with clerestory roof, being 52ft. over the head stocks, with an inside width of 7ft. 12in. It is divided into three compartments, that at the forward end being some 15ft. 3in. long, and contains an 80-b.h.p. four-cylinder Wolseley horizontal petrol motor, and generator, while between this and the passenger portion is a gangway to admit of access both to the engine-room and the passenger compartment. A small vestibule at the rear serves as a "van" for the conductor, and also contains a controller for operating the car from the far end, thus obviating the necessity of turning the vehicle round for the return journey. At the half-yearly meeting of the company, Viscount Ridley, who presided, stated that from the traffic point of view the electric system had proved very satisfactory, but the novelty of the system had caused them to be beset with a great many difficulties, which though they were surmounting gradually were real difficulties—difficulties both as to the safety of workmen and passengers, and the convenience of the latter. Although it was very early to speak of profit and loss of the undertaking, 53,402 train miles were run in the half-year up to June 30 at a cost of £4,911. By way of comparison he pointed out that the bookings during the week ended July 9 last and the corresponding week of last year had increased by 25 per cent. and the money by 22 per cent.

Wednesbury.—At a meeting of the Town Council on Monday the Mayor referred to the tramway deadlock. He urged that as the tramway company were not prepared to make some arrangements with the Corporation with regard to the Darlaston and Tipton sections, the Corporation should take a stand in the matter and endeavour to force the company to lay down a new system on the Walsall branch. He thought it was high time the Corporation appealed again to the Board of Trade, and requested them to do something not only to compel the company to electrify the line from Darlaston to Wednesbury, but also to put down new rails between Wednesbury and the Pleck, so that people could travel in comfort and decency. Another member of the Corporation suggested that the company should now be asked for a definite decision. The town clerk defined the position as follows: The Corporation were now quite ready to purchase their portion of the tramway route. The tramway company said they (the Corporation) must buy the depôt at Darlaston with the track, at a cost of £10,000. They had, in their agreement with the lessee company, a clause to the effect that if they purchased the depôt they (the company) would buy it from them within 60 days at the same price. Now the lessee company said if the Corporation purchased the depôt for £10,000, they would not buy it off them. That was the difficulty that had arisen, and the Corporation did not want the depôt on their hands. The difficulty had really cropped up between the two companies, and when they had settled their differences they would be able to carry out the purchase of the track and to lease it to the lessee company. He mentioned that three months ago the Corporation suggested arbitration, but this the tramway company had not accepted. The Council agreed with the Mayor that strong measures should be taken, but no further action was decided upon.

Reading.—At last week's meeting of the Town Council a preliminary statement was presented of the first year's working of the tramways. The passenger receipts amounted to £31,482. 9s. 2d., and £220 odd was derived from advertising on tickets and other small sales, making a total income from all sources of £31,702. The total operating expenses, inclusive of rates, insurances, and all establishment charges, were £18,267, leaving a gross profit of £13,434. Of this, interest on capital (£6,705), sinking fund charges (£5,272), and income tax (estimated at £200), absorbed £12,177, leaving a net profit on the year's working of £1,258. In addition to this there was an unearned contribution of £1,670 derived from capital moneys temporarily on deposit at bankers, bringing the total profit up to £2,927 for the year. There had been no special depreciation charged against the revenue account, but the full cost of repairs and renewals had been charged. The passenger receipts average 9·03d. per car mile run, and sundry receipts ·06d. per car mile, making 9·14d. per car mile from all sources. The operating expenses per car mile were 5·28d., and with the addition of 3·50d. per mile for interest, sinking fund, etc., the total expenses reached 8·78d. per car mile, leaving ·36d. per car mile net profit. The average receipts per passenger was ·98d., which was accounted for by the large number of persons travelling at workmen's fares. The ratio of operating expenses to income was 57 per cent., as against an average of 62½ per cent. for some 40 tramway systems in this country. The number of passengers carried during the year was 7,657,569, or equivalent to the whole of the inhabitants of Reading (estimated at 75 000) being carried 102 times during the year, and the number of car miles run was 831,983. There had been a loss on the Bath-road section, and workmen were also carried at a loss, but notwithstanding this there was a balance of profit on the year's working of £2,927. The tramways engineer and manager (Mr. Binns) was warmly congratulated by several members of the Corporation.

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Manchester.—The Corporation have concluded an agreement with the Bucklow Rural District Council, who control the parishes of Northenden, Northern Etchells, Dunham Massey, and Timperley. Under it the Corporation are to take over the powers of the Southern Manchester Tramways Act, 1903, and construct and become the owners of the tramways in the districts named. At the end of 35 years the lines in Timperley and Dunham Massey are to be handed over to the local authority, while those in Northenden and Northern Etchells are to be retained for another seven years. The scheme includes the laying of a line from the end of the Withington tramways at Palatine Bridge, along Northenden-road to Sale, and along Langley-lane to the terminus of the Stockport tramways at Gatley. The line to Dunham Massey and Timperley will be laid on Chester-road between Sale and Altrincham. A tramway is being constructed along Chester-road from the Old Cock Hotel, Stretford, towards Sale. In the course of a week or so the Sale boundary will be reached, and it is expected that the work then will have to stop, as there are certain legal difficulties in the way of Sale allowing Manchester to lay lines in their district at the present time. The Board of Trade have granted the Gorton District Council sanction to borrow £18,926 for the purchase and reconstruction of the tramways in the district, but as Gorton has no tramway system of its own the money will practically be repaid by the Manchester Corporation as rent for the lease of the tramways which they run through the Gorton district. By this arrangement no further cost will fall upon the ratepayers of Gorton. The Manchester Corporation have written to the Gorton Council stating they are prepared to advance the money for the purchase of the tramway undertaking in that district at 3½ per cent., also the money for the reconstruction account at the rate of 3¾ per cent., and that the Tramways Committee have arranged to bear the entire costs in connection with the arbitration proceedings with the old Carriage and Tramways Company. This offer will probably be accepted by the Gorton Council. The traffic returns for last week constitute a record in the history of the undertaking. The number of passengers was 2,702,465. and the receipts came to £13,819. 12s. 9d. The receipts on Bank Holiday amounted to £3,017, also a record.

Corwen, Bettws-y-coed, etc., Railway.—An enquiry was held last week by the Light Railway Commissioners, represented by Colonel G. F. O. Boughey, R.E., C.S.I., Mr. Henry Allan Steward, and Mr. Alan D. Erskine (secretary), respecting the proposed electric railway between Corwen, Bettws-y-coed, and Penmachno. Several influential landowners, including Lord Penrhyn, supported the scheme, but the Hon. C. H. Wynn opposed. Mr. Rhys Williams, barrister, who appeared for the promoters, explained that the first proposed railway would extend from Corwen to Bettws-y-coed for a distance of 23½ miles, and the second railway would be from Bettws to Penmachno, a further distance of nearly five miles. The new railway would be of 1ft. 11½in. gauge, with overhead trolley system similar to Snowdon and Bettws Railway. The first railway would run through 14 villages and towns, and afford a better connection with Carnarvon and Portmadoc. Electric motive power would be obtained from a generating station near Lake Gwynant, and the North-Western Power Company were supporting the promoters in every way; 500 square miles of almost isolated country would benefit by the projected railway. The promoters estimated net receipts per annum of £12,220. Denbigh, Merioneth, and Carnarvon County Councils had passed a resolution favouring the scheme. Mr. James Owen, of Mansfield, Owen, and Co., London, the engineers to the company, stated that for the railway itself £134,000 would be required, but the whole scheme, including the appurtenances, was estimated to cost £250.000. Up to the present 1,975 shares had been allotted, and £1,580 in deposit money had been received. Of those shareholders 171 were residents in the districts interested. The construction of the railway presented no special engineering difficulties. Mr. Graham, who appeared for the opposition, said that a large portion of the estate of the Hon. C. H. Wynn would be irretrievably injured. A proposed embankment would increase the flood on that gentleman's lands some 10 times a year, over some 275 acres. He suggested to the Commissioners that no order could be granted to include such embankment, which he was advised by experts could be easily dispensed with. The Commissioners subsequently communicated their sanction, subject to an arrangement being entered into with Mr. Wynn. The result has caused much satisfaction among the inhabitants.

LIGHTING AND GENERAL.

Bridgend.—The profit on the electric light scheme for the past year was £150.

Batley.—The Batley Working-Men's Club premises are to be lighted by electricity.

Beetle.—New mains are to be laid at an estimated cost of £435 and £75 respectively.

Fenton.—Mr. G. V. Fowler contemplates applying for a lighting provisional order.

North-East Ireland Electricity Bill.—This Bill has been reported for third reading.

Neath.—The Town Council propose to apply for sanction to borrow £3,000 for electric lighting purposes.

Mynyddislwyn.—The question of applying for a provisional order for electric lighting is being discussed.

Electric Lighting (London) Bill.—This Bill has been read a third time and passed in the House of Lords.

Crewe.—Application has been made for sanction to borrow £4,500 for additional plant at the electricity works.

Boston.—The Town Council on Tuesday resolved to put down an electric light installation at a cost of £17,270.

Burnley.—Applications for current have been received by the electrical engineer from one chapel and two churches.

Ootacamund.—The scheme for the electric lighting of Government House will soon be taken in hand.—*Indian Engineering.*

Dover.—The Corporation are considering the question of seeking powers for raising £3,500—£2,000 for meters and £1,500 for free wiring.

Cumberland.—We understand that tenders will be advertised for lighting the Garlands Asylum extension. The estimate for lighting by electricity is £8,000.

Colchester.—The tenders of Messrs. Joslins, Limited, for wiring 40 houses and 10 shops under the prepayment meter system has been accepted by the Town Council.

Bursiem.—An enquiry has been held into the Corporation's application for sanction to borrow £21,000 for electric supply purposes and £10,000 for a refuse destructor.

Spalding.—The Urban District Council have decided to apply for a provisional order for electric lighting with a view to prevent outside companies from obtaining powers.

Boston.—It is proposed that application be at once made for leave to borrow £20,000, which is considered sufficient for the first outlay to carry out the electric lighting order.

Folkestone.—The Town Council have now decided to instal electricity at the town hall, and to make adequate provision for a supply of gas in the event of the electric light failing.

Airdrie.—The Lighting Committee have acquired a site for the generating station and engine-house for the supply of electricity to light the special district of Broxburn and Uphall.

Cannock.—An enquiry has been held into the application of the Urban District Council for sanction to borrow £10,000 for the purpose of supplying electric light and power for the district.

Exmouth.—It appears that Messrs. Crompton have all the machinery ready for installing in the generating station, and hope to commence the supply before the end of the current year.

Change of Title.—The title of the Blackheath and Greenwich District Electric Light Company, Limited, has been altered to South Metropolitan Electric Light and Power Company, Limited.

Plymouth.—An enquiry is to be held on the 18th inst. into the application of the Borough Council for sanction to borrow £20,000 for the electric undertaking and £4,462 for refuse destructor purposes.

Derby.—The Town Council have granted £570 for fitting up a mechanical workshop and an electrical engineering laboratory at the technical college, and application will be made for sanction to borrow £550.

Leyland.—The Urban District Council have received from the Board of Trade an extension of the period for the carrying out of the provisional order for the electric lighting of the town for 12 months from July 23.

Market Harborough.—It has been decided to call a special meeting, if necessary, to consider what steps shall be taken in respect to the proposal of an outside company to supply electricity within the Council's area.

Hebden Bridge.—An electrical exhibition will be held from Oct. 6 to 8 to celebrate the formal opening of the municipal electric supply works, which have been insured for £5,000. The lamps connected number 2,000.

Litherland.—Messrs. Ayrton, Radcliffe, and Co. intend to apply for a provisional order for the supply of electric power to the Council's district. The District Council, however, gave notice some time ago of making a similar application.

London County Council.—The Holborn Borough Council are making representations to the County Council with a view to the adoption of electric lighting for Kingsway, which the latter Council projected illuminating by incandescent gas.

Charing Cross and Strand Electricity Supply Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year ended June 30, 1904. Warrants will be posted on the 15th inst.

Wolverhampton.—A switchboard is to be provided at the refuse destructor at a cost of £350. It will also be necessary to carry out alterations to the existing switchboard at a cost of £150. The work is to be done by the Corporation's own men.

Kabul.—The Ameer of Afghanistan, says an Indian paper, contemplates an electric installation in Kabul, which will give both power and light. The fuel bill for his factories last year is said to have been eight lakhs of Kabuli rupees, or upwards of four lakhs calculated in Indian currency.

Glasgow.—Councillor Willcock, convener of the Electricity Committee, is visiting Berlin, at his own expense, in order to inspect the generators which are being manufactured in the German capital for the sub-stations. Mr. W. A. Chamen, the Corporation electrical engineer, accompanies him.

Inverness.—The Town Council have postponed the date of commencing the electric supply, on the suggestion of Edmundson's Electricity Corporation, until the end of next April, so as to avoid the inconvenience of opening the streets before the end of September for laying the cables.

Paddington.—The Borough Council have received notice of intention to apply for a lighting provisional order from the Central Electricity Supply Company, and also from the Paddington Electric Supply Company, which is identified with the former company. Consent is not likely to be granted.

Cheltenham.—An independent expert is to report upon the Council's electric supply undertaking, dissatisfaction having been expressed by a section of the ratepayers. Meantime the Council have passed a resolution of confidence in the Electric Lighting Committee and the electrical engineer.

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London Gazette.—The partnership between William Henry Heath and John James Reynolds, carrying on business as electrical and general engineers at Mary-street, St. Paul's, Birmingham, Warwick, under the style of the Electrical Power Engineering Company, has been dissolved by mutual consent.

Plymouth.—The Borough Council have agreed to the laying of a cable from the works to the Victoria Wharves at a cost of £430. The annual outlay for interest and sinking fund is estimated at £30, and the income at £70. Similar extensions will be made to York-street, Torrington-place, and Peverell-park.

Chelsea.—The revised specification for wiring the wards of the infirmary for electric light has been referred to the Building Committee of the Guardians for consideration, as well as the issuing of instructions for advertisements for tenders for the work. The erection of a gas-engine and dynamo will probably be recommended.

City and Guilds of London Institute.—Particulars of the session 1904 5 of the courses of instruction at the institute's central technical college, Exhibition-road, for students not under 16 years of age and those at the institute technical college, Finsbury, for students not under 14 years of age, appear in another column.

Felixstowe.—A report has been presented with regard to the electricity works site stating that the lease contains restrictions which very considerably affect the use of the site for the purpose of an electric generating station, and that practically it cannot be used as such. A suggestion to remove the station to a larger site is being considered.

Ware.—The agreement with the North Metropolitan Electricity Company for the taking over and working of the Ware electrical lighting order has been sealed. The agreement provides that the company shall pay £186 and costs for the order, while the Council shall have the right of purchase of the undertaking at the expiration of 14 years.

Cheltenham.—Mr. Swinburne, M.I.C.E., has been asked to report upon the electricity undertaking. The following resolution has been passed: "That as at present advised the committee see no reason to abate their confidence in the Electric Lighting Committee, nor in their selection of a chairman of the committee, nor in the electrical engineer."

Sale of Plant.—The Corporation of Bristol have for immediate disposal two Lancashire boilers, 24ft. by 8ft., 140lb. pressure; four 210-kw. Siemens alternators, 2,000 volts, 93 periods; two 88-kw. Siemens alternators, 2,000 volts, 93 periods; one 52-kw. Siemens-Willans 100-volt direct-current generator. Particulars appear in another column.

Rawtenstall.—The Town Council have held a lighting provisional order for the past five years, but have taken no steps to put it into action on account of the unfavourable character of the area. The chairman of the Electrical Committee suggests that the best solution would be the purchase of energy in bulk from the Lancashire Electric Power Company.

South Shields.—A site has been chosen for the poles and of a wireless telegraph station near South Shields, on the summit of the cliffs which form the northern cheek of Marsden Bay. The motive power, generating plant, etc., will be housed in buildings to be erected between the Marsden coastguard station and the Marsden colliery railway, a few yards inland.

Dewsbury.—The electricity department's balance sheet shows a profit of £1 859, owing to an increase in the sale of current not only to ordinary consumers (£5,761), but also to the traction company (£2,733). A balance of £1,009, after paying £1,235 for interest, £1,475 to sinking fund, and £850 to reserve fund, is very satisfactory, compared with a loss of £378 only two years ago.

Stock Exchange.—Application has been made to the Stock Exchange Committee to allow the Metropolitan District Railway Company's £500,000 4 per cent. perpetual debenture stock, in lieu of the scrip now quoted, to be quoted in the official list. The committee have ordered the Madras Electric Tramways (1904), Limited, £50,000 5 per cent. debenture stock to be quoted in the official list.

North-Eastern Railway.—A dividend of 5 per cent. was declared on Friday at the half-yearly meeting of the company at York, and £20,000 was put to reserve, leaving a balance forward of £40,000. Viscount Ridley, who presided, said the traffic on the electrified portion of the system round Newcastle had proved satisfactory, the number of passengers having increased. All possible steps were being taken to secure the safety and convenience of the travellers.

Finchley.—The Urban District Council have adopted a report of the Highways Committee on an application received from the telegraph department of the General Post Office to lay cables through a number of streets in their district. It is proposed to lay the mains under the footways, and to proceed with the work before the Council's pavement improvements are put in hand. The Department will be informed that any application for erection of pole lines will be considered upon its merits when submitted.

West Bromwich.—An enquiry has been held into the application of the Council for sanction to borrow £1,300 to defray the cost of laying an electric main down Spon-lane. It appears that the tender which has been accepted is for £1,306, or within £6 of the estimate. The borough electrical engineer, Mr. Wray, mentioned that the present plant at the generating station was ample to supply this new demand, and, further, that the charge for power was 1d. per unit, and at this price the Corporation were able to make a profit.

Wednesbury.—The Light and Water Committee in a report issued on Friday recommend that meter rents be not charged to consumers of electricity where the consumer's account amounts to £1 per quarter. Further, that if desired by consumers electricity will be supplied for the outside lighting of shops, either by arc or large Nernst lamps, at a flat rate of 4d. per unit, such lamps being connected to a separate meter. This alternative rate will only be allowed on the conditions that a rent for the extra meter is paid in accordance with the rates stated in the supply regulations, and that no gas, but electricity only, is used inside the premises.

Loughborough.—At the last meeting of the Town Council the Gas Committee reported a communication from Mr. Gadsby stating that the only remaining contracts for machinery other than small items requiring to be let were the booster and mechanical stoker, and that he had invited Messrs. Siemens Bros. to estimate for the booster, as he proposed to adopt a machine of which they make a speciality, and was awaiting their tender, and that he had obtained a quotation from Messrs. Bennis and Co. for two patent double machine stokers (including driving shaft and 2½-h.p. motor for driving same), at the sum of £320. 7s. 10d. The quotation was, in his opinion, a reasonable one, and he recommended its acceptance. The recommendation was adopted.

Penrith.—In their last report the Electric Lighting Sub-Committee state that they have received tenders for the erection of the buildings, and for the supply and fixing of all necessary plant and cables, or mains, and that, together with the surveyor's estimate of work to be executed in his department, the total cost of the whole scheme proposed amounts to £6,850. The scheme adopted by the Council contemplated the use of oil-engines, but, on the advice of the engineer, gas-engines with suction gas plant are now substituted. For the sum of £6,850 the Council will obtain a complete installation of greater capacity, and with buildings of a more substantial type, than was provided in the estimate of £7,507. Application is to be made for sanction to borrow £6,850.

Glasgow.—The gross revenue of the Corporation Electricity Committee for the year ended May 31 amounted to £158,150, and the working expenditure was £61,738. After paying interest on loans and contribution to the sinking fund, and deducting the proportion of the cost of lamps and fittings supplied consequent on the change of voltage, the net balance amounts to £42,522. The committee recommend £32,180 be written off for depreciation, leaving a surplus of £10,341 on the year's working. The committee have repaid to the gas department the debit of the previous year, £13,895, so that there is a debit balance of £3,553, which the committee recommend should be carried forward to next year's account. The total capital expenditure since the starting of the department in 1892 has been £1,119,037.

Durham.—The Electric Supply Committee, which is ambitious of forming a county electric supply system, presented a report at the last meeting of the County Council upon the electric supply and tramway companies within the area. The committee desired authority to engage an expert to ascertain whether a county scheme would be practicable, and the cost of it, with a view to submitting the report of the expert to a conference of the local authorities, and which 77 have expressed their willingness to attend as against 31 who have declined, the remainder not having replied. It was pointed out at the meeting of the Council, however, that expenditure upon the fees of an expert without first obtaining parliamentary sanction would be *ultra vires*, and so the matter was adjourned for further consideration.

Grimsby.—The borough electrical engineer's last report states that during June there had been an increase of 506 private lamps and motors, and an increase of 881 in the total number connected and applied for. The units sold showed an increase on June of last year of 3,212 for traction and 8,606 to private consumers or a total increase of 11,718. The figures for the first quarter of the present year (1904-5) showed that 16,570 were sold for power purposes, as compared with 16,519 for the whole of the previous year (1903-4). The units sold to private consumers during the past quarter for lighting and power were 61,703, as against 35,461; for traction, 112 011, as against 98,444; and for public lighting, 16,913, as compared with 17,422. It is proposed to apply for permission to borrow £2,600 to carry out extensions required during the current financial year.

Mauritius.—The Board of Trade have received from the Government of Mauritius a copy of Ordinance No. 33 of 1903, which was assented to by the acting-governor of the colony on Nov. 19, 1903, regulating the erection and use of stations and machinery for wireless telegraphy. By Section 1 of the present ordinance it is provided that "no telegraphic or electrical station, apparatus, machinery, or implements whatsoever, for the purpose of electrical communications, transmission, emission, or reception of messages, by what is generally known as 'wireless telegraphy,' between any places in Mauritius, or between any place in Mauritius with any place out of Mauritius, shall be erected or used in any place in Mauritius, whether on public or private property, without the sanction of the governor previously obtained." Any person contravening the above provisions is liable to a fine not exceeding Rs.5,000, and to have the apparatus, etc., confiscated.

Maidenhead.—The *Maidenhead Advertiser* comments upon the Maidenhead electric lighting extension as follows: "Parliamentary sanction has at last been given to the application of the Corporation for powers to supply electricity to the parishes of Cookham, Taplow, and Bray, from whence many applications have come. Unfortunately, at the instance of the Eton Rural District Council, the parishes of Hitcham and Burnham were added to the original application, and this called up fierce opposition in the House of Lords from the gas company and the Great Western Railway Company. A modified 'Bermondsey clause' was adopted by the committee to satisfy the gas company, and Hitcham and Burnham were thrown out in response to the crushing case against their inclusion made out by the G.W.R. This, however, called up opposition from the Eton Council in the House of Commons, who practically said, 'If you will not have Hitcham and Burnham you shall not have Taplow.' The mayor, the town clerk, and the engineers appeared before the House of Commons Committee on Thursday last and wiped out the Eton opposition. The Corporation have therefore got what they originally applied for, though at considerable cost both to themselves and their opponents."

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Hereford.—The Electric Lighting Committee's return showing the output of current for the quarters ended June 25, 1903, and June 24, 1904, contains the following particulars: Units sold for lighting 15,686, against 14,896 the corresponding quarter last year; units sold for power 5,378, against 3,733; total units sold 21,064, against 18,629; equivalent number of 8-c.p. lamps at beginning of quarter 10,900, against 9,372; 8-c.p. lamps added 1,265, against 526; equivalent number of 8-c.p. lamps at end of quarter 12,165, against 9,698; number of arc lamps connected 22, against 20; numbers of meters connected 17, against 14; horse-power of motors connected 50½, against 47.

Lowestoft.—Denmark-road is to be lighted by electric lamps to be fixed on poles at a capital charge of £245. The cost per annum will be £69. 12s. for 24 lamps. At the last meeting of the Electric Lighting Committee the accountant submitted a report of expenditure for the half-year ending June 30, as follows: Expenditure—generation, £2,792; distribution, £31; public lamps £173; rates and taxes, £105; management, £507; insurance, £19; interest and sinking fund, £1,277—total, £4,904. Income—private lighting, £2,089; slot meters, £8; power, £264; traction, £1,401; public lighting, £678; meter rents, £110; sundries, £5—total, £4,555. To be provided from rate, £349. The resident engineer reported that there are now connected to the mains 534 consumers, representing 26,945 8-c.p. lamps. During the month 11 new consumers have been connected, representing 1,347 8-c.p. lamps.

Telephone Purchase.—Mr. Weir, M.P., asked the Postmaster-General on Monday whether he was still negotiating with the National Telephone Company for the purchase of their undertaking; and, if so, when would members of that House be informed of the proposed terms, and whether the London telephone area would be treated separately. Lord Stanley replied: "I am still in negotiation with the National Telephone Company, and the hon. member will recognise that while the negotiations are still in progress it is undesirable to make any statement as to the nature or terms of the arrangement under discussion. Having regard to the date which we have reached, I shall certainly not be in a position to make any communication to the House on this subject before the end of the present session; but if an agreement is arrived at, it shall, as I have already promised, be laid before Parliament before it becomes binding, in order that the House may have an opportunity of considering it."

Hampstead.—At the last meeting of the Borough Council the Lighting Committee recommended the Council to support the Shoreditch Borough Council in their efforts to amend the Supply of Electricity Bill by deleting Clause 6, which is as follows: "Notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority shall be granted by the Board of Trade except with the consent of such local authority, unless the Board of Trade, in any case in which the consent of such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in such case they shall make a special report, stating the grounds upon which they have dispensed with such consent." The committee also recommended the Council to support the St. Pancras Borough Council in their efforts to amend the Bill so as to prevent actions against electric lighting authorities in respect of vibration unless serious damage or nuisance is occasioned by their works, and in that event to empower them to acquire compulsorily the interests affected. The recommendations were adopted.

Stourbridge.—In April the Urban District Council applied for sanction to a loan of £16,000 for erecting a generating station and other purposes, but it was urged that the Council, instead of providing works of their own, should purchase electricity in bulk from the Midland Electric Corporation, whose mains run up to the northern boundary of Stourbridge. Last week an enquiry was held into an application for sanction to a reduced loan of £4,000 for distribution and cognate purposes only. The Town Clerk (Mr. Goddard) said the agreement with the Midland Corporation was not fully completed, but it was proposed that the flat rate for power should be 1·5d., subject to discounts according to the consumption; and 2·55d. for electric lighting. Mr. J. B. Clarke, electrical engineer, said the estimated capital for laying down mains in the compulsory area and for other items and contingencies was £2,940, and there was £1,000 put down for meters and services, which would repay 5 per cent. Mr. McLean, of the Midland Electric Corporation, said his directors were agreeable to the proviso that the arrangement should end by 12 months' notice on either side. The Inspector intimated that the Board would not sanction the loan till they had the agreement in a completed form before them.

Dumfries.—The Town Council have approved an agreement with the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, for the electric lighting of the town. The Council are to transfer their provisional order to the company, who are to repay the expenses incurred by the Council in connection with the order, and their engineers' fee, amounting in all to about £700, and also an annual sum of £30 for an annual inspection of the works by the Council's engineers. The company are to carry out the installation at their own cost, on a site to be provided by the Council, for which they are to pay an annual rent of £100. They are to pay for the maintenance of the works, including renewals of plant, out of their revenue account, and the Council are to have the option, at any time after the lapse of 7½ years, to acquire the undertaking on paying to the company the amount of the original capital outlay and an additional 25 per cent. The Council are under no obligation to take a supply of electricity from the company either for street-lighting or other purposes. The Council have been advised in their negotiations by Messrs. Buchan and Hogarth, Edinburgh, as their consulting engineers. They have made a provisional arrangement to purchase a site for the works at a cost of about £1,050, but another site, being part of the town's property, will also be put before the company.

Hammersmith.—The annual report of the Borough Council's electric supply undertaking shows a total revenue of £32,725, as against £27,185 for the previous year. The working expenditure amounted to £19,276, leaving a gross surplus of £13,449. Interest and sinking fund charges absorb £11,594, leaving a net profit of £1,855, which is some £800 in excess of the previous year. The units sold totalled 2,223,923, of which 1,897,192 were taken by private consumers, the remainder being used for public lighting. Of the public lamps, 177 are arc lamps and 75 are incandescents. The consumers have increased from 1,226 to 1,469, and the motors connected from 66 to 98. When the land in Fulham Palace-road, on which the electricity works now stand, was purchased by the late Vestry, it was decided that one-half of it should be allocated to the electricity undertaking, and the other half to the general purposes of the Vestry. Subsequently it was found that the undertaking would not for some time require so large an area, and the matter was readjusted and a much smaller area was allocated for the purposes of the electricity station. The cost of the land was charged in the proportions of £1,671 to the electricity undertaking, and £5,329 to the general rate. Having regard to the extension of the electricity works which has been decided upon, and to future extensions, it is essential that the undertaking should have considerably more land than has been allocated to it, and the committee therefore recommended that the whole of the vacant land belonging to the Council and adjoining the electricity works be allocated to the purposes of such work, and that it be referred to the Finance Committee to consider and report as to what financial readjustment this proposal will involve.

Colliery Plant.—A most extensive use of electric machinery is now being made in the United Kingdom by colliery owners for working pumps, haulage gears, coal-cutters, etc. In connection with this movement, Messrs. Ernest Scott and Mountain, Limited, of the Close Works, Newcastle-on-Tyne, report contracts from the Mickley Coal Company for a complete electrical transmission of power plant, including two sets of horizontal coupled compound slow-speed engines of 360 effective horse-power each, and two direct-current generators each of 270 kw., mounted on the engine crankshafts. These dynamos are of the firm's latest type, each dynamo being fitted with 18 poles, and arranged to give the output stated above when running at a speed of 110 revolutions per minute. In addition to the two sets of generating machinery, this contract includes a booster which will raise the pressure of the current at the far end to compensate for the loss in the cables. There are also included a 150-h.p. main and tail haulage gear, complete with friction clutches and electric motor, and two electric winding gears, together with the main and branch cables, main and distributing switchboards, and starting switches, and smaller motors for smiths' shops, etc., at bank. For the Littletown Colliery, near Durham, the same firm have in hand an electrical pumping plant, consisting of a quadruple centrifugal pump to deliver 350 gallons of water per minute against a head of 250ft., this pump being driven by one of Scott and Mountain's multipolar electric motor of 66 effective horse-power, running at a speed of 1,220 revolutions per minute, the motor being placed between the pumps—*i.e.*, a series of two pumps being placed at each side of the motor. The same firm are also supplying for collieries a 30 effective horse-power electric motor for driving an existing haulage gear, and a complete arrangement of motor room switchboards and cables. For the Globe Phœnix Gold Mining Company, which has its mines in Rhodesia, Messrs. Scott and Mountain are supplying one of their latest types of three-phase alternating-current generators of 112 kw. capacity, which will be driven by the company's existing steam-engine at the mine, together with one of their well-known three-throw mining pumps, which will deliver 170 gallons of water per minute against a vertical head of 1,000ft., complete with three-phase induction motor of 40 effective horse-power, switchboards, cables, overhead equipment, starting switches, etc. The firm have lately put on the market a disc machine suitable for working in thin seams, the height of their coal-cutting machine being 14in. This machine can be made to work on rails or skids, the total height from the floor to the top of the machine when on rails being 22in., and when mounted on skids 20in. The firm also report orders for coal-cutting machines for Hamsterley Colliery, Shilbottle Colliery, Old Silkstone Colliery (near Barnsley), Messrs. Newton, Chambers, and Co., Sheffield, and others.

PROVISIONAL PATENTS, 1904.

JULY 28.

16603. Improvements in or relating to electric arc lamps. Adrian Denman Jones and the Jandus Arc Lamp and Electric Company, Limited, Hartham Works, Hartham-road, Holloway-road, London.

16608. Improvements in or in connection with means for electrically operating typewriting machines. Sidney Harper Haywood, 3, Brown-street, Market-street, Manchester.

16613. Improvements in electric time switches. David John Steele and Charles Kratt, 154, St. Vincent-street, Glasgow.

16619. Improvements in electric ignition apparatus for exploding gases in rotary or reciprocating engines. George William Somerville, 68, Owen-street, Accrington.

16637. Improved method of forming electromagnetic coils. William Liebert, 65, Chancery-lane, London.

16662. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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16653. **Improvements relating to starting switches for electric motors.** Stothert and Pitt, Limited, and Walter Pitt, 24, Southampton-buildings, Chancery-lane, London.

16659. **Improvements in electric switches.** Charles Smith, 33, Chancery-lane, London.

16663. **Improvements in electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16664. **Improvements in starting resistances for electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16667. **Improvements in arc lamps.** William Reginald Ridings, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

JULY 29.

16718. **A self-acting guide for trolley wheels of electric cars to facilitate catching the overhead line in the groove of the trolley wheel.** Albert Berkshire and Patrick Blanchfield Walsh, 16, Kingsland-road, Plaistow, London.

16723. **Improvements in compounding dynamo-electric machines for three-wire systems.** Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 31, 1903, being date of application in Germany.) (Complete specification.)

16729. **Improvements in contact shoes for electrically-propelled vehicles.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16746. **An electric automatic stop motion for lace machines.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (A. Pocheron, F. Cellery, and Co., France.)

16751. **Improvements in and relating to receptacles for elements or accumulators.** Heinrich Paul Rudolf Ludwig and Gustav Adolph Wedekind, 27, Chancery-lane, London. (Complete specification.)

16758. **Improvements in or relating to electrolytic electricity meters.** Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

16760. **Device for balancing the like poles of magnets or magnetic systems.** Hermann Gercke, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, July 31, 1903, being date of application in Germany.) (Complete specification.)

16762. **An improved method and means for joining together the ends of telegraph wires and the like.** Georg E. Schmidmer, 18, Buckingham-street, Strand, London. (Complete specification.)

16764. **Improvements in electric switches.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Voigt und Haeffner Aktien-Gesellschaft, Germany.)

JULY 30.

16789. **An overhead trolley wire cut-out.** Frank Edwards, 50, High-street, Aston.

16814. **Electric installation for transmitting the time.** David Perret, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 11, 1903, being date of application in Switzerland.) (Complete specification.)

16815. **Armature connection for motor electricity meters.** Julius Geyer, 61, Planufer, Berlin, Germany. (Complete specification.)

16820. **Electric winding-up device for clocks and other chronometrical instruments with or without clockwork.** Jean Baptiste Julien Sallin, 33, Cannon-street, London. (Complete specification.)

16837. **Improvements in connections for electric conductors, more especially intended for use with "earthed" pipes or pipes for protecting electrical conductors.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Hartmann und Braun Aktien-Gesellschaft, Germany.)

AUGUST 2.

16842. **Convertible electric cable connecting box for twin and single cored or wired waterproof cables.** George William Owen, Knowsley Hall Laundry, Knowsley, near Prescot, Lancs.

16846. **Improvements in time element devices applicable to electric circuit breakers and other apparatus.** John Grice Statter, Norfolk House, Norfolk-street, Strand, London.

16853. **An improved method of signalling for electric tramcars and the like.** George Wright, 15, Holley-gardens, Thorneywood, Nottingham.

16871. **Receiving telegraph instrument.** Charles Reginald Underhill, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16875. **An improved method of indicating the stopping places of electric and other street cars by day and night.** Frank Cochrane, The Rowans, Cheadle, Hulme, Cheshire.

16894. **Improvements in apparatus for electrically indicating the position of railway signals, points, or other gear.** Siemens Bros. and Co., Limited, and Luiz Moraes Gomez Ferreira, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16894. **A safety cable and suspender for the transmission of electric currents.** Ernest Marsh Ginders, 12, College-road, Moseley, Birmingham.

16910. **Improvements in wet magnetic ore separators.** Arthur Freemore Spooner, 323, High Holborn, London. (Magnetic Ore Separating Company Proprietary, Limited, Victoria.)

16932. **Improvements relating to electromagnetic brakes for vehicles.** Erwin Kramer, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 7, 1903, being date of application in Germany.) (Complete specification.)

AUGUST 3.

16964. **Improvement in the arrangement for lighting and extinguishing gas by the application of electricity.** George Hill, The Grove, Ashton-on-Mersey, Cheshire.

16968. **An enclosed arc lamp.** William Everitt Cook, 13, Wallness-terrace, Wallness, Pendleton, Manchester.

16978. **Art of electrical signalling.** Charles Reginald Underhill, 23, Southampton-buildings, Chancery-lane, London.

16985. **Improvements in and connected with arc lamps.** Francois de Zea Bermudez, 33, Cannon-street, London.

17006. **Improvements in electromagnetic relays.** Edward Tyer, Frederick Thomas Hollins, and Frederick William Leake, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17011. **An improved voltaic cell or element.** Philippe Delafon, 53, Chancery-lane, London.

17016. **Improvements in electric motor-control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17017. **Improvements in electric motor-control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17018. **Improvements in electro-pneumatic control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17019. **Improvements in alternating-current meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17020. **Improvements in emergency devices for brake systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17021. **Improvements in electric motor-control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17022. **Improvements in electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17023. **Improvements in electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17024. **Improvements in electric controllers for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17029. **Improvements in connection with guards for trolley wheels of electric tramways and the like.** Reginald Shaw, 18, Southampton-buildings, Chancery-lane, London.

17041. **Improvements in supports or insulators for telegraph and other wires.** Storr Garlake, 47, Lincoln's-inn-fields, London. (W. R. Portingale and H. W. Godwin, Cape Colony.)

17043. **Improvements connected with electric bells, indicators, and domestic telephones.** Shanker Abaji Bhisey, 38, Chancery-lane, London.

AUGUST 4.

17046. **A system of electric traction for railways and tramways.** Arthur Marshall, 38, Sunninghill-terrace, Loampit Hill, Lewisham, London. (Complete specification.)

17051. **Improvements in and relating to electrical switches, known as tumbler switches.** George Sperryn and William Henry Wood, 104, Colmore-row, Birmingham.

17058. **Improvements in apparatus for operating the points of electric tramways.** William Redfern Evans, 55, Market-street, Manchester.

17059. **Improvements in electromagnetic controlling devices.** Henry Mostyn Darrah and Lewis Arthur Hackett, 55, Market-street, Manchester.

17080. **Improvements in magnetic compasses.** Abel Edgar Morrall, New Club, Brighton.

17092. **Improvements in prepayment wattmeters.** Frank Walker, The Westinghouse Patent Bureau, Westinghouse-buildings, Norfolk-street, Strand, London.

17101. **Improvements in emergency brake-control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company United States.)

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17102. Improvements in air-brake systems and valves therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17121. Improvements in and relating to the electrolytic deposition of metals. Sherard Osborn Cowper-Coles, 70, Chancery-lane, London.

AUGUST 5.

17130. A new or improved contact breaker for electric ignition for gas and oil engines. Harry Frank Rogers and Frank Edward Brown, 29A, Longmore-street, Birmingham.

17133. An electric governer for internal-combustion engines. George Augustus Edward Roberts, Twyford, near Winchester.

17140. Covering a live electric rail. Richard Parkin, 28, Ingoe-street, Lemington-on-Tyne.

17169. An improved chain for suspending electroliers and the like. Charles Isaac Clements, 77, Colmore-row, Birmingham.

17162. Improvements in telephone and like sound transmitters and receivers, and in apparatus for recording and reproducing the sounds received. Ernest George Craven, 55, Chancery-lane, London.

17168. Improvements relating to gas or vapour electric apparatus. Stanwood Edwards Flitchner, Westinghouse Patent Bureau, Westinghouse-buildings, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Aug. 10, 1903, being date of application in United States.) (Complete specification.)

17176. Improvements in and connected with electric arc lamps. Georg Peritz, 6, Lord-street, Liverpool.

17181. Improvements in contact devices for apparatus for electrically lighting and extinguishing gas. Johan Fredrik Testor, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17190. An improvement in the manufacture of electric glow lamps to represent candles. Edward Alfred Gimingham, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17191. Manufacture of filaments for electric glow lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Albert de Madaillan, France.)

17196. Improved manufacture of plates and electrodes for electric accumulators and storage batteries. Georges Schauli and George Petrides, 173, Fleet-street, London.

AUGUST 6.

17201. An improvement in third-rail systems for electric railways. Alfred Edwin Hardaker, 12, Mayfield-road, Eccles, Lancs.

17207. Improvements in and relating to trolley pulleys for electric railways, tramways, and the like. Archibald Welsh, 96, Buchanan-street, Glasgow.

17220. A system of connecting monophase motors having armatures furnished with collectors employed in connection with electric rails and working together in pairs. Union Elektricitäts-Gesellschaft (in liquidation), 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 8, 1903, being date of application in Germany.) (Complete specification.)

17236. Improvements in electric transmission poles. John Laing Weller, 4, South-street, Finsbury, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 25, 1904.

1903.

17272. Device for electrically firing blasting cartridges and the like. Grainger.

18853. Electric relays. Armstrong and Orling.

19053. Method of guiding trolley-heads along frogs and crossings attached to overhead wires in connection with electric railways and tramways. Cooley.

20219. Surface contact and like systems of electric traction, and apparatus therefor. Boult and Boult.

21078. Party-line telephone system. Heide. (Lowry.)

22269. Brushes for electrical machines Gibson.

23793. Electrically operated trains. Lüdorf.

1904.

3882 Dynamos. Deutsch.

8297. Systems of electrical distribution. Hewitt. (Date applied for under International Convention, April 25, 1903.)

8321. Receiving apparatus for use in wireless telegraphy. Möller.

8963. Arrangements of electrically-driven fluid-compressing pumps and pressure-controlled electric switches therefor. Hyde.

9397. "Clusters" for incandescence electric lamps. Dale.

9468. Method of and apparatus for heating the charge of electric furnaces. Neuburger and Minet.

14143. Vapour electric lamps or rectifiers. Kruh. (Date applied for under International Convention, June 22, 1903.)

14169. Electromotive apparatus for electric clocks and other mechanism. Palmer.

14814. Clip for clamping or binding the trolley wires to fittings in overhead wire systems of electric traction. Luby and Harris.

14815. Section insulator for overhead wire systems of electric traction. Luby and Harris.

14911. Electric arc lamps. Bellardent. (Date applied for under International Convention, Sept. 5, 1903.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	⅛-¼
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	5¾-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5¾-6 xd
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	101-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅜-3¼
—— 4 per cent. Mortgage Debenture Stock	100	–	86-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,751 ..	2	–	¼-1
—— Non. Cum., 6 per cent. Pref.	2	–	¾-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	96-99
—— 4½ per cent. 2nd Debenture Stock	100	–	71-76
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9¼-10¼
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	3	–	1¼-2
—— 5 per cent. Debentures	100	–	94-97
Edison and Swan United, "A" Shares, 1-99,251	5	–	¼-½
—— "A" Shares, 01-017,139	5	–	1-2
—— 5 per cent. Debentures	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼ xd
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	11-12
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-18¾
—— 4 per cent. Debentures	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	35-38
—— 5 per cent. Bonds	100	–	99-102
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200 ..	1	–	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv. ..	100	–	102-106
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	–	102-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary	5	–	10¾-11¼
—— 7 per cent. Preference	5	–	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 ..	5	–	7-7¼
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	106-109
Charing Cross and Strand, Nos. 1-70,000	5	–	7¼-8
—— 4½ per cent. Cum. Pref.	5	–	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	105-109
City of London, Ordinary	10	–	10¼-10¾
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	102-105
County of London Electric Supply, Ordinary	10	–	7¼-8¼
—— 6 per cent. Cum. Pref.	10	–	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	100-103
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6 6¼ xd
—— 6 per cent. Cum. Pref.	5	–	5¾-6
—— 4½ per cent. First Mort. Deb.	100	–	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	99-102 xd
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13 xd
—— per cent. Debenture Stock Red	100	–	102-105
Kensington and Knightsbridge and Notting Hill	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1¼-1¾
—— 6 per cent. Pref.	5	–	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	94-97
Metropolitan Ordinary	10	–	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	108-112
—— 5½ per cent. Mortgage Debenture, Red.	100	–	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14-15
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) ..	100		100-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510.....	5	–	5¾-6¼
—— 4 per cent. Debenture Stock	100	–	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2¾-3¼
—— 4 per cent. Debenture Stock	100	–	85-88 xd
South London, Ordinary			3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	14-15 xd
—— 7 per cent. Pref.	5	–	8-9
—— 5½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 6-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¾-5¼
Westminster, Ordinary	5	–	12¾-13¼ xd
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	5-5¼

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 –	89-91
—— 4 per cent. Pref.	100 –	102-104
—— ,, ,, deferred	100 –	79-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 –	106-109
City and South London, Consolidated Ordinary	100 –	44-46
—— 4 per cent. Debenture Stock	100 –	105-108
—— 5 per cent. Pref. Stock '91	100 –	123-126
—— ,, ,, ,, '96	100 –	120-123
—— ,, ,, ,, '01	100 –	115-122
Liverpool Overhead, 5 per cent, Pref.	10 –	10-10¼
—— Ordinary, 1-50,000	10 –	3¼-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	– –	99-101
Waterloo and City, Ordinary	100 –	89-92
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 –	5¼-5½
—— Permanent 5 per cent. Debenture Stock, 1888	100 –	137-141
Blackpool and Fleetwood Tramroad	10 –	13⅝-13⅞
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 –	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 –	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 –	96-101
British Columbia Electric Railway Co., Ord. Def.	100 –	99-102
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 ..	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 –	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	97-100
British Electric Traction Ord. 1-500,000 & 60,001-90,000	10 –	8⅜-9¼
—— 6 per cent. Cm. Pf., 50,001-60,000	10 –	10¾-11¼
—— 5 per cent. Perpetual Debenture Stock	100 –	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	2⅞-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 –	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 –	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 –	106-108
—— Prov. Cert., all paid	100 –	101-104
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅞-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-103

Name.	Amount paid.	Last price
	£	£
Cork Electric Tramways and Lighting Co., Ordinary	10 –	9½-10
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12½-13½ xd
—— 5 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 5½ per cent. Mort. Debs., 1-5,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18-19
—— 6 per cent. Cum. Pref.	all –	14-14½
—— 4½ per cent. Deb Stock	100 –	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 50,001-60,000	5 –	3¼-4
—— 4 per cent. Debenture Stock	100 –	88-91
Kidderminster and District Lighting and Traction, Pref.	5 –	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10½-10¾
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	103-105
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 –	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 –	¾-1
New General Traction, Ordinary	5 –	¼
—— 6 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 –	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12½
—— 5 per cent. Cum. Pref.	10 –	9⅞-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 –	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	9-10
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,152 6 per cent. Preference	1 –	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. –	100 p.c.
Telephones.—		
National Telephone, Preferred	100 –	103-105 x
—— Deferred Stock	100 –	86-89 xd
—— 6 per cent. Cum. First Pref.	10 –	12-14 xd
—— 6 per cent. Cum. Second Pref.	10 –	11-13 xd
—— 5 per cent. Non-Cum. Third Pref.	5 –	5-5½ xd
—— 5½ per cent. Deb. Stock, Red.	100 –	97-99
—— 4 per cent. Deb. Stock, Red.	100 –	103-105
Oriental Telephone and Electric Company	1 –	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 6	1,664	1,378	+ 285	+14,735h	13½	13½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Aug. 6	34	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 7	1,227	1,225	+ 2	+ 218	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 6	6,224	5,572	+ 650	+11,320	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 5	1,012	834	+ 178	+ 1,757	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 4	2,871	2,078	+ 793	+ 2,318	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	July 30	1,232	1,176	+ 115	—	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	Aug. 7	1,931	1,938	+ 43	+ 201	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 3	1,713	1,654	+ 49	+ 1,302	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 1	4,800	4,011	+ 789	+15,937	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 7	2,211	1,722	+ 489	+ 1,632h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 5	7,008	6,613	+ 395	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 6	1,044	902	+ 142	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 7	505	—	—	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 6	2,813	2,596	+ 216	+ 1,152	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 6	251	250	+ 1	+ 309	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 6	5,656	6,115	– 449	– 1,970h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	36·6a
City & South London Railway	,, 7	2,242	2,353	– 111	– 810h	6⅝	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 4	555	971	– 415	– 1,730	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 5	231	222	+ 8	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 6	370	341	+ 29	—	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 5	177	132	+ 45	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 5	4,740	4,473	+ 217	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 5	1,551	1,373	+ 183											
Dundee City Tramways	,, 3	876	872	+ 4	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 6	995	990	+ 5	+ 1,234	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 6	14,901	13,097	+1,804	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 3	550	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	July 27	3,343	3,066	+ 277	+ 1,871	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	Aug. 8	2,517	1,445	+1,071	—	34	34	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 6	2,583	2,097	+ 486	+ 5,159	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	July 9	528	552	– 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Aug. 4	207	254	– 47	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 3	240	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 6	7,909	6,764	+1,245	—	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 6	2,087	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	July 30	10,953	10,700	+ 253	+11,081	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Aug. 7	1,768	1,951	– 193	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	July 2	13,329	11,485	+1,844	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 31	357	332	+ 19	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	Aug. 6	13,820	13,149	+ 671	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 6	123	92	+ 31	+ 837	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corpn.	,, 6	3,965	3,751	+ 214	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 6	777	717	+ 60	+ 1,956	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,026	+ 466	+ 3,451	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Aug. 4	645	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 1	4,887	4,257	+ 330	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 6	626	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 7	5,288	5,887	– 599	—	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	July 28	1,031	1,109	– 77	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Aug. 3	805	659	+ 146	+ 851	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 5	806	411	+ 394	+ 4,977	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 7	1,786	1,855	– 69	+ 645	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	,, 6	1,099	1,047	+ 52	—	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 4	1,472	—	—	—	1⅞	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 3	1,003	460	+ 543	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Report on Naval Boilers.—In connection with the various trials, which have been recorded in these columns from time to time regarding the types of boilers to be used in the navy, the final report of the committee appointed to deal with the question has just been published, in which they recommend the adoption of the Babcock-Wilcox and the Yarrow large-tube types.

The Institution Journal.—The issue of the Institution *Journal* dated July contains Messrs. Edgcumbe and Punga's paper on "Direct-Reading Measuring Instruments for Switchboard Use," with discussion; "The Steam-Turbine as applied to Electrical Engineering," by the Hon. C. A. Parsons, Mr. G. G. Stoney, and Mr. C. P. Martin, with discussion; "The Distribution of Electricity in Shipyards and Engine Works" (Newcastle Section), by Mr. J. A. Anderson, with discussion; and "Steam-Turbines" (Dublin Section), by Mr. F. C. Porto, with discussion.

Yorkshire Electric Power Company's Progress. The power station for this great undertaking is practically complete so far as the structure is concerned, and such rapid progress is being made in the construction of the plant and the laying down of the mains, that the company expect to be quite ready to supply energy by December, in accordance with several contracts which they have already entered into. The exhausters and condensers are partly fixed, the boilers and flues have been practically completed by Messrs. Babcock and Wilcox, the water-drums are being erected, the automatic stokers are already fixed, and an extensive scheme of cables is being proceeded with.

North-East Coast Institution of Engineers and Shipbuilders.—We have received a copy of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, dated July, which contains the resumed discussion on Mr. F. H. Alexander's paper, "Longitudinal Engine-Room Bulkheads in Merchant Vessels in Relation to Transverse Stability when Bilged," with Mr. Alexander's reply; the resumed discussion on Mr. H. M. Wilson's paper, "Automatic Governing of Marine Engines," with Mr. Wilson's reply; and a paper by Engineer-Lieutenant E. F. Baker, R.N., on "The Management of Belleville Boilers at Sea," with the discussion on same.

Live-Rail Precautions.—A correspondent to the *Times* suggests that, in view of the number of accidents recently reported, owing to contact with live rails, it would be advisable that some protective marking should be adopted wherever such rails or fittings are exposed to the public. The marking should be compulsory and uniform throughout the kingdom, and should act as a warning or indication of danger by day or night. He proposes that a black and white chequer or stripe should be used for this purpose and painted on the rails or fittings, universally indicating danger. This is an excellent idea, and we are not sure that it has not been adopted in places.

Centre Poles in Streets.—It will be remembered that a few weeks back the Roads Improvement Association approached the Board of Trade with a view to securing the prohibition of centre poles, while they also made representations upon other matters. The Board has now sent a reply. With reference to centre poles, it does not see its way to recommend their prohibition, but is prepared to exact that these shall not be used without the express consent of the Board. On the question of a statutory limit for the width of roads, the Board does not think it would be advisable to fix one, as such a proceeding might have the effect of prohibiting urgently needed lines. The question of road bridges over railways and canals, the Board state, should be dealt with by the Local Government Board.

Telephone Service to France.—A heavy-gauge telephone circuit having been erected between Calais and Lille, some further experiments have been made in telephonic communication between England and the North of France, and it has been found that it will be possible to extend the service. On and from Sept. 1 communication by users of the Post Office system will be practicable between London and Abbeville, Amiens, Aniche, Anor, Armentieres, Arras, Bethune, Boulogne-sur-Mer, Calais, Cambrai, Denain, Douay, Dunkirk, Fourmies, Lens, Lille, Masnidres, Montreuil, Peronne, Roubaix, St. Omer, St. Quentin, Tourcoing, Valenciennes. The charge for each period of three minutes will be 8s.

Electric Lighting Pamphlet.—An excellent little pamphlet on the advantages to tradesmen of using electric light is published by Messrs. Jacomb Bros., of Wingfield-road, Stratford. The author, Mr. G. Rockley, has been employed by the electricity department of the West Ham Corporation for some years as official canvasser and general outside representative, and in this booklet he strikes out quite a new line, particularly in enlarging upon the special advantages of the electric light from the stock-keeper's standpoint, rather than by relying on the usual arguments to controvert the exaggerated circulars of the gas companies. Many of the reasons advanced by the author in favour of the adoption of electric lighting by tradesmen of all kinds are distinctly cogent. The publishers supply this booklet at the rate of £1. 12s. 6d. for 250, or £5. 5s. per 1,000.

The Forms of Sulphur in Coal.—The *Journal* of the American Chemical Society contains some notes by Mr. E. E. Somermeier on the forms in which sulphur occurs in coal, their calorific values, and their effects on the accuracy of the heating powers, calculated by Dulong's formula. The author observes that the estimation of the calorific value of coal from the ultimate analysis involves the calorific value of the sulphur present. When the amount of sulphur is large, the question is important, especially as to how the heating value is affected by the different forms in which sulphur may occur. The author has studied the question experimentally. Since pyrites does not burn completely in a calorimeter, the samples used were burned with coal. As an average of three determinations with one sample and four with another, the value 2,637 calories for 1 grm. of pyrites was obtained. With 53·2 per cent. of sulphur in the pyrites, the calorific value per gramme of sulphur as pyrites is 4,957 calories; 2,915 calories is the heat of combustion of 1 grm. of sulphur as pyrites under ordinary conditions of combustion.

Tramway up Mont Blanc.—The conditions of a concession to a financial syndicate for an electric tramway up Mont Blanc are, according to the Paris correspondent of the *Standard*, as follows: The line is to start from Le Fayet, St. Gervais, and the route to be followed is to include stations at St. Gervais-les-Bains, Motivon, the Col de Voza, the Pavillon de Bellevue, Mont Lachat, Les Rognes, Tete Rousse, and the summit of the Aiguille du Gouter. The final plans are to be presented within a year of the signing of the decree, and the construction of the railway must be commenced within another year, and prosecuted in such a way that it is completed within a period of six years from the commencement of the work. The gauge of the railway is to be 3·28ft., and the minimum number of journeys to be made daily each way from June 15 to Sept. 15 is fixed at two. The trains will be composed of two carriages, and the maximum speed is to be five miles

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an hour. The fares will be calculated upon a scale of 2s. per mile, and for goods or luggage the rate is to be 4s. per ton per mile.

Sound-Proof Telephone Apartment.—The *Western Electrician* of Chicago describes a telephone booth manufactured by the Yesbera Manufacturing Company, of Ohio. This booth has double walls. The inside and outside walls both extend to the floor on which the booth stands. The edges of the booth floor fit into grooves ploughed crosswise of the inside walls. The inside walls are first put into position, the edges of the side walls fit into grooves ploughed lengthwise of the front and back walls; screws draw them tightly together at the corners of the booth. The outside walls are put into position and fastened in the same manner as are the inside walls. The ceiling fits over the inside walls, the top over the outside walls, giving a clear air-space on all sides and at the top. The floor rests on felt cushions. The outside and inside walls are held the proper distance apart by four small cushioned blocks at the extreme corners of each side. The doors walls are separate, and swing on different sets of hinges, necessitating the use of an adjustable extension lock, which is supplied with each booth. By this construction the best possible sound-proof qualities are obtained.

Cost of Trackless Trolley Roads.—The figures furnished by the Berlin General Electric Company show that a trackless overhead trolley car capable of holding 22 passengers uses about the same amount of electric current as an ordinary street car with accommodation for 28 passengers, representing a higher cost of some 25 per cent. It should also be remembered that the maintenance of the cars, owing to a greater wearing out of the rolling-stock and extensive need of lubricators, etc., is larger than on track cars, though in the latter case provision has to be made for repairs to the permanent way. The total operating costs worked out at about 4d. per mile. Favourable figures are also given for the operation of the trackless line in the Bila Valley. According to the latest reports, after three months' operation the cost of electric current was double that of a track road. This greater utilisation of current, however, is calculated to represent only one-tenth of the sum which track roads require for interest and maintenance. A large part of the income of these trackless roads is obtained by carrying goods. It has been found that the streets are not at all injured by the trackless cars.

The American Visit.—The programme in connection with the forthcoming visit of the Institution to America has now been finally settled, and contains a large quantity of highly useful information, the substance of which has, however, been given in previous issues of this journal. A special notice intimates that arrangements have been made for the United States Custom House officials to board the steamer "Republic" shortly before arrival in Boston in order to pass the baggage and personal effects, thus obviating any delay on landing. The White Star Company have also kindly agreed to make special provision for facilitating the customs examination and the immediate transport of the luggage to the hotel in Boston by placing the luggage of the whole party together in the baggage room. To enable this to be done, all luggage not specially wanted on the voyage should be dispatched beforehand to Liverpool, each member consigning it to himself, addressed: "Passenger by s.s. 'Republic,' sailing Aug. 25, White Star Line, Canada Dock, Liverpool." This notice does not apply to luggage required in the state-rooms during the voyage, which need not be forwarded in advance. The White Star Company are sending to the members their own baggage-room labels, in addition to which the Institution labels must also be affixed to all articles for the purpose of identification. The labels for the hold previously sent out by the White Star Company are to be discarded, but the state-room labels must be kept for the hand luggage.

The Weybridge Injunction.—The Weybridge Urban District Council has obtained an injunction against the Urban Electric Supply Company, to which it transferred its electric lighting order, restraining the company from supplying the adjoining parish of Walton. The injunction was granted by Mr. Justice Joyce, and the effect of it is to prevent the company from supplying energy outside the Weybridge area, the defendants being prohibited from disturbing the Weybridge roads to lay mains for this purpose. Though we have not the full facts of the case before us, the Urban District Council do not appear to have exhibited much business acumen. It is surely to the advantage of the inhabitants of Weybridge that the company should supply energy at the lowest possible rate. The demand is a prominent factor in the rate, and by going to adjoining districts the company obtains a larger demand, and consequently is able to produce more cheaply. We gather that objection to the generating station at Weybridge was one of the causes for the application for the injunction. His Lordship, however, implied that the company might overcome the difficulty by approaching the Board of Trade for a license to supply energy outside the Weybridge area, and granted a stay of the injunction for this purpose.

The Telephone Question.—The Postmaster-General has replied, in the form of a parliamentary paper, to a question by Mr. Claude Hay with reference to the transfer of the National Telephone Company's undertaking to the Government. Mr. Hay asked the Postmaster-General "whether, in the event of his coming to an arrangement with the National Telephone Company during the autumn as to the purchase of their undertaking, he will give the House an opportunity of discussing the terms of purchase before the Government are committed to the same, in order that the interests of the users of the telephone and the taxpayers may be properly protected; whether he will agree in any event to refer the agreement (if any) to a Select Committee; and whether, in the event of his deciding to postpone the purchase until 1911, he will reduce the rates of the Post Office service, especially the charge for unlimited service." Lord Stanley reiterates his pledge that no agreement for purchase between the Post Office and the company will be considered binding until the House of Commons has had an opportunity of expressing its opinion thereon. In regard to the rates charged for the Post Office service, Lord Stanley states that this matter must be considered on its merits, apart from any question of purchase.

Hydro-Electric Scheme for Simla.—It is reported that the committee appointed by the Punjab Government to investigate the question of increasing the water supply of Simla will submit its report in a few days. The members have definitely rejected General Beresford-Lovett's scheme, so far as it relates to the pumping of water from the Sutlej, but have, at the same time, decided that the electrical power shall be derived from Nauti Khud. It is understood that they will recommend a modification of a project worked out by the Public Works Department of the Punjab in 1889 for tapping the streams north of Mahasu, where a very ample supply is obtainable. The motive power will, as suggested by the Simla Extension Committee of 1898, be derived from the water of the Naut-Khud stream, and will be transmitted electrically to the pumps, which will be situated in the bottom of the valley below Phagu. If the recommendations of the committee now assembled are accepted, practically all the houses at

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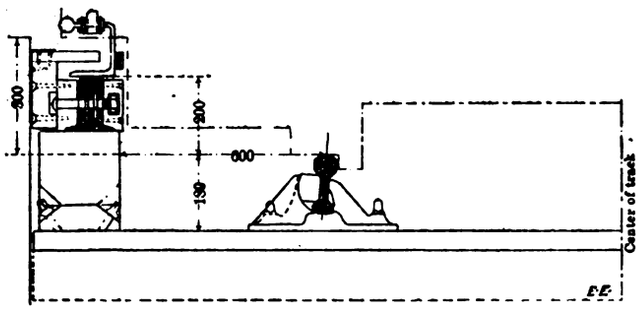
Mahasu and Mashobra, as far as Naldera, will be served from the new water-mains, and an increase of the supply up to one million gallons a day can be sent into Simla to meet the future demands of population, and still leave a margin for further extensions. The cost of the hydro electric installation will be about 10 lakhs, which sum will not only provide electric power for the pumps in the day-time and electric light at night, but will also include the cost of the laying down of electric mains all over the station for public and private lighting.

Third-Rail System of the Paris-Orleans Railway.—A description is given in the *Street Railway Journal* of the Paris-Orleans Railway Company's extension of their third-rail system. The newly-electrified section, which is some dozen miles in extent, covers the suburban districts between the Paris (Austerlitz) terminus and the important junction at Juvisy. As on the New York Central, the trunk-line trains also will be hauled over the converted section to the terminus by electricity. It will be seen from the accompanying diagram (in which the dimensions are



given in millimetres) that the distance between the running rail and the third rail carrying the current is considerably in excess of the standard practice in England. Thus, while the exact distance between the inner edge of the running rail and the third rail is not given, the dimension shown of 600mm. indicates a distance of considerably over 2ft., whereas the standard agreed upon at the conference of English railway companies was 1ft. 7½in. Again, the height of the third rail is nearly 8in., as against 3in. on English lines. The wooden protection shown is not unlike that which has been adopted in this country for protecting the third rail in stations.

The Labour Market in 1903.—The report of the Labour Department of the Board of Trade for 1903 on the subject of changes in rates of wages and hours of labour in the United Kingdom shows that the coal-mining, iron and steel, engineering, shipbuilding, and glass trades were the ones most affected by the fall in wages during the year. The fall, taking all industries, was, however, less than in the two preceding years. In the industries for which it was possible to obtain definite statistics with regard to the number of persons affected, the report shows that about 897,000 workpeople had their wages changed during 1903. Of this number about 21,000 obtained increases amounting to rather more than £1,500 per week, while 875,000 sustained decreases amounting to more than £39,800 per week. The net result of all the changes reported to the department in 1903 was thus a decrease of £38-300 in weekly wages, compared with decreases of £72,700 in 1902 and £77,300 in 1901. When the various dates at which the changes came into operation are taken into account, the net decrease in the year's wages bill due to the changes recorded in this report may be roughly estimated at £500,000, as compared with decreases of £2,300,000 in 1902 and £1,600,000 in 1901. It is satisfactory to note that in 1903, as also in 1901 and 1902, the number of workpeople whose changes in wages were preceded by a stoppage of work formed but an insignificant fraction of the whole, the percentage affected in 1903 being only 1·5 per cent. of the total. Changes affecting 78 per cent. of the total number of workpeople affected were arranged by conciliation, arbitration, wages boards, sliding scales, or other conciliatory agencies, though these percentages do not take account of abortive strikes. The changes in hours of labour recorded in 1903 were unimportant, but those which took place resulted in a net reduction. The number of workpeople affected was the lowest recorded in any year since the statistics were first collected in 1893.

Wireless Telegraphy Bill.—This measure, upon which we expressed our views a week or two ago, has become law in practically the form of the draft Bill, and it may be of interest to record the attitude of the Government as voiced by Lord Selborne, who moved the second reading in the Upper Chamber. His Lordship stated that the Bill did not attempt to settle once for all the great questions which were beginning to be raised by the introduction of wireless telegraphy—questions which affected the defence of this country, the trade and internal communications of this country, and the progress of the invention, since the measure was of a tentative character, and would expire in two years. In view of experience in the matter of electricity, there was a good deal of disinclination to settle this question in a manner which might have the effect supposed to have been produced by the legislation passed 20 years ago in dwarfing and checking the progress of invention. He thought that the plan adopted by the Government obviated those difficulties and disarmed criticism, and, at the same time, met two very pressing needs. In the first place, it was a standing danger to the defence of this country by land and by sea that there was no method of controlling wireless telegraphy at all. It was perfectly possible for anybody who chose to do so to set up a wireless telegraph installation and to communicate with anybody by sea or across the Channel. It was really a pressing necessity of national defence that power should be taken to control all installations of this kind. A peculiarity of wireless telegraphy was that unless it was controlled its utility might be negatived, and nothing but chaos would supervene. If the coast were studded with wireless telegraph stations under no control and competing with each other, proper communication would be impossible, and ships would not be able to communicate with the shore. Therefore, for the proper civilised use of the invention, control was essential. The third point was that at this transition period it was very important that vested rights should not be allowed to grow up which the State hereafter might have to purchase at an immense cost. These three points were dealt with in the Bill, though no attempt was made to arrive at a permanent settlement.

New South Wales Department of Mines.—The annual report of the New South Wales Department of Mines for the year 1903, just received, contains an abundance of information upon the mining industries of that State. In the first place, the document records that the improvement anticipated was realised, increases being shown in nearly all the metals and minerals found in that region. The value of the year's production was £6,059,486, being a net increase of £421,341 over the previous year. The coal obtained amounted to 6,354,846 tons, representing an increase in value over the previous year of £113,061. The gold produced totalled 295,778oz., signifying an increased value of £395,059. Copper, however, showed the greatest advance, the 9,200 tons obtained indicating an enhanced value of £122,263 over the previous year's

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output. In regard to iron, however, matters are at a standstill, and nothing is likely to be done until the report of the Royal Commission has been considered by the Federal Government. The total number of persons engaged in the mining industries is estimated at 37,559, as compared with 33,695 during the previous year. An electric apparatus for relighting safety lamps was introduced into several coal collieries. A Jeffrey electrical coal-cutting machine was introduced into one of the mines with satisfactory results, and it is understood that electrical machines will be employed by a number of proprietors in the near future. In one section of the report it is stated that a certain amount of dissatisfaction has been expressed with the mining laws, which are regarded as illiberal compared with those of other countries, and it is considered that more generous provisions in reference to tenure are needed, so as to attract more capital to the mines. It is also considered that the consolidation of the various Acts would be of great benefit, as their number tends to complicate their administration. During the year the Legislative Assembly passed a Bill to regulate wages in coal mines, and another to limit the period of employment below ground in coal mines to eight hours a day, but both were rejected by the Legislative Council. The report states that there is every reason to hope for a continuance of the improvement in the mining industries during the ensuing year.

Electric Traction at Hong Kong.—News reaches us of some successful trials over the completed portion of the new electric railway at Hong Kong, for which Messrs. Dick, Kerr, and Co. are the contractors. The initial run was made at the commencement of last month, the first car to leave the sheds being run under the direction of Mr. Emerson, superintending engineer. Mr. Hackwood inspected on behalf of the consulting engineers, Messrs. Dickinson, of Birmingham. The party in this first car included, besides those above mentioned, Mr. Scott, general manager; Mr. Windsor and Mr. Graham, of Messrs. Dick, Kerr, and Co.; Mr. Graham, of the Callender Cable Company; Mr. Fung Wa Chun; and Mr. Chan A. Tong. The car, leaving the sheds at four o'clock, headed for Bowrington Canal, and then ran along Morrison-hill-road. It returned shortly afterwards along the Praya, and stopped at No. 2 Station. After remaining there for a while it was run back to the sheds. The trial was quite a success, and the car ran smoothly along the rails. After the return of this first car another preliminary run on another car was taken under the direction of Mr. Scott, the general manager, who was accompanied by Mr. A. Course, traffic superintendent, and the staff of inspectors. The same course was travelled over, and with all success. Much interest was taken by those present in the smart behaviour of the Chinese motormen and conductors. Mr. Scott said that so far he had every reason to be quite satisfied with the manner in which they had come through the trial. The organisation of an efficient staff has been no easy matter. The men were all new to the work, and it has been necessary for the Chinese motormen and conductors to learn the names of all the different parts of the car. Henceforward, until the opening of the entire system, the Chinese motormen and conductors are to be subjected to rigid training, and there will be trial trips each day. No pains or expenses are being spared to organise a thoroughly efficient and reliable staff in which the public can place confidence. The opening of the tramways to the public awaits the completion of the track along Arsenal-street. A local journal credits a Celestial who witnessed the opening ceremony with the remark: "No makee pull, no makee pushee, how fashun can makee run?" which observation, or something pretty similar, does not sound altogether unfamiliar.

Electricity in the Philippines.—The Manila correspondent of the *American Electrician* contributes to the August number of that journal an interesting account of the somewhat crude materials which electricians in the Philippine Islands are often compelled to use. After a rather amusing description of the implements employed by native helpers of the Electrical Corps of the United States army, he calls attention to the odd style of combination bamboo poles which one is obliged to use in certain parts of the Philippines, where other stock is not available. Fig. 1 represents one of these combination poles, consisting of a dozen or two of the slender, elastic bamboo pieces united as shown in the illustration, and bound up with wrappings of cord and sometimes wire. The great advantage of this type of pole is, it appears, that it will stand a great deal of typhoon and earthquake without fracturing—no small consideration in that tempestuous region. The poles are often bent over by the high winds, but seldom break. They are difficult for the American wiremen to ascend, but easy to the barefooted native wireman. Cross-arms for poles are often constructed on the rather crude yet effective and practical style shown in Fig. 2. The cross-piece is usually cut through and the pole inserted as shown.

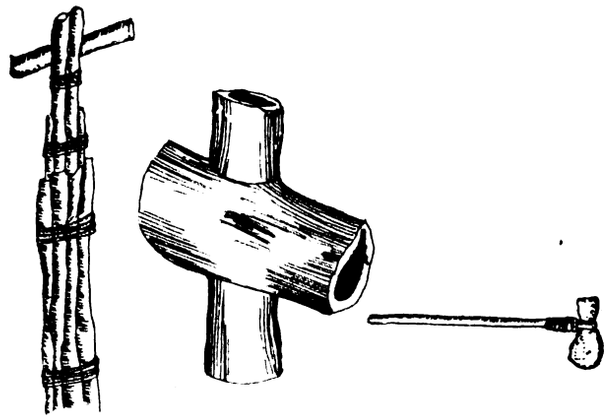

FIG. 1. FIG. 2. FIG 3.

Nails or screws are seldom used; sometimes wooden pins are driven in to secure the parts. The design of hammer frequently observed in the belt of the native wireman is illustrated in Fig. 3. The hammer-head is made of stone or metal, and bound to a handle of hard wood with wrappings of split vegetation, thoroughly dried and exceedingly tough.

The Pacific Cable.—A White Paper issued by the Government on the Pacific cable contains, in addition to a formal statement of the money issued under the provisions of the Pacific Cable Act, a report by the Pacific Cable Board to the effect that during the year 1903-4 the cable was maintained and remained in efficient working order, and no interruption of any kind occurred. The gross message revenue received during the year was £81,832, and the net message revenue £79,824. The number of messages and words transmitted during the year were 176,351 and 2,095,573 respectively, of which 107,747 messages and 1,226,460 words were inter-Colonial. In January last the Fiji Government opened telegraph communications between Suva and Levuka. The actual expenditure of the Board on the service of the cable during the 12 months ended March 31 last amounted to £54,824, or £25,000 less than the gross receipts. As, however, the Board set aside during the year under review £35,500 as a renewal fund, and as it has also to pay an

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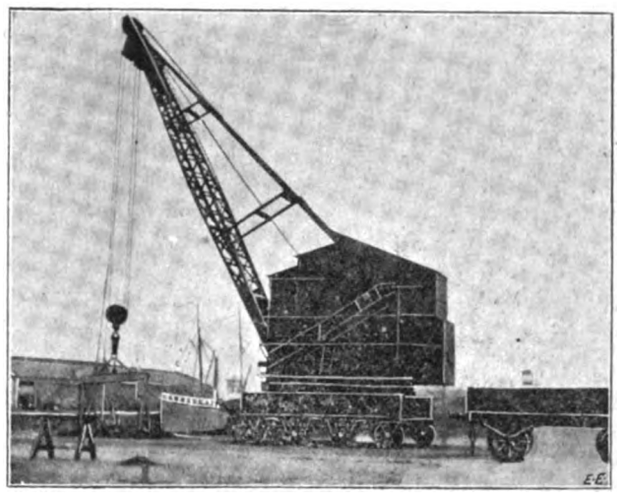
annuity of £77,544 to meet the interest on its capital and to replace the whole capital in 50 years, the actual deficit amounted to rather more than £88,000, and that sum has to be provided by the contributing Governments. The renewal fund amounted to £52,000, of which £12,500 was held in spare cable. The Board hesitates to make any exact forecast of its probable revenue and expenditure during the current year, but if no contingencies arise, it believes that after providing for the annuity, renewal fund, and working expenses there will be a deficit of £89,810. The Board believes that as one result of the construction of the cable and the competition to which it has led, the average time of transmission between Australasia and the United Kingdom has been sensibly reduced. Arrangements have been made for provisioning outlying stations, and the Board has endeavoured to supply its officers with rational means of amusement. A post office and a Lloyd's signal station have been instituted on Fanning Island, and if a lighthouse were provided the Board considers that the place would be of value to merchant vessels and the navy. The Board is glad to know that a conference will immediately be held in London between the representatives of the various Governments interested in the cable under the presidency of the Secretary of State for the Colonies, with the object of settling certain matters at issue between them, and believes that the meeting will have the effect of solving many difficulties and indirectly promoting the prosperity of the cable.

Electricity in Mining.—A new type of electric locomotive for gathering the coal in mines has been devised by the Jeffrey Manufacturing Company, of Columbus, Ohio, the distinctive feature of which is that it can be operated without earth rails or overhead wires. Locomotives of this type are made with a total height of as low as 29in. A flexible cable, insulated with the best rubber and protected from mechanical injury by heavy braidings, is wound upon a reel, which, with a spooling device, is mounted at one end of the locomotive. The cable is connected to terminals provided for the purpose, and is automatically paid out as the locomotive recedes and rewound upon the reel, in even layers and in uniform tension, as it returns. The cable is of sufficient length to permit the locomotive to reach the greatest depth of rooms found in mining practice. A cable with a single conductor is used when the tracks in the rooms are laid with steel rails, but when the track is laid partly with steel and partly with wooden rails, it becomes necessary, in order to convey the current required, to employ a cable with twin conductors. All electric contacts and conductors are substantially enclosed in dust-proof compartments, so that it is quite impossible for them to be touched accidentally. A standard trolley is provided for use on any portions of the track where there is an overhead wire. The reel is operated by a friction clutch, which is positively driven by a silent running chain and sprocket from the motor, the control of the clutch being placed within easy reach of the man at the operating end of the locomotive. The speed of the cable-reel when the cable is being wound up is such that it tends to produce a slight tension in the unwound portion of the cable; in other words, the cable is wound up faster than the locomotive advances on the track. When the tension of the cable is increased the friction clutch allows the reel to slip, and thus prevents injury to the cable from excessive tension. The clutch can be adjusted to produce any tension desired on the cable, but from practical tests it has been found that about 25lb. is sufficient. Thus, when the locomotive is running the winding of the cable is positive, regardless of speed, and the locomotive can never run over it. When the reel is unwinding the cable, as when the locomotive is going into a room, just enough tension is automatically kept on the cable to prevent it from kinking, should it have a tendency to do so. With this device the cable is not dragged over the ground, but is merely laid down as it is paid out and again picked up as it is rewound upon the reel. The even winding of the cable is accomplished by a spooling device of simple construction. We summarise the preceding from *Dun's Review*.

Electric Coal Cranes in Scotland. — Electric cranes, both for coal loading and general goods work, are going to displace hydraulic cranes in Scottish ports. Glasgow has just placed an order for six cranes for the Clydebank Dock with a Bath firm. Exhaustive trials with a crane in the Princes Dock have led to this action on the part of the Clyde Trustees. At Leith the first electric coal crane was erected—in the Victoria Dock—by a Carlisle firm recently, and at present additional rails are being laid so as to add to its usefulness. It replaced an old steam crane which had been in position for nearly 50 years. In the other docks in Leith the coal hoists are all hydraulic worked, but so great has been the satisfaction with this new one that there is no likelihood of any other cranes being erected but those driven by electricity. This Carlisle (Covans, Sheldon, and Co.) built crane runs upon a railway, 15ft. gauge, and has a normal lifting capacity of 25 tons at a radius of 29ft., although it has been successfully tested with a load of 32 tons. It is



driven by three motors — one for main lifting, one for revolving, and one for derricking. This latter motor is also used for travelling the crane, the change of gear being effected by clutches. The electric current is taken from the town installation, and is conveyed to the crane through a flexible armoured cable into a collector fixed on the crane carriage, and from thence to the switchboard, and so to the different motors. At intervals along the wharf connecting boxes are placed for bringing the flexible cable into contact with the main cable. The carriage upon which the crane is mounted is built of steel, and runs upon four pairs of wheels, the front and back pairs being geared for travelling the crane, and the two centre pairs having sliding bearings on springs to ensure each wheel getting its due proportion of the superincumbent weight. The centre pillar is a steel forging having a solid head, under which runs a series of case-hardened steel rollers. Steel-wire ropes are used, the barrels being large enough to allow of the full length of rope being wound upon them without any overlapping. The main rope is 410ft. long by 4in. in circumference, and that for tipping is 114ft. by 3½in. All the machinery in connection with the crane is enclosed in a large steel house, with windows so arranged that the engineman has a view of the work he has to do.

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THE BRITISH ASSOCIATION.

CAMBRIDGE MEETING, 1904.

[BY OUR SPECIAL CORRESPONDENT.]

CAMBRIDGE, *Wednesday.*

This year's meeting of the British Association at Cambridge promises to be a great success, both as regards numbers attending and from the interest of the papers to be read. The accommodation for presidential address and the lectures is already completely filled, and arrivals to-day have mostly been disappointed in their applications for seats. These lectures are respectively:

"The Origin and Growth of the University," by Mr. J. Willis Clark, M.A., in the theatre on Thursday, Aug. 18, at 5.30 p.m.

"Ripple-Marks and Sand-Dunes," by Prof. George Darwin, F.R.S., in the theatre on Friday, Aug. 19, at 8.30 p.m.

"Recent Palaeontological Discoveries in the Rocky Mountains," by Prof. Osborn, of New York, in the theatre on Monday, Aug. 21, at 8.30 p.m.

The sectional programmes, as far as arranged at present, are as follows, but the dates are subject to alteration, and certain additional papers:

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Thursday, Aug. 18.

2. "Experiments to decide whether the Ether Moves with the Earth or not," by Prof. W. Wien (Würzburg).
4. "The Reaction of the Radiation on a Moving Electron," by Prof. M. Abraham (Göttingen).
9. A modification of Fitzgerald's model of the ether, by J. Butler Burke.

Monday, Aug. 22.

4. Report of Committee on Electrical Standards.
6. "Standards of Wave-Length," by Prof. Kayser (Bonn).
7. "On the Effect of Electrical Oscillations in Optically Active Bodies," by Prof. W. Voigt (Göttingen).

Tuesday, Aug. 23.

1. "A Correlation between the Electric Conductivity of Air and the Variation of Barometric Pressure," by J. Don.
2. "On the Ionisation of the Atmosphere," by Prof. A. Schuster, F.R.S.
3. Discussion on "The Radioactivity of Ordinary Matter," to be opened by Prof. J. J. Thompson, F.R.S.
6. "Plan of a Combination of Atoms to have the Properties of Polonium or Radium," by Lord Kelvin, F.R.S.
7. "Electrical Insulation in Vacuum," by Lord Kelvin, F.R.S.
8. "Electrical Conductivity of Flames," by Dr. H. A. Wilson.
9. "Electrical Properties of Hot Bodies," by Dr. O. W. Richardson.
10. "The Production of Radioactive Surfaces," by C. E. S. Phillips.
11. "The Kinetic Theory: Determination of the Size of Molecules," by J. H. Jeans.

Wednesday, Aug. 24.

1. "Electric Waves along Spiral Wires, and Applications to Wireless Telegraphy," by Prof. J. A. Fleming, F.R.S.
2. "Magnetic and Electric Properties of Nickel at High Temperatures," by Prof. C. G. Knott.
3. "Eddy-Current Losses in the Lead Sheaths of Three-Phase Cables," by W. B. Field.
4. "On the Viscosity of Colloidal Iron Hydrate," by Dr. A. D. Denning.
5. "Magnetic Double Refraction of Colloidal Iron Hydrate," by Dr. A. D. Denning.
6. "On the Electric and Thermal Conductivities of certain Alloys of Iron," by Prof. W. F. Barrett, F.R.S.
7. "A New Apparatus for Producing Magnetic Fields of Force," by Prof. M. Hartog.

SECTION F.—ECONOMICS AND STATISTICS.

Thursday, Aug. 18.

3. "A Moot Point in the Theory of International Trade," by Prof. F. Y. Edgeworth.
4. "Improvements in Agriculture and their Effect on Economic Rent," by Prof. A. W. Flux.

SECTION G.—ENGINEERING.

Thursday, Aug. 18.

11.30 a.m.—Presidential address.

2 p.m.—"The Origin of Sand Ripples," by Mrs. Ayrton.

Friday, Aug. 19.

1. "Flame Temperatures in Internal-Combustion Motors," by E. Dugald Clerk.
2. "Exhaust Gas Calorimetry," by Prof. B. Hopkinson, to be followed by a general discussion.
3. "The Effects of Receiver Drop in a Compound Engine,' by J. W. Hayward.
4. "Superheated Steam: throttling and other experiments," by A. H. Peake.

Monday, Aug. 22.

1. "The Use of Electricity on the North-Eastern Railway and on Tyneside," by C. H. Merz and W. McLellan.
2. "Electricity from Water Power," by A. A. Campbell Swinton.
3. "Energy Losses in Magnetising Iron," by W. M. Mordey and A. G. Hansard.
4. "Testing Alternating-Current Induction Motors by a Hopkinson Method," by Dr. W. E. Sumpner and R. W. Weekes.
5. "Large-Bulb Incandescent Lamps as Secondary Standards of Light," by Prof. J. A. Fleming.
6. "Some Investigations on the 10-c.p. Harcourt Pentane Lamp made at the National Physical Laboratory," by Clifford Paterson.

Tuesday, Aug. 23.

1. "The Control of the Nile," by Major Sir Hanbury Brown, K.C.M.G.
2. "A Universal Testing Machine of 300 tons for full-sized Members of Structures," by J. H. Wicksteed.
3. "The Effect of Rapidly Alternating Stresses on Structural Steels," by Prof. J. O. Arnold.
4. "A New Process for the Protection of Iron and Steel from Corrosion," by S. Cowper-Coles.
5. "The Electrical Conductivity of certain Aluminium Alloys as affected by Exposure to London Atmosphere, and a Note on their Microstructure," by Prof. E. Wilson.

2 30 p.m.—Lecture on "Indicator Diagrams of a Small Petrol Motor, with Experimental Demonstration," by Prof. H. L. Callendar.

Wednesday, Aug. 24.

1. Report of the Mersey Tidal Regime Committee.
2. "Testing Alternating Motors with Direct Current," by W. Cramp.
3. "The Action of Lightning Strokes on Buildings," by Killingworth Hedges.

SECTION I.—PHYSIOLOGY.

Thursday, Aug. 18.

1. "Reflex and Direct Response to Galvanic and Faradic Currents," by Prof. MacWilliam.

SECTION L.

1. The school-leaving certificate of the Board of Education, University of London, and other examining bodies.
2. The national and local provision for training of teachers.
3. The method of imparting manual instruction (in its broadest sense) in the various grades of schools.
4. "Realistic Arithmetic," by Lieut.-Colonel Mackinlay.
5. "The Place of Hemistic Method in Teaching Experimental Physics," by Dr. R. W. Stewart.
6. "Specialisation in Science Teaching," by J. H. Leonard.
7. Report on "Influence of Examinations upon Teaching."
8. Report on "Courses of Practical, Experimental, and Observational Studies in Elementary Schools."

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Address

BY THE RIGHT HON. A. J. BALFOUR, D C L, LL.D, M.P, F.R S., CHANCELLOR OF THE UNIVERSITY OF EDINBURGH, PRESIDENT.

Reflections Suggested by the New Theory of Matter.

The meetings of this great society have for the most part been held in crowded centres of population, where our surroundings never permit us to forget, were such forgetfulness in any case possible, how close is the tie that binds modern science to modern history, the abstract researches of the student to the labours of the inventor and the mechanic. This, no doubt, is as it should be. The interdependence of theory and practice cannot be ignored without inflicting injury on both; and he is but a poor friend to either who undervalues their mutual co-operation.

Yet, after all, since the British Association exists for the advancement of science, it is well that now and again we should choose our place of gathering in some spot where science rather than its applications, knowledge, not utility, are the ends to which research is primarily directed.

If this be so, surely no happier selection could have been made than the quiet courts of this ancient university. For here, if anywhere, we tread the classic ground of physical discovery. Here, if anywhere, those who hold that physics is the true *Scientia Scientiarum*, the root of all the sciences which deal with inanimate nature, should feel themselves at home. For, unless I am led astray by too partial an affection for my own university, there is nowhere to be found, in any corner of the world, a spot with which have been connected, either by their training in youth or by the labours of their maturer years, so many men eminent as the originators of new and fruitful physical conceptions. I say nothing of Bacon, the eloquent prophet of a new era; nor of Darwin, the Copernicus of biology; for my subject to-day is not the contributions of Cambridge to the general growth of scientific knowledge. I am concerned rather with the illustrious line of physicists who have learned or taught within a few hundred yards of this building—a line stretching from Newton in the seventeenth century, through Cavendish in the eighteenth, through Young, Stokes, Maxwell in the nineteenth, through Kelvin (who embodies an epoch in himself) down to Rayleigh, Larmor, J. J. Thomson, and the scientific school centred in the Cavendish laboratory, whose physical speculations bid fair to render the closing years of the old century and the opening years of the new as notable as the greatest which have preceded them.

Now what is the task which these men, and their illustrious fellow-labourers out of all lands, have set themselves to accomplish? To what end led these "new and fruitful physical conceptions" to which I have just referred? It is often described as the discovery of the "laws connecting phenomena." But this is certainly a misleading, and in my opinion a very inadequate, account of the subject. To begin with, it is not only inconvenient, but confusing, to describe as "phenomena" things which do not appear, which never have appeared, and which never can appear, to beings so poorly provided as ourselves with the apparatus of sense-perception. But apart from this, which is a linguistic error too deeply rooted to be easily exterminated, is it not most inaccurate in substance to say that a knowledge of Nature's laws is all we seek when investigating Nature? The physicist looks for something more than what, by any stretch of language, can be described as "co-existences" and "sequences" between so-called "phenomena." He speaks for something deeper than the laws connecting possible objects of experience. His object is physical reality: a reality which may or may not be capable of direct perception; a reality which is in any case independent of it; a reality which constitutes the permanent mechanism of that physical universe with which our immediate empirical connection is so slight and so deceptive. That such a reality exists, though philosophers have doubted, is the unalterable fate of science; and were that faith *per impossibile* to perish under the assaults of critical speculation, science, as men of science usually conceive it, would perish likewise.

If this be so, if one of the tasks of science, and more particularly of physics, is to frame a conception of the physical universe in its inner reality, then any attempt to compare the different modes in which, at different epochs of scientific development, this intellectual picture has been drawn, cannot fail to suggest questions of the deepest interest. True, I am precluded from dealing with such of these questions as are purely philosophical by the character of this occasion, and with such of them as are purely scientific by my own incompetence. But some there may be sufficiently near the dividing line to induce the specialists who rule by right on either side of it to view with forgiving eyes any trespasses into their legitimate domain which I may be tempted during the next few minutes to commit.

Let me, then, endeavour to compare the outlines of two such pictures, of which the first may be taken to represent the views prevalent towards the end of the eighteenth century; a little more than 100 years from the publication of Newton's "Principia," and, roughly speaking, about midway between that epoch-making date and the present moment. I suppose that if at that period the average man of science had been asked to sketch his general conception of the physical universe, he would probably have said that it essentially consisted of various sorts of ponderable matter, scattered in different combinations through space, exhibiting most varied aspects under the influence of chemical affinity and temperature, but through every metamorphosis obedient to the laws of motion, always retaining its mass unchanged, and exercising at all distances a force of attraction on other material masses, according to a simple law. To this ponderable matter he would (in spite of Rumford) have probably added the so-called "imponderable" heat, then often ranked among the elements; together with the two "electrical fluids," and the corpuscular emanations supposed to constitute light.

In the universe as thus conceived, the most important forms of action between its constituents was action at a distance; the principle of the conservation of energy was, in any general form, undreamed of; electricity and magnetism, though already the subjects of important investigation, played no great part in the whole of things; nor was a diffused ether required to complete the machinery of the universe.

Within a few months, however, of the date assigned for these deliverances of our hypothetical physicist came an addition to this general conception of the world, destined profoundly to modify it. About 100 years ago Young opened, or reopened, the great controversy which finally established the undulatory theory of light, and with it a belief in an interstellar medium by which undulations could be conveyed. But this discovery involved much more than the substitution of a theory of light which was consistent with the facts for one which was not; since here was the first authentic introduction* into the scientific world-picture of a new and prodigious constituent—a constituent which has altered, and is still altering, the whole balance (so to speak) of the composition. Unending space, thinly strewn with suns and satellites, made or in the making, supplied sufficient material for the mechanism of the heavens as conceived by Laplace. Unending space filled with a continuous medium was a very different affair, and gave promise of strange developments. It could not be supposed that the ether, if its reality were once admitted, existed only to convey through interstellar regions the vibrations which happen to stimulate the optic nerve of man. Invented originally to fulfil this function, to this it could never be confined, and, accordingly, as everyone now knows, things which from the point of view of sense-perception are as distinct as light and radiant heat, and things to which sense-perception makes no response, like the electric waves of wireless telegraphy,† intrinsically differ, not in kind, but in magnitude alone.

This, however, is not all, nor nearly all. If we jump over the century which separates 1804 from 1904, and attempt to give in outline the world-picture as it now presents itself to some leaders of contemporary speculation, we shall find that in the interval it has been modified, not merely by such far-reaching discoveries as the atomic and molecular composition of ordinary matter, the kinetic

* The hypothesis of an ether was, of course, not new. But before Young and Fresnel it cannot be said to have been established.

† First known through the theoretical work of Maxwell and the experiments of Herz.

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theory of gases, and the laws of the conservation and dissipation of energy, but by the more and more important part which electricity and the ether occupy in any representation of ultimate physical reality.

Electricity was no more to the natural philosophers in the year 1700 than the hidden cause of an insignificant phenomenon.* It was known, and had long been known, that such things as amber and glass could be made to attract light objects brought into their neighbourhood; yet it was about 50 years before the effects of electricity were perceived in the thunderstorm. It was about 100 years before it was detected in the form of a current. It was about 120 years before it was connected with magnetism; about 170 years before it was connected with light and ethereal radiation.

But to-day there are those who regard gross matter—the matter of everyday experience—as the mere appearance of which electricity is the physical basis; who think that the elementary atom of the chemist, itself far beyond the limits of direct perception, is but a connected system of monads or sub-atoms which are not electrified matter, but are electricity itself; that these systems differ in the number of monads which they contain, in their arrangement, and in their motion relative to each other and to the ether; that on these differences, and on these differences alone, depend the various qualities of what have hitherto been regarded as indivisible and elementary atoms; and that while in most cases these atomic systems may maintain their equilibrium for periods which, compared with such astronomical processes as the cooling of a sun, may seem almost eternal, they are not less obedient to the law of change than the everlasting heavens themselves.

But if gross matter be a grouping of atoms, and if atoms be systems of electrical monads, what are these electrical monads? It may be that, as Prof. Larmor has suggested, they are but a modification of the universal ether, a modification roughly comparable to a knot in a medium which is inextensible, incompressible, and continuous. But whether this final unification be accepted or not, it is certain that these monads cannot be considered apart from the ether. It is on their interaction with the ether that their qualities depend, and without the ether an electric theory of matter is impossible.

Surely we have here a very extraordinary revolution. Two centuries ago electricity seemed but a scientific toy. It is now thought by many to constitute the reality of which matter is but the sensible expression. It is but a century ago that the title of an ether to a place among the constituents of the universe was authentically established. It seems possible now that it may be the stuff out of which that universe is wholly built. Nor are the collateral inferences associated with this view of the physical world less surprising. It used, for example, to be thought that mass was an original property of matter, neither capable of explanation nor requiring it; in its nature essentially unchangeable, suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to, or identified with, each material fragment, howsoever much that fragment might vary in its appearance, its bulk, its chemical or its physical condition.

But if the new theories be accepted these views must be revised. Mass is not only explicable, it is actually explained. So far from being an attribute of matter considered in itself, it is due, as I have said, to the relation between the electrical monads of which matter is composed and the ether in which they are bathed. So far from being unchangeable, it changes, when moving at very high speeds, with every change in its velocity.

Perhaps, however, the most impressive alteration in our picture of the universe required by these new theories is to be sought in a different direction. We have all, I suppose, been interested in the generally accepted views as to the origin and development of suns with their dependent planetary systems; and the gradual dissipation of the energy which during this process of concentration has largely taken the form of light and radiant heat. Follow out the theory to its obvious conclusions, and it becomes plain that the stars now visibly incandescent are those in mid-journey between the nebulæ from which they sprang and the frozen darkness to which they are predestined. What, then, are we to think of the invisible multitude of the heavenly bodies in which this process has been already completed? According to the ordinary view, we should suppose them to be in a state where all possibilities of internal movement were exhausted. At the temperature of interstellar space their constituent elements would be solid and inert; chemical action and molecular movement would be alike impossible, and their exhausted energy could obtain no replenishment unless they were suddenly rejuvenated by some celestial collision, or travelled into other regions warmed by newer suns.

This view must, however, be profoundly modified if we accept the electric theory of matter. We can then no longer hold that if the internal energy of a sun were as far as possible converted into heat either by its contraction under the stress of gravitation or by chemical reactions between its elements, or by any other inter-atomic force; and that, were the heat so generated to be dissipated, as in time it must be through infinite space, its whole energy would be exhausted. On the contrary, the amount thus lost would be absolutely insignificant compared with what remained stored up within the separate atoms. The system in its corporate capacity would become bankrupt—the wealth of its individual constituents would be scarcely diminished. They would lie side by side, without movement, without chemical affinity; yet each one, howsoever inert in its external relations, the theatre of violent motions, and of powerful internal forces.

Or, put the same thought in another form. When the sudden appearance of some new star in the telescopic field gives notice to the astronomer that he, and perhaps, in the whole universe, he alone, is witnessing the conflagration of a world, the tremendous forces by which this far-off tragedy is being accomplished must surely move his awe. Yet not only would the members of each separate atomic system pursue their relative course unchanged, while the atoms themselves were thus riven violently apart in flaming vapour, but the forces by which such a world is shattered are really negligible compared with those by which each atom of it is held together.

In common, therefore, with all other living things, we seem to be practically concerned chiefly with the feebler forces of Nature, and with energy in its least powerful manifestations. Chemical affinity and cohesion are on this theory no more than the slight residual effects of the internal electrical forces which keep the atom in being. Gravitation, though it be the shaping force which concentrates nebulæ into organised systems of suns and satellites, is trifling compared with the attractions and repulsions with which we are familiar between electrically charged bodies; while these again sink into insignificance beside the attractions and repulsions between the electric monads themselves. The irregular molecular movements which constitute heat, on which the very possibility of organic life seems absolutely to hang, and in whose transformations applied science is at present so largely concerned, cannot rival the kinetic energy stored within the molecules themselves. This prodigious mechanism seems outside the range of our immediate interests. We live, so to speak, merely on its fringe. It has for us no promise of utilitarian value. It will not drive our mills; we cannot harness it to our trains. Yet not less on that account does it stir the intellectual imagination. The starry heavens have from time immemorial moved the worship or the wonder of mankind. But if the dust beneath our feet be indeed compounded of innumerable systems, whose elements are ever in the most rapid motion, yet retain through uncounted ages their equilibrium unshaken, we can hardly deny that the marvels we directly see are not more worthy of admiration than those which recent discoveries have enabled us dimly to surmise.

Now, whether the main outlines of the world-picture which I have just imperfectly presented to you be destined to survive, or whether in their turn they are to be obliterated by some new drawing on the scientific palimpsest, all will, I think, admit that so bold an attempt to unify physical nature excites feelings of the

* The modern history of electricity begins with Gilbert, but I have throughout confined my observations to the post-Newtonian period.

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most acute intellectual gratification. The satisfaction it gives is almost æsthetic in its intensity and quality. We feel the same sort of pleasurable shock as when from the crest of some melancholy pass we first see far below us the sudden glories of plain, river, and mountain. Whether this vehement sentiment in favour of a simple universe has any theoretical justification I will not venture to pronounce. There is no *a priori* reason that I know of for expecting that the material world should be a modification of a single medium, rather than a composite structure built out of 60 or 70 elementary substances, eternal and eternally different. Why, then, should we feel content with the first hypothesis and not with the second? Yet so it is. Men of science have always been restive under the multiplication of entities. They have eagerly noted any sign that the chemical atom was composite, and that the different chemical elements had a common origin. Nor, for my part, do I think such instincts should be ignored. John Mill, if I rightly remember, was contemptuous of those who saw any difficulty in accepting the doctrine of "action at a distance." So far as observation and experiment can tell us, bodies *do* actually influence each other at a distance. And why should they not? Why seek to go behind experience in obedience to some *a priori* sentiment for which no argument can be adduced? So reasoned Mill, and to his reasoning I have no reply. Nevertheless, we cannot forget that it was to Faraday's obstinate disbelief in "action at a distance" that we owe some of the crucial discoveries on which both our electric industries and the electric theory of matter are ultimately founded; while at this very moment physicists, however baffled in the quest for an explanation of gravity, refuse altogether to content themselves with the belief, so satisfying to Mill, that it is a simple and inexplicable property of masses acting on each other across space.

These obscure intimations about the nature of reality deserve, I think, more attention than has yet been given to them. That they exist is certain; that they modify the indifferent impartiality of pure empiricism can hardly be denied. The common notion that he who would search out the secrets of Nature must humbly wait on experience obedient to its slightest hint, is but partly true. This may to his ordinary attitude; but now and again it happens that observation and experiment are not treated as guides to be meekly followed, but as witnesses to be broken down in cross-examination. Their plain message is disbelieved, and the investigating judge does not pause until a confession in harmony with his preconceived ideas has, if possible, been wrung from their reluctant evidence.

This proceeding needs neither explanation nor defence in those cases where there is an apparent contradiction between the utterances of experience in different connections. Such contradictions must, of course, be reconciled, and science cannot rest until the reconciliation is effected. The difficulty really arises when experience apparently says one thing and scientific instinct persists in saying another. Two such cases I have already mentioned; others will easily be found by those who care to seek. What is the origin of this instinct, and what its value; whether it be a mere prejudice to be brushed aside, or a clue which no wise man would disdain to follow, I cannot now discuss. For other questions there are, not new, yet raised in an acute form by these most modern views of matter, on which I would ask your indulgent attention for yet a few moments.

That these new views diverge violently from those suggested by ordinary observation is plain enough. No scientific education is likely to make us, in our unreflective moments, regard the solid earth on which we stand, or the organised bodies with which our terrestrial fate is so intimately bound up, as consisting wholly of electric monads very sparsely scattered through the spaces which these fragments of matter are, by a violent metaphor, described as "occupying." Not less plain is it that an almost equal divergence is to be found between these new theories and that modification of the common-sense view of matter with which science has in the main been content to work.

What was this modification of common sense? It is roughly indicated by an old philosophic distinction drawn between what were called the "primary" and the "secondary" qualities of matter. The primary qualities, such as shape and mass, were supposed to possess an existence quite independent of the observer; and so far the theory agreed with common sense. The secondary qualities, on the other hand, such as warmth and colour, were thought to have no such independent existence, being, indeed, no more than the resultants due to the action of the primary qualities on our organs of sense-perception; and here, no doubt, common sense and theory parted company.

You need not fear that I am going to drag you into the controversies with which this theory is historically connected. They have left abiding traces on more than one system of philosophy. They are not yet solved. In the course of them the very possibility of an independent physical universe has seemed to melt away under the solvent powers of critical analysis. But with all this I am not now concerned. I do not propose to ask what proof we have that an external world exists, or how, if it does exist, we are able to obtain cognisance of it. These may be questions very proper to be asked by philosophy; but they are not proper questions to be asked by science. For, logically, they are antecedent to science, and we must reject the sceptical answers to both of them before physical science becomes possible at all. My present purpose requires me to do no more than observe that, be this theory of the primary and secondary qualities of matter good or bad, it is the one on which science has in the main proceeded. It was with matter thus conceived that Newton experimented. To it he applied his laws of motion; of it he predicated universal gravitation. Nor was the case greatly altered when science became as much preoccupied with the movements of molecules as it was with those of planets. For molecules and atoms, whatever else might be said of them, were at least pieces of matter, and, like other pieces of matter, possessed those "primary" qualities supposed to be characteristic of all matter, whether found in large masses or in small.

But the electric theory which we have been considering carries us into a new region altogether. It does not confine itself to accounting for the secondary qualities by the primary, or the behaviour of matter in bulk by the behaviour of matter in atoms; it analyses matter, whether molar or molecular, into something which is not matter at all. The atom is now no more than the relatively vast theatre of operations in which minute monads perform their orderly evolutions; while the monads themselves are not regarded as units of matter, but as units of electricity; so that matter is not merely explained, but is explained away.

Now the point to which I desire to call attention is not to be sought in the great divergence between matter as thus conceived by the physicist and matter as the ordinary man supposes himself to know it, between matter as it is perceived and matter as it really is, but to the fact that the first of these two quite inconsistent views is wholly based on the second.

This is surely something of a paradox. We claim to found all our scientific opinions on experience; and the experience on which we found our theories of the physical universe is our *sense-perception* of that universe. That *is* experience; and in this region of belief there is no other. Yet the conclusions which thus profess to be entirely founded upon experience are to all appearance fundamentally opposed to it; our knowledge of reality is based upon illusion, and the very conceptions we use in describing it to others, or in thinking of it ourselves, are abstracted from anthropomorphic fancies, which science forbids us to believe and Nature compels us to employ.

We here touch the fringe of a series of problems with which inductive logic ought to deal, but which that most unsatisfactory branch of philosophy has systematically ignored. This is no fault of men of science. They are occupied in the task of making discoveries, not in that of analysing the fundamental presuppositions which the very possibility of making discoveries applies. Neither is it the fault of transcendental metaphysicians. Their speculations flourish on a different level of thought; their interest in a philosophy of nature is lukewarm; and howsoever the questions in which they are chiefly concerned be answered, it is by no means certain that the answers will leave

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the humbler difficulties at which I have hinted either nearer to or further from a solution. But though men of science and idealists stand acquitted, the same can hardly be said of empirical philosophers. So far from solving the problem, they seem scarcely to have understood that there was a problem to be solved. Led astray by a misconception to which I have already referred; believing that science was concerned only with (so-called) "phenomena," that it had done all that it could be asked to do if it accounted for the sequence of our individual sensations, that it was concerned only with the "laws of Nature," and not with the inner character of physical reality; disbelieving, indeed, that any such physical reality does in truth exist—it has never felt called upon seriously to consider what are the actual methods by which science attains its results, and how those methods are to be justified. If anyone, for example, will take up Mill's logic, with its "sequences and co-existences between phenomena," its "method of difference," its "method of agreement," and the rest; if he will then compare the actual doctrines of science with this version of the mode in which those doctrines have been arrived at, he will soon be convinced of the exceedingly thin intellectual fare which has been hitherto served out to us under the imposing title of inductive theory.

There is an added emphasis given to these reflections by a train of thought which has long interested me, though I acknowledge that it never seems to have interested anyone else. Observe, then, that in order of logic sense-perceptions supply the premisses from which we draw all our knowledge of the physical world. It is they which tell us there *is* a physical world; it is on their authority that we learn its character. But in order of causation they are effects due (in part) to the constitution of our organs of sense. What we see depends not merely on what there is to be seen, but on our eyes What we hear depends not merely on what there is to hear, but on our ears. Now, eyes and ears, and all the mechanism of perception, have, as we know, been evolved in us and our brute progenitors by the slow operation of natural selection. And what is true of sense-perception is, of course, also true of the intellectual powers which enable us to erect upon the frail and narrow platform which sense-perception provides, the proud fabric of the sciences.

Now natural selection only works through utility. It encourages aptitudes useful to their possessor or his species in the struggle for existence, and for a similar reason it is apt to discourage useless aptitudes, however interesting they may be from other points of view, because, being useless, they are probably burdensome.

But it is certain that our powers of sense-perception and of calculation were fully developed ages before they were effectively employed in searching out the secrets of physical reality—for our discoveries in this field are the triumphs but of yesterday. The blind forces of natural selection, which so admirably simulate design when they are providing for a present need, possess no power of prevision, and could never, except by accident, have endowed mankind, while in the making, with a physiological or mental outfit adapted to the higher physical investigations. So far as natural science can tell us, every quality of sense or intellect which does not help us to fight, to eat, and to bring up children is but a by-product of the qualities which do. Our organs of sense-perception were not given us for purposes of research; nor was it to aid us in meting out the heavens or dividing the atom that our powers of calculation and analysis were evolved from the rudimentary instincts of the animal.

It is presumably due to these circumstances that the beliefs of all mankind about the material surroundings in which it dwells are not only imperfect, but fundamentally wrong. It may seem singular that down to, say, five years ago our race has, without exception, lived and died in a world of illusions, and that its illusions, or those with which we are here alone concerned, have not been about things remote or abstract, things transcendental or divine, but about what men see and handle, about those "plain matters of fact" among which common-sense daily moves with its most confident step and most self-satisfied smile. Presumably, however, this is either because too direct a vision of physical reality was a hindrance, not a help, in the struggle for existence; because falsehood was more useful than truth, or else because with so imperfect a material as living tissue no better results could be attained. But, if this conclusion be accepted, its consequences extend to other organs of knowledge besides those of perception. Not merely the senses, but the intellect, must be judged by it; and it is hard to see why evolution, which has so lamentably failed to produce trustworthy instruments for obtaining the raw material of experience, should be credited with a larger measure of success in its provision of the physiological arrangements which condition reason in its endeavours to turn experience to account.

Considerations like these, unless I have compressed them beyond the limits of intelligibility, do undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which is built out of materials provided by natural science alone. Extend the boundaries of knowledge as you may; draw how you will the picture of the universe; reduce its infinite variety to the modes of a single space-filling ether; retrace its history to the birth of existing atoms; show how under the pressure of gravitation they became concentrated into nebulæ, into suns, and all the host of heaven; how, at least in one small planet, they combined to form organic compounds; how organic compounds became living things; how living things, developing along many different lines, gave birth at last to one superior race; how from this race arose, after many ages, a learned handful, who looked round on the world which thus blindly brought them into being, and judged it, and knew it for what it was: perform, I say, all this, and, though you may indeed have attained to science, in nowise will you have attained to a self-sufficing system of beliefs. One thing at least will remain, of which this long-drawn sequence of causes and effects gives no satisfying explanation; and that is knowledge itself. Natural science must ever regard knowledge as the product of irrational conditions, for in the last resort it knows no others. It must always regard knowledge as rational or else science itself disappears. In addition, therefore, to the difficulty of extracting from experience beliefs which experience contradicts, we are confronted with the difficulty of harmonising the pedigree of our beliefs with their title to authority. The more successful we are in explaining their origin, the more doubt we cast on their validity. The more imposing seems the scheme of what we know, the more difficult it is to discover by what ultimate criteria we claim to know it.

Here, however, we touch the frontier beyond which physical science possesses no jurisdiction. If the obscure and difficult region which lies beyond is to be surveyed and made accessible, philosophy, not science, must undertake the task. It is no business of this society. We meet here to promote the cause of knowledge in one of its great divisions; we shall not help it by confusing the limits which usefully separate one division from another. It may, perhaps, be thought that I have disregarded my own precept—that I have wilfully overstepped the ample bounds within which the searchers into Nature carry on their labours. If it be so, I can only beg your forgiveness. My first desire has been to rouse in those who, like myself, are no specialists in physics, the same absorbing interest which I feel in what is surely the most far-reaching speculation about the physical universe which has ever claimed experimental support; and if in so doing I have been tempted to hint my own personal opinion that as natural science grows it leans more, not less, upon an idealistic interpretation of the universe, even those who least agree may perhaps be prepared to pardon.

Address to the Engineering Section.

BY HON. CHARLES A. PARSONS, M.A., F.R.S., M I C E., PRESIDENT OF THE SECTION.

On this occasion I propose to devote my remarks to the subject of invention. It is a subject of considerable importance, not only to engineers, but also to men of science and the public generally. I also propose to treat invention in its wider sense, and to include under the word discoveries in physics, mechanics, chemistry, and geology.

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Invention throughout the Middle Ages was held in little esteem. In most dictionaries it receives scant reference except as applied to poetry, painting, and sculpture. Shakespeare and Dryden describe invention as a kind of muse or inspiration in relation to the arts, and when taken in its general sense to be associated with deceit, as "Return with an invention, and clap upon you two or three plausible lies." As to the opposition and hostility to scientific research, discovery, and mechanical invention in the past, and until comparatively recent times, there can be no question, in some cases the opposition actually amounting to persecution and cruelty.

The change in public opinion has been gradual. The great inventions of the last century in science and the arts have resulted in a large increase of knowledge and the powers of man to harness the forces of Nature. These great inventions have proved without question that the inventors in the past have, in the widest sense, been among the greatest benefactors of the human race. Yet the lot of the inventor until recent years has been exceptionally trying, and even in our time I scarcely think that anyone would venture to describe it as altogether a happy one. The hostility and opposition which the inventor suffered in the Middle Ages have certainly been removed, but he still labours under serious disability in many respects under law as compared with other sections of the community. The change of public feeling in favour of discovery and invention has progressed with rapidity during the last century. Not only have private individuals devoted more time and money to the work, but societies, institutions, colleges, municipalities, and governments have founded many research laboratories, and in some instances have provided large endowments. These measures have increased the number of persons trained to scientific methods, and also provided greatly improved facilities for research; but perhaps one of the most important results to engineers has been the direct and indirect influence of the more general application of scientific methods to engineering.

Sir Frederick Bramwell, in his presidential address to this association in 1888, emphasised the interdependence of the scientist and the civil engineer, and described how the work of the latter has been largely based on the discoveries of the former, while the work of the engineer often provides data and adds a stimulus to the researches of the scientist. And I think his remarks might be further appropriately extended by adding that since the scientist, the engineer, the chemist, the metallurgist, the geologist, all seek to unravel and to compass the secrets of Nature, they are all to a great extent interdependent on each other. But though research laboratories are the chief centres of scientific invention, and colleges, institutions, and schools train the mind to scientific methods of attack, yet in mechanical, civil, and electrical engineering the chief work of practical investigation has been carried on by individual engineers, or by firms, syndicates, and companies. These not only have adapted discoveries made by scientists to commercial uses, but also, in many instances, have themselves made such discoveries or inventions.

To return to the subject, let us for a moment consider in what invention really consists, and let us dismiss from our mind the very common conception which is given in dictionaries and encyclopædias that invention is a happy thought occurring to an inventive mind. Such a conception would give us an entirely erroneous idea of the formation of the great steps in advance in science and engineering that have been made during the last century; and, further, it would lead us to forget the fact that almost all important inventions have been the result of long training and laborious research and long-continued labour. Generally, what is usually called an invention is the work of many individuals, each one adding something to the work of his predecessors, each one suggesting something to overcome some difficulty, trying many things, testing them when possible, rejecting the failures, retaining the best, and by a process of gradual selection arriving at the most perfect method of accomplishing the end in view. This is the usual process by which inventions are made. Then, after the invention, which we will suppose is the successful attempt to unravel some secret of Nature, or some mechanical or other problem, there follows in many cases the perfecting of the invention for general use, the realisation of the advance or its introduction commercially; this after-work often involves as great difficulties and requires for its accomplishment as great a measure of skill as the invention itself, of which it may be considered in many cases as forming a part. If the invention, as is often the case, competes with or is intended to supersede some other method, then there is a struggle for existence between the two. This state of things has been well described by Mr. Fletcher Moulton. The new invention, like a young sapling in a dense forest, struggles to grow up to maturity, but the dense shade of the older and higher trees robs it of the necessary light. If it could only once grow as tall as the rest, all would be easy; it would then get its fair share of light and sunshine. Thus it often occurs in the history of inventions that the surroundings are not favourable when the first attack is made, and that subsequently it is repeated by different persons, and, finally, under different circumstances it may eventually succeed and become established.

We may take in illustration almost any of the great inventions of undoubted utility of which we happen to have the full history—for instance, some of the great scientific discoveries, or some of the great mechanical inventions, such as the steam-engine, the gas-engine, the steamship, the locomotive, the motorcar, or some of the great chemical or metallurgical discoveries. Are not most, if not all, of these the result of the long-continued labour of many persons, and has not the financial side been in most cases a very important factor in securing success? The history of the steam-engine might be selected, but I prefer on this occasion to take the internal-combustion engine, for two reasons—firstly, because its history is a typical one; and, secondly, because we are to hear a paper by that able exponent and great inventor in the domain of the gas-engine, Mr. Dugald Clerk, describing not only the history, but the engine in its present state of development and perfection, an engine which is able to convert the greatest percentage of heat units in the fuel into mechanical work, excepting only, as far as we at present know, the voltaic battery and living organisms.

The first true internal-combustion engine was undoubtedly the cannon, and the use in it of combustible powder for giving energy to the shot is strictly analogous to the use of the explosive mixture of gas or oil and air as at present in use in all internal-combustion engines; thus the first internal-combustion engine depended on the combination of a chemical discovery and a mechanical invention, the invention of gunpowder and the invention of the cannon. In 1680 Huygens proposed to use gunpowder for obtaining motive power in an engine. Papin, in 1600, continued Huygens's experiments, but without success. These two inventors, instead of following the method of burning the powder under pressure, as in the cannon, adopted, in ignorance of thermodynamic laws, an erroneous course. They exploded a small quantity of gunpowder in a large vessel with escape valves, which after the explosion caused a partial vacuum to remain in the vessel. This partial vacuum was then used to actuate a piston or engine and perform useful work. Subsequently several other inventors worked on the same lines, but all of these failed on account of two causes, which now are very evident to us. Firstly, gunpowder was then, as it still is, a very expensive form of fuel, in proportion to the energy liberated on explosion; secondly, the method of burning the powder to cause a vacuum involves the waste of nearly the whole of the available energy, whereas had it been burned under pressure, as in the cannon, a comparatively large percentage of the energy would have been converted into useful work. But even with this alteration, and however perfect the engine had been, the cost of explosives would have debarred its coming into use, except for very special purposes.

We come a century later to the first real gas-engine. Street, in 1794, proposed the use of vapour of turpentine in an engine on methods closely analogous to those successfully adopted in the Lenoir gas-engine of 80 years later, or 30 years ago. But Street's engine failed from crude and faulty construction. Brown, in 1823, tried Huygens's vacuum method, using fuel to expand air instead of gun

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powder, but he also failed, probably on account of the wastefulness of the method. Wright, in 1833, made a really good gas-engine, having many of the essential features of some of the gas-engines of the present day, such as separate gas and water pumps, and water-jacketed cylinder and piston. Barnett, in 1839, further improved on Wright's design, and made the greatest advance of any worker in gas-engines. He added the fundamental improvements of compression of the explosive mixture before combustion, and he devised means of lighting the mixture under pressure, and his engine conformed closely to the present-day practice as regards fundamental details. No doubt Barnett's engine, so perfect in principle, deserved commercial success, but either his mechanical skill or his financial resources were inadequate to the task; and the character of the patents would seem to favour this conclusion, both as regards Barnett and other workers at this period. Up to 1850 the workers were few, but as time went on they gradually increased in numbers; attention had been attracted to the subject, and men with greater powers and resources appear to have taken the problem in hand. Among these numerous workers came Lenoir, in 1860, who, adopting the inferior type of non-compression engine, made it a commercial success by his superior mechanical skill and resources. Mr. Dugald Clerk tells us: "The proposals of Brown (1823), Wright (1833), Barnett (1838), Bansanti and Matteucci (1857), show gradually increasing knowledge of detail and the difficulties to be overcome, all leading to the first practicable engine in 1866, the Lenoir." This stage of the development being reached, the names of Siemens, Beaude Roches, Otto Simon, Dugald Clerk, Priestman, Daimler, Dowson, Mond, and others, appear as inventors who have worked at and added something to perfect the internal-combustion engine and its fuel, and who have helped to bring it to its present state of perfection.

In the history of great mechanical inventions there is, perhaps, no better example of the interdependence of the engineer, the physicist, and the chemist than is evinced in the perfecting of the gas-engine. The physicist and the chemist together determine the behaviour of the gaseous fuel, basing their theory on data obtained from the experimental engines constructed by the mechanical engineer, who, guided by their theories, makes his designs and improvements. Then, again, from the results of the improvements fresh data are collected and the theory further advance, and so on till success is reached. But though I have spoken of the physicist, the chemist, and the engineer as separate persons, it more generally occurs that they are rolled into one, or at most two, individuals, and that it is indispensable that each worker should have some considerable knowledge of all the sciences involved to be able to act his part successfully.

Now let us ask, Could not this very valuable invention, the internal-combustion engine, have been introduced in a much shorter time by more favouring circumstances, by some more favourable arrangement of the patent laws, or by legislation to assist the worker attacking so difficult a problem? I think the answer is that a great deal might be done, and I will endeavour to indicate some changes and possible improvements. The history of this invention brings before our minds two important considerations. Firstly, let us consider the patentable matter involved in the invention of the gas-engine, the utilisation for motive power purposes of the then well-known properties of the explosive energy of gunpowder or of mixtures of gas and oil with air. Are not these obvious inferences to persons of a mechanical turn of mind, and who had seen guns fired, or explosions in bottles containing spirits of turpentine when slightly heated and a light applied to the neck? Surely no fundamental patent could have been granted under the existing patent laws for so obvious an application of known forces. Consequently, patent protection was sought in comparative details, details in some cases essential to success which were evolved or invented in the process of working out the invention. In this extended field of operations a slight protection was in some instances obtained. But in answer to the question whether such protection was commensurate with the benefits received by the community at large, there can, I think, be only one reply. Generally, those who did most got nothing, some few received insufficient returns, and in very few cases, indeed, can the return be said to have been adequate. The second important consideration is that of the methods of procedure of the patentees, for it appears that very few of them had studied what had been suggested or done before by others before taking out their own patent. We are also struck by the number of really important advances that have been suggested and have failed to fructify, either from want of funds or other causes, to be forgotten for the time and to be reinvented later on by subsequent workers. What a waste of time, expense, and disappointment would be avoided if we in England helped the patentee to find out easily what had been done previously, on the lines adopted by the United States and German Patent Offices, who advise the patentee after the receipt of his provisional specification of the chief anticipatory patents, dead or alive! And ought we in England to rest content to see our patentees awaiting the report of the United States and German Patent Offices on their foreign equivalent specifications before filing their English patent claims? Ought not our Patent Office to give more facilities and assistance to the patentee?

Before proceeding further to discuss some of the possible improvements for the encouragement and protection of research and invention, I ask you to further consider the position of the inventor—the man anxious to achieve success where others have hitherto failed. To be successful he must be something of an enthusiast; and usually he is a poor man, or a man of moderate means, and dependent on others for financial assistance. Generally, the problem to be attacked involves a considerable expenditure of money; some problems require great expenditure before any return can thereby accrue, even under the most favourable circumstances. In the very few cases where the inventor has some means of his own they are generally insufficient to carry him through, and there have unfortunately been many who have lost everything in the attempt. In nearly all cases the inventor has to co-operate with capital; the capitalist may be a sleeping partner, or the capital may be held by a firm or syndicate, the inventor in such cases being a partner—a junior partner—or member of the staff. The combination may be successful and lasting, but unfortunately the best inventors are often bad men of business. The elements of the combination are often unstable, and the disturbing forces are many and active; especially is this so when the problem to be attacked is one of difficulty, necessitating various and successive schemes involving considerable expenditure, generally many times greater than that foreshadowed at the commencement of the undertaking. Under such circumstances, unless the capitalist or the senior partner or board be in entire sympathy with the inventor or exercise great forbearance, stimulated by the hope of ultimate success and adequate returns, the case becomes hopeless, disruption takes place, and the situation is abandoned. Further, in the majority of cases, after some substantial progress has been made it is found that under the existing patent laws insufficient protection can be secured, and the prospect of a reasonable return for the expenditure becomes doubtful. Under such circumstances the capitalist will generally refuse to proceed further unless the prospect of being first in the field may tempt him to continue.

Very many inventors, as I have said, avoid the expense of searching the patent records to see how far their problem has been attacked by others. In some cases the cost of a thorough search is very great indeed; sometimes it is greater than the cost of a trial attack on the problem. In the case of young and inexperienced inventors there sometimes exists a disinclination to enter on an expensive search; they prefer to spend their money on the attack itself. There are some, it is true, who have a foolish aversion to take steps to ascertain if others have been before them, and who prefer to remain in ignorance and trust to chance. It will, however, be said that the United States and German Patent Office reports ought to suffice to warn or protect the English patentee, but my own experience has been that such protection is not entirely satisfactory. There is, firstly, a considerable interval before such reports are received, and the life of a patent is short. Then, if the patent is upon an important subject, attracting

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general attention, the search is vigorous and sometimes overwrought, and the patent unjustly damaged or refused altogether. If, however, the patent is on some subject not attracting general attention, it receives too little attention, and is granted without comment.

In some few instances it may be said that ignorance has been a positive advantage, and that if the patentee had realised how much of his patentable work was honeycombed by previous publications and patents, he would have lost heart and given up the task. It is, I think, a case of the exception proving the rule, and the patentee ought, as far as possible, in all cases to know his true position, and make his choice accordingly. The present patent law has some curious anomalies. Let us suppose some inventor has the good fortune to place the keystone in the arch of an invention, to add some finishing touch which makes the whole invention a complete success, and valuable. Then, success having been proved possible, others try to reap the results of his labour and good fortune, and, as often happens, it is discovered after laborious search that someone else first suggested the same keystone in some long-forgotten patent or obscure publication, but for some reason or other the public were none the better for his having done so. What does the law do? It says this is an anticipation, and instead of apportioning to all parties reasonable and equitable shares in the perfected invention, to which no one could object, it says that the patent is injured or perhaps rendered useless by the anticipation, and that its value to everyone concerned is thereby diminished or destroyed, as the case may be, and thrown open to the public. Up till a few years ago, any anticipations, however old, might be cited; but recently the law has been amended, and at present none rank as anticipations which are more than 50 years old.

The perfecting of inventions and their introduction into general use requires capital, as we have seen—sometimes a considerable amount, as in the introduction of the Bessemer process for steel, or the linotype system of printing—before any commercial success can be realised. Capital having been found, the next difficulty is in the conservatism of persons and communities who are the buyers of the invention. There is always present in their minds the risk of failure and its consequent loss and worry to themselves, and in the event of success the advantage, in their estimation, may not be sufficient to counterbalance the risk. In large departments and companies whose management is conducted by officials receiving fixed salaries, acting under non-technical supervision, there is a strong tendency among the officials to leave well alone, the organisation being such that the risk of failure, even though it be remote, more than counterbalances, in their estimation, the advantages that would result in the event of success. Next is the opposition of those who are financially interested in competing trades or older inventions, and if the invention is a labour-saving appliance, then the active opposition of the displaced labour is a serious, though generally only a temporary, barrier. Fortunately, however, for the community, for research, and for invention, there is always to be found a considerable percentage of persons who, apart from the inventor, are able and willing to risk, and indeed to sacrifice, their personal interests in the cause of progress for the benefit of the community at large; and were it not for such persons the task of the introduction of most inventions would be an impossible one.

There are many problems of the highest importance in physics, engineering, chemistry, geology, and the arts, of which the investigation might probably prove of great benefit to the human race, and of which the probable monetary cost of the attack would be considerable, and of some very great indeed. Let us, then, enquire how the necessary funds could be raised. It is possible in the case of some of the more attractive problems that a group of rich philanthropists might be found, but in most cases it would be impossible to form a company on business lines under the existing laws of this and other countries, as I shall endeavour to show. In the case of many of the problems, no patents will give adequate protection; in some cases there is no subject matter of novelty and importance involved. In other cases the probable duration of the investigation is so long that any initial patents would have expired before a commercial result was reached, and under either of these circumstances there would be no inducement to business men or financiers to undertake the risk.

As an illustration of my meaning, I will take two investigations that have doubtless occurred to the minds of most of those present, though many others of greater or less importance might be cited. One is the thorough investigation of the problem of aerial navigation, with or without the assistance of flotation by gas. This problem could undoubtedly be successfully solved by an organised attack of skilled and properly-trained engineers and the expenditure of a large sum of money. Assuming the problem solved and commercially successful, it appears to be impossible under the existing patent laws to secure any adequate monopoly so as to justify the expectation of a reasonable return on the capital expended on the invention. For in view of the multitude of suggestions that have been made and the experiments that have been carried out, the practical solution of the problem would appear to rest on a judicious selection of old ideas by means of exhaustive experiments.

Another and perhaps more important investigation which has not, as yet, been attacked to any material extent, is the exploration of the lower depths of the earth. At present the deepest shaft is, I believe, at the Cape, of a little over one mile in depth, and the deepest borehole is one made in Silesia, by the Austrian Government, of about the same depth. What would be found at greater depths is at present a matter for conjecture, founded on the dip and thicknesses of strata observed on or near the surface Much money and many valuable lives have been devoted to exploration of the polar regions, but there can be no comparison between the scientific interest and the possible material results of such exploration and the one I have chosen for illustration of the inadequate protection afforded by law—namely, a great engineering attack on a problem of geology.

I would ask you to consider the commercial aspect of this engineering geological enterprise, as compared with exploration into new or unknown areas on the surface of the earth. An exploring expedition into a new country has before it generally the probability of the acquisition of territorial and mineral rights or possessions bringing material gain to the undertakers. The rights of such enterprises are well known, and capital can be obtained with or without national support, as the case may be. On the other hand, the explorer into the depths of the earth has no rights or monopolies beyond the mineral rights of the land he has purchased over his boring; further, it is improbable that he can obtain any patent of substantial value for his methods of boring to great depths. To succeed in the undertaking a great expenditure of money must be incurred, an expenditure far greater than that of an exploring expedition, and analogous to that of a military expedition or a small invading army, and to raise this sum the pioneers have practically no security to offer. For if they succeed in finding rich deposits of precious minerals in greater abundance, or succeed in making some geological discovery associated with deep borings, they gain no exclusive title to these under existing laws. Any other person or syndicate acting upon the experience gained could sink other shafts in other places or countries, and, benefiting by the experience gained by the pioneers, could probably carry out the work more advantageously, and thus depreciate the first undertaking or render it valueless, as has often occurred before.

Let us consider more closely some of the essential features of sinking a shaft to a great depth, for I think it will be seen that it presents no unsurmountable difficulties beyond those incidental to an enterprise of considerable magnitude, involving the ordinary methods of procedure and the ordinary methods adopted by mining engineers. That there would be some departures from ordinary practice on account of the great depth it is true, but these are more of the character of detail. On the design of this boring I have consulted Mr. John Bell Simpson, the eminent authority on mining in the North of England. The shaft would be sunk in a locality to avoid as far as possible water-bearing strata and the necessity of pumping. It would be

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of a size usual in ordinary mines or coal pits. The exact position of such shaft would require some consideration as to whether it should commence in the primary or secondary strata. It would be sunk in stages, each of about half a mile in depth, and at each stage there would be placed the hauling and other machinery, to be worked electrically, for dealing with each stage. The depth of each stage would be restricted to half a mile in order to avoid a disproportionate cost in the hauling machinery and the weight of rope, as well as increased cost in the cooling arrangements arising from excessive hydraulic pressures. At each second or third mile in depth there would be air-locks to prevent the air pressure from becoming excessive owing to the weight of the superincumbent air, which at from two to three miles would reach about double the atmospheric pressure at the surface. A greater rise of pressure than this would be objectionable for two reasons—firstly, from the inconvenience to the workmen; secondly, from the rise of temperature due to the adiabatic compression of the circulating air for ventilating purposes. The air-pressure immediately above each air-lock would thus reach to about two atmospheres, and beneath to one atmosphere. In order to carry on the transfer of air through the air-locks for ventilating purposes, pumps coupled to air-engines would be provided, the energy to work the pumps being obtained from electromotors. To maintain the shaft at a reasonable temperature at the greater depth, powerful means of carrying the heat to the surface would be provided. The most suitable arrangement for cooling would probably consist of large steel pipes, an upcast and a downcast pipe, connected at the top and bottom of each half-mile section in a closed ring. This ring would be filled with brine, which by natural circulation would form a powerful carrier of heat, but the circulation, assisted by electrically-driven centrifugal pumps, would be capable of carrying an enormous quantity of heat upwards to the surface. At each half-mile stage there would be a transfer of the heat from the ring below to the ring above by means of an apparatus similar in construction to a feed-water heater, or to a regenerator constructed of small steel tubes, through which the brine in the ring above would circulate, and around the outside the brine in the ring below could also circulate, the heat being transmitted through the metal of the tubes from brine ring to brine ring.

We have now presented to us two alternative arrangements for cooling. One arrangement would be to cool the brine to a very low temperature in the top ring at the mouth of the shaft by refrigerating machinery, so as to provide a sufficient gradation of temperature in the whole brine system, to ensure the necessary flow of heat upwards from brine ring to brine ring, and overcome all the resistances of heat transfer, and so maintain the lowest ring at the temperature necessary for effectual cooling at the lowest section of the shaft. But a better arrangement would be to place powerful refrigerating machinery at certain of the lower stages, the function of this machinery being to extract heat from the ring below and deliver it to the ring above. This latter method would increase to a very great extent the heat-carrying power of the system, which in the first arrangement is limited by the freezing temperature of brine in the descending column and the highest temperature admissible in the ascending brine column. The amount of heat conducted inwards through the rock-wall and requiring to be absorbed and transferred to the surface depends upon the temperature and conductibility of the strata. But there is no doubt that the methods I have indicated would be capable of maintaining a moderate temperature in the shaft to depths of 12 miles.

During the process of sinking at the greater depths the shaft bottom would require the application of a special cooling process in advance of the sinkers, similar to the Belgian freezing system of M. Poesche used for sinking through water-bearing strata and quicksands, and now in general use. It consists in driving a number of boreholes in a circle outside the perimeter of the shaft to be sunk; through these boreholes very cold brine is circulated, thus freezing the rocks and quicksands and the water therein, and when this process is completed the sinking of the shaft is easily accomplished. In our case this process would be maintained not only on the shaft bottom, but also for some time on the newly-pierced shaft sides, until the surrounding rock had been cooled for some distance from the face. As to the cost, rate of boring, and normal temperature of the rock, an approximate estimate has been made, based on the experience gained on the Rand, but including the extra costs for air-locks and cooling:

	Cost.	Time in years.	Temperature of rock.
For 2 miles depth from the surface ...	£500,000	10	122° F.
,, 4 ,, ,, ,, ...	1,100,000	25	152° F.
,, 6 ,, ,, ,, ...	1,800,000	40	182° F.
,, 8 ,, ,, ,, ...	2,700,000	55	212° F.
,, 10 ,, ,, ,, ...	3,700,000	70	242° F.
,, 12 ,, ,, ,, ...	5,000,000	85	272° F.

I hope I have succeeded in showing in the short time at our disposal that an exploration to great depths is not an impossible undertaking. But my main object in discussing the enterprise at some length has been to show that a pioneer company would not acquire any subsequent monopoly of similar works under the existing patent laws or the laws of any country. In the scheme as I have described it, there appears to be nothing that could be patented; but let us suppose that some good patent could have been found that was absolutely essential to the success of the undertaking, it would certainly have expired before the pioneer company could have reaped any substantial return, and probably before the first enterprise had been completed. It follows, therefore, that at the present time there is no adequate protection, or indeed any protection at all, for the promoters of many great and important pioneer enterprises, some of which might prove of immense benefit to mankind.

Let us ask what change in the laws would place great pioneer research works on a sound financial basis. A Government grant, except for very special purposes, seems to be out of the question, seeing that the benefits to be derived are generally not confined to any one country. An extension of the life of patents, which is now from 14 to 16 years in different countries, would be undoubtedly a step in the right direction. It would be of great benefit generally if some scale of duration of patents could be fixed internationally, the scale being fixed according to the subject matter, the difficulty of the attack, and the past history of the subject, more especially in view of the utility of the invention. One of the chief objections raised by the Privy Council against the extension of patents in this country has rightly been that undue prolongation is unfair to the British public, seeing that abroad no prolongations are granted. Therefore, if the duration of patents for important matters is to be extended at home, it must also be extended abroad. In other words, such prolongations, to be effective, should necessarily extend to other countries. They should be international, and concurrent in all the countries interested. One possible solution of this difficult question would be to place such matters under the jurisdiction of a central international committee, who would have the apportionment of the life and privileges of patents and of the extension or curtailment of their duration, according to their handling by the owners. I would ask, Why has a patent a life of only 14 to 16 years, while copyright is for 42 years? Why has a pioneer company making a railway under Act of Parliament generally rights for ever unless it abuses its privileges, or the requirements of the district necessitate the construction of competing lines, while a patent has in comparison a life of infinite shortness? I might also cite gas companies, electrical supply companies under Act of Parliament or provisional orders of 42 years' duration; and this reminds us of the fact that until the term of life for electric supply companies had been extended from 21 years to 42 years by the Bill of 1884, it was impossible to find capital for such undertakings.

Now, it may be urged that the grant of a patent is a different thing from the grant of power to a railway company, a gas or electric supply company. But the object of this address has been to show that a patent, to be fair to the patentee, ought in many cases to be analogous to an Act of Parliament or a provisional order. Would it not place matters in a fairer position, especially in the case of expensive and lengthy researches, to grant to those who pledge themselves to spend a suitable and minimum sum within a stated period on the research a reasonable and

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fair monopoly, so that such person or syndicate might in the event of success be in the position to reap a reasonable return for their expenditure and risk? Some such measure would unquestionably give an immense stimulus to research and invention by enabling capital to be raised and works started on commercial lines in fields of great promise at present almost untouched.

I pass over the disadvantages to the British inventor of the hostile patent tariffs of Continental nations, and of the protective patent laws of some of the British dependencies, disadvantages greater than those imposed by protective tariffs on the ordinary British manufacturer. There is, however, another aspect of the question to which I would briefly allude; it is the great benefits that the world at large has derived from the work of inventors in the past. Think of the multitude and power of the great steam-engines and gas-engines that drive our factories, and pump the water out of our mines, and supply our cities with water, light, and power; of the great steamships scattered over the ocean, and the locomotives on the railways. Think of the billions of tons of steel that have been made by the Bessemer, Siemens-Martin, and Thomas Gilchrist processes, and of the great superiority and less cost of the material over the puddled iron which it superseded. Think of the vast work performed by the electric telegraphs and telephones, and we must not fail to include the great chemical and metallurgical processes carried on all over the world, besides the countless other inventions and labour-saving appliances. Can we form any idea of the commercial value of all these gigantic tools that past inventors have left as a heritage to the human race, and can we venture to place any order of magnitude on so vast a sum?

If we take as our unit of value the whole of the money spent on all inventions, both successful and unsuccessful, I think we shall be much below the mark if we assume that the value of the benefits have on the average exceeded by ten-thousandfold the money spent on making and introducing the inventions. If this is so, let us see what it means. It means that for every unit of capital spent by the inventors and their friends on invention, they have in some cases received nothing back. In some cases they have just got their capital back, in some cases two or threefold, occasionally tenfold, very rarely a hundredfold. Whereas the world at large has received a present of ten-thousandfold greater value than all the money spent and mis-spent by the small band of past inventors.

In conclusion, let us hope that the inventor will in the future receive more encouragement and support, that the patent laws will be further modified and extended, that the people at large will consider these matters more closely, and recognise that they are of first importance to their progress and welfare, and that in the future it may be easier, nay in some cases possible, to carry on many great researches into the secrets of Nature.

Address to Section A.

In his address to the mathematical and physical division of the association at Cambridge, Prof. HORACE LAMB, the sectional president, remarked that of the various subjects which fall within the scope of this section there was no difficulty in naming that which at the present time excites the widest interest. The phenomena of radioactivity, ionisation of gases, and so on were not only startling and sensational in themselves, they had suggested most wonderful and far-reaching speculations; and, whatever be the future of these particular theories, they were bound in any case deeply to influence our views on fundamental points of chemistry and physics. No reference to this subject would be, he thought, satisfactory without a word of homage to the unsurpassed patience and skill in the devising of new experimental methods to meet new and subtle conditions which it had evoked. It was felt as a matter of legitimate pride to many present that the University of Cambridge had been so conspicuously associated with this work.

Commenting upon the modern tendency in science, Prof. Lamb observed that one significant result of the modern tendency was that we no longer with the same obstinacy demanded a mechanical explanation of the phenomena of light and electricity, especially since it had been made clear that if one mechanical explanation were possible, there would be an infinity of others. Some minds, indeed, revelling in their new-found freedom, had attempted to disestablish ordinary or "vulgar" matter altogether. He referred to a certain treatise which, by some accident, did not bear its proper title of "Æther and *no* Matter," and to the elaborate investigations of Prof. Osborne Reynolds, which presented the same peculiarity, although the basis was different. Speculations of that nature had, however, been so recently and, he might add, so brilliantly dealt with by Prof. Poynting before that section, that there was little excuse for dwelling further on them now. He would only advert to the question whether, as some suggest, physical science should definitely abandon the attempt to construct mechanical theories in the older sense. The question would appear to be very similar to this, whether we should abandon the use of graphical methods in analysis. In either case we ran the risk of introducing extraneous elements, possibly of a misleading character; but the gain in vividness of perception and in suggestiveness was so great, that we were not likely altogether to forego it, by excess of prudence, in one case more than the other.

WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

(*Concluded from page 229.*)

SIGNALLING TO AND FROM MOVING RAILWAY TRAINS.

Mr. T. A. Edison in 1885 invented, or rather perfected, a method of doing this, said to be due to Mr. Willoughby Smith (see Edison and Gilliland English patent No. 7,583 of 1885). He had a large board 8in. wide, covered with tinfoil, placed along the roof of each car. He used static electricity, and to use his own words, "making the electricity jump 35ft., and transforming every running train of cars into a telegraph station accessible to every other telegraph station on the road, as well as to the passengers." "When the train is telegraphed to," he adds, "the message jumps from the ordinary telegraph wire at the side of the track and alights on this board, being conveyed to the apparatus in the train below." The board is well insulated from the carriage by blocks of glass, all the boards, or rather strips of metal, being electrically connected. A wire is connected with this board or condenser, and through the carriage body to the earth. The apparatus required is an induction coil, the secondary wire of which is of very high resistance, and is in the circuit of the grounding wire referred to, in which may be also a telephone of high resistance. In the primary of the induction coil are a local battery and a revolving circuit breaker. The circuit breaker is shunted by a back-point key, which normally short-circuits it and prevents it from affecting the induction coil. A switch is provided which short-circuits the secondary wire of the induction coil when receiving a message and opens it on transmitting one. The ordinary telegraph wires on poles at the side of the line, and earthed at their ends, are used collectively for conveying the signals—they, in fact, form the other surface of the condenser, the metal strips on the carriages being one surface, whilst the air between is the dielectric. In signalling between *trains* the key in one telegraph office upon one train is worked; this causes static impulses at the condenser surface on this train which affect the wires, and these in turn affect the condensing surface on the other train, and cause audible signals in the telephones there. At each signalling station by the side of the line a large metallic condensing surface is provided, a wire running from this condenser surface to the station, where it is earthed through similar apparatus to those in the carriages, or a separate wire may be run from each telegraph wire to the station, where it is connected to one side of a condenser. The ordinary telegraph Morse keys are shunted by condensers, which do not, it is said, interfere with the ordinary telegraph work, at the same time forming constantly closed paths for the induction impulses. The trains and stations were connected inductively with the line wires in "multiple arc," signals being transmitted as

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described, Morse characters being employed. The system was put in operation first at Staten Island, United States; next on the Chicago, Milwaukee, and St. Paul line, and by October, 1887, also on the Lehigh Valley line. Messages were sent and received perfectly even when the trains ran at speeds of 60 miles an hour, over 400 messages being sent during one run, and the same winter all the snowed-up trains on the latter line were in constant communication. The system soon fell into disuse, as nobody seemed to want it much.

The De Forest Company are, we understand, at present making arrangements to equip the "Twentieth Century, Limited" express on the New York Central Railroad with their apparatus, so that communication may be kept up with "wireless" stations near the line and about 100 miles apart. The same thing is also being tried in Germany, the train aerials being horizontal and occupying a position similar to that of the communication cord on English lines. Experiments on wireless telegraphy to moving trains have also recently been carried out in Canada on the Grand Trunk Railway there by Profs. Rutherford and Barnes, of McGill University. Whether their system is like that of Mr. Edison or on more modern lines, following Marconi and De Forest, we do not know, but, in any case, the matter is not one of great importance, as it was found in the United States, and probably will be found elsewhere, that very few people, even in America, wish to devote themselves to business to such an extent as to require telegraphic communication during a train journey. It would scarcely pay a railway company, on the other hand, to instal such a system unless a considerable number of passengers require the communication.

Wireless Railway Signalling.—Experiments in connection with wireless intercommunication between moving trains, and between trains and fixed stations along or near the line, have been carried out in England with the Marconi system, in America with the De Forest system, in Germany with the Braun-Slaby system, and in Belgium with the Guarini system (Belgian patent, No. 167,023, Nov. 29 1902). These experiments have shown one thing at any rate—viz., that great power is requisite even for comparatively short distances. It takes (on the authority of M. Guarini) an expenditure of no less than 1 h.p. to communicate "wirelessly" with a moving train only six miles distant. The distance of successful wireless signalling depends, with good apparatus, not only on the power supplied, but on the length of aerials used. In the case of moving trains tall aerials are inadmissible, and horizontal aerials have not proved very successful, their rapid displacement in space having apparently a prejudicial effect. It has been proposed to place a special continuous horizontal aerial near the track, influencing this first by the transmitter, and thus allowing it to act on the receiver connected, say, to a horizontal wire laid along the roofs of the carriages. This special wire by the track would involve considerable expense, and it is doubtful if the utility of wireless intercommunication is, in this case, such as to warrant the expense. M. Emile Guarini, assisted by M. Cesar and Lieutenant Poncelet, made some interesting experiments recently on the Belgian State line, using the ordinary telegraph wires and (unlike Edison, who tried the use of these wires in 1886) a true Hertzian-wave system. In addition to the telegraph wires, intermediate wires were employed to communicate with the transmitter and receiver respectively. M. Guarini, in fact, created at a fixed point, say a station, or at a moving point (on a train) an electromagnetic disturbance by using an oscillator. Such a disturbance is readily detected by a coherer or like receiver at the other fixed (or moving) point near the telegraph wires. The latter take up the Hertz-wave disturbances and radiate them after the manner of aerials.

The energy employed in some of these experiments was 40 watts, the aerial at the fixed station consisting of 40 strands of wire 32·8ft. long, communication being successfully maintained through a distance of 10·4 miles. With energy equivalent to only 15 watts and $\frac{1}{10}$in. spark, a good coherer being employed on a car at a distance of $2\frac{1}{2}$ miles, successful telegraphing was accomplished; the aerial on the car being only $6\frac{1}{2}$ft. long, and consisting of an iron tube 4in. in diameter. Signals were successfully transmitted both ways even when the car was 100ft. to 130ft. away from the telegraph wires, but no data are furnished as to what effect the speed of the car, when moving, had on the distance successfully traversed. No disturbance of any sort was observed in any of the telegraph or telephone instruments connected to the wires along the line. This fact is of interest, and agrees with the results obtained by Profs. Slaby, Turpain, and others. In fact, the high-frequency oscillating currents employed in wireless work do not interfere with the ordinary currents of telegraphic work. It was not even necessary in the experiments of M. Guarini to connect one pole of the oscillator to earth, as it was found that a condenser or simple capacity, consisting of a tube laid parallel with the earth, was sufficient.

M. Guarini tried how the rails would do instead of the telegraph wires. With power equal to 100 watts and a sensitive Blondel coherer, signals were successfully sent, but over a very much shorter distance than before. M. Guarini thinks that a cheap and effective block system might be established by using the telegraph wires to communicate with the *engine* of a moving train. What means would have to be adopted, however, to prevent half a dozen different engines from receiving a given message it is difficult to say, but it might be possible to ensure that a given engine (or van) should be able to communicate only with the train immediately preceding or following—possibly the distance itself would ensure this in most cases. M. Guarini thinks that submarine cables might perform a similar function to that of the telegraph wires in the above experiments. Thus without interfering with the ordinary cable business it might be possible to communicate readily with ships within a certain distance of the cables or with certain portions of coast at present remote from ordinary telegraph stations. In fact, without using the enormous amount of energy required for Transatlantic wireless signalling, the cables might be used as intermediaries, the news being radiated both by land and sea by the wireless methods now so common.

Screening—The Effect of Obstacles, Weather, Light, etc.

Captain Jackson, F.R.S., of the British Navy, read a very interesting paper on "Some Phenomena affecting the Transmission of Electric Waves over the Surface of the Sea and Earth" before the Royal Society in May, 1902. This paper gave the results of most important observations respecting the intercepting power of various obstacles. For instance, in regard to various kinds of rock, soft sandstone, shale, etc., hard limestone, and iron ores transmit electric vibrations with completeness represented by the numbers 72, 58, and 32 per cent. respectively. Barometric variations were also studied and their effect on, or, rather, connection with, the distance of signalling. He finds that, contrary to some of Mr. Marconi's statements, an electrical state of the atmosphere *diminishes* the distance to which signals can be transmitted, although in one case such a state momentarily increased the distance *by nearly 50 per cent.* Mist or dust laden air *diminishes* the distance, and a want of synchronism in the oscillatory discharge of the transmitter, when proper syntonic apparatus are not used, causes zones of silence at the receiver. The irregularity of the trains of waves causing interference at different points of their path may account for this. Captain Jackson's results hardly bear out the extremely optimistic views of some experimenters who stated that bad weather and obstacles had no ill-effect on the signals sent out by the wireless system. Mr. Marconi's observations on the effect of day and night are interesting; they are given in a paper read by Mr. Marconi before the Royal Society in June, 1902.

The Effect of Daylight on Wireless Signalling.—It is found that signals transmitted by night carry much farther and better than during the day. Up to 500 miles little difference was detected by Mr. Marconi, but for greater distances the difference became more and more marked as the distance increased. Aerials 12m. high sufficed at night, but, other things being equal, a height of 18·5m. was required by day. Mr. Marconi suggests that the effect may be due to

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the diselectrification of the transmitting aerial or elevated conductor by daylight, the electrical oscillations being, therefore, prevented from attaining the large amplitude they would attain by night. The effect is probably more noticeable where, as at Poldhu, a very high potential is necessary in the elevated conductors. The true explanation is probably that referred to by Prof. J. J. Thomson and others—viz., that the sun sending out streams of electrons gives rise to what has been termed an "electron fog," which acts on the long-wave impulses of wireless messages much in the same way that an ordinary fog does in the case of light waves. The ionisation of the air in sunlight is the now generally accepted cause of the difficulty experienced in sending messages over long distances by day.

The Effect of Electrical Storms.—The effect of atmospheric electrical conditions were observed by Captain Jackson. The effect of lightning discharges was to make a record in the receiver even when no lightning was visible to the observer at the receiving station. The approach of electrical disturbances is usually denoted by the printing of a few dots at intervals on the receiving tape, the most frequent record being three dots, the first being separated from the other two by a slight interval like the letters "e i" in the Morse code, this record being that of *distant* lightning. There are other irregular signs—often spelling words on the Morse code—probably due to the same cause. These disturbances are most frequent in summer, and also most frequent near high mountains. They are most frequent at night and between 8 and 10 p.m. When they are present, the distance of successful signalling is reduced by 20 to 70 per cent. as compared with that under the most favourable atmospheric conditions. Many electrical disturbances or magnetic storms which give rise to severe earth currents do not affect wireless instruments, as the following letter, referring to the great disturbances to ordinary telegraphy experienced on Oct. 31, 1903, shows: "Marconi Wireless Telegraph Company, Limited, Finch-lane, London, Nov. 3, 1903. Dear Sir,—In reply to your letter of 2nd inst. we beg to inform you that, from all reports to hand at time of writing, the recent electrical disturbance has had no effect whatever on wireless communication. This is only natural, as these disturbances are apparently oscillations of so long a period as to be altogether outside the range of wireless apparatus operated on the Marconi system.—Yours faithfully, ANDREW GRAY (for the Marconi Wireless Telegraph Company, Limited)."

The Difference between Sea and Land.—Ether vibrations of the wave-length used in wireless telegraphy, say 500ft. to 1,000ft., are much more readily transmitted over sea than over land. This seems to be due to the fact that the sea acts as a sort of mirror, reflecting these waves but not allowing them readily to pass through it; whereas the earth does allow them to diffuse themselves through it more readily. Hence over the sea the waves may be bent or diffracted, so as to adapt themselves to the curvature of the earth much more readily than over land. There will be a mountain of water something like 150 miles high between Cornwall and Cape Cod, so that the ether waves conveying Mr. Marconi's recent messages between the two places must have suffered considerable bending or reflection without extinction. In regard to the speed of ether waves, Dr. Fleming gives a very interesting comparison between water, air, and ether waves. A water wave, at the speed of usual ocean waves, would take 100 hours to reach America, a sound wave four hours, and an ether wave about *the one-sixtieth part of a second.* The results of the experiments of Captain Jackson and others may be summed up in a few sentences as follows: (1) Signalling is much more successful over sea than over land. (2) Signalling is much more successful by night than by day. (3) *Intervening* land or mountains reduces the distance of signalling. (4) Particles held in suspension, such as dust, saline, vapour, etc., also reduce the distance. (5) Electrical disturbances act as adverse factors, and give rise to false signals, known as "strays." Some severe electric storms, however, have no effect on wireless apparatus. (6) With certain transmitting apparatus there may be zones of silence due, perhaps, to interference effects.

CONCLUSION.

Of the future of this wonderful system of message transmission with its many modifications, who can predict? Whilst fully alive to its defects, and to the uncertainty as to results, especially over land, which render it a still not very formidable rival to the older cable systems, one cannot but reflect that the rapidity of advance in the last few years warrants the belief in still greater achievements in the near future. The good work already done must not be minimised by reflections as to unaccomplished possibilities. It may be that in a short time the earth shall be girdled with a complete system or systems of stations, so that all nations may thus be linked in a community of interest—let us hope for universal advancement and peace An important message sent out by a powerful station in England or America may then be read, not only on multitudinous ships at sea, but by lonely missionaries in the swamps of Africa, and by trained mountaineers amid the eternal snows of polar climes. Thus the savage and sage alike, though far from the haunts of civilisation, may at any rate *read* the message eternal love, and sojourners may learn from friends at home how each is remembered in the "dear homeland." Thus may all be encouraged by brotherly help to follow the way which leads "upward every day"; and so through the ether, by means of a new wave-length which man has only recently found eyes to see, may the old command receive further fulfilment: "Let there be light."

ASHTON-UNDER-LYNE ELECTRICITY ACCOUNTS.

The accounts of the Ashton-under-Lyne electricity department for the year ended March 25, 1904, show a total expenditure on capital account to that date of £62,756. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	4,328	11	1
Distribution of electricity	246	5	10
Attending and repairs to public lamps	151	9	8
Rents, rates, and taxes	406	6	7
Management expenses, salaries, etc.	913	19	10
Special charges, insurances, etc.	233	13	11
Decrease in value of stock	23	11	2
	6,303	18	1
Amount carried to net revenue account	4,974	2	3
	£11,278	0	4

Cr. Income.	£	s.	d.
Sale of current per meter	5,364	0	6
Sale of current under contracts	4,821	4	8
Public lighting	861	7	6
Rental of meters and other apparatus	79	18	0
Attending and repairs to public lamps	151	9	8
	£11,278	0	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	61,158	0	0
Sinking fund account	6,093	2	9
Advanced by bank—Capital account	1,112	8	11
Ditto—revenue account	3,951	8	6
	£72,315	0	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	62,270	8	11
Stores in hand	193	7	2
Sundry debtors for current supplied	2,863	18	0
Securities held (cost price)	6,093	2	9
Balance deficiency	894	3	4
	£72,315	0	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,617,769
Quantity sold	Public lamps	103,365	1,539,730
	By contract	1,190,140	
	Private consumers by meter	246,225	
Quantity used on works			29,250
Total quantity accounted for			1,568,980
Quantity not accounted for			48,788
Number of public lamps			220
Total maximum supply demanded (kilowatts)			951

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FAITH AND THE B.A.

For what our teachers teach, let us be thankful. The one prevailing thought in reading the presidential address of Mr. Balfour at Cambridge is that we must have "faith," unlimited, untiring faith in our teachers when they are expounding or evolving new theories. Every generation has probably had a theory to explain the phenomena of Nature, or if it had no theory or explanation did not worry on the subject—the world moving on just as quickly or as slowly as it always had done. Just now we have a regeneration of an old theory—only the old theory is now explained in a different manner. Once we heard of "mind, no matter," of centres of force, of knots in the ether; once it was held that whatever existed or did not exist, matter and mass were permanent—eternal. The present theory may be given by extracts from Prof. Sir Oliver Lodge's article in the current issue of *Harper*:

"Matter then appears to be composed of positive and negative electricity, and nothing else."

That is the resultant theory—the imagination plays its part, as will be seen from the following:

"Our present view of an atom of matter, therefore, is something like the following: Picture to oneself an individualised mass of positive electricity diffused uniformly over a space as big as an atom—say a sphere of which two hundred million could lie edge to edge in an inch, or such that a million million million million could be crowded tightly together into an apothecary's grain. Then imagine, disseminated throughout this small spherical region, a number of minute specks of negative electricity, all exactly alike, and all flying about vigorously, each of them repelling every other but all attracted and kept in their orbits by the mass of positive electricity in which they are embedded and flying about. In so far as an atom is impenetrable to other atoms, its parts act on the sentinel principle, not on the crowd principle. There are two ways of keeping hostile people out of an open building. One is to fill it with your own supporters; another is to place an armed policeman at every door. The electrons are extremely energetic and forcible, though in bulk mere specks or centres of force. Every speck is exactly like every other, and each is of the size and weight appropriate to the electron. Different atoms—that is, atoms of different kinds of matter—are all believed to be composed in the same sort of way; but if the atoms of a substance are such that each possesses twenty-three times as many electrons as hydrogen has, we call it sodium. If each atom has two hundred times as many as hydrogen, we call it lead or quicksilver. If it has more than that, it begins to be conspicuously radioactive."

That is the gist of the new theory. We take it on trust, having faith in our teachers; but as for understanding it, we don't. It seems simply to be another stretch of the imagination of the mind of science, and leads us simply to ask questions differing little from those that have been asked before. Does the ether exist, or is it merely an effort of the imagination? Science endows it with every property science requires in the formulation of new theories. What causes repulsion; what attraction? Is velocity eternal? What about space? Action at a distance is tabooed, but surely the distances between repellent specks is comparable with the distance between the earth and the sun. Action at a distance is still the prevailing notion. Still, we have faith—great faith. Our teachers can, as they ought to, imagine things inconceivable to ordinary minds. They are experts, and hence we live in the hope that the rough may be made smooth, and the hidden quite

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plain. Mr. Balfour touches upon these interesting and troublesome subjects with the hand of a master. It is almost impossible to discover that he shines in another sphere and is not one of the select in the house of the experts. Surely the presidential address at Cambridge will afford ample food for thought.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY AT GLASGOW.

SIR,—Your contributor, "The Writer on Telephony," narrows the controversy on the above subject down to whether it is true or not that the 1897 estimate was made "for the special purpose of showing what *the then existing telephone system* in Glasgow *ought to have cost* the National Telephone Company." "W. O. T." quotes a statement by Mr. Bennett to the effect that the 1897 estimate was made for that special purpose, and he says that he accepts that statement as the truth, the whole truth, and nothing but the truth, and has based on it all that he has written. I do not accept that statement, but the person who most effectively contradicts Mr. Bennett is not I, but Mr. A. R. Bennett himself.

If Mr. Bennett had made an estimate purely for comparative purposes to show what the then existing system ought to have cost, he would properly have made an estimate for a similar system. The then existing system was an overhead single-wire system. The estimate put in by Mr. Bennett was entitled "Estimate for Glasgow municipal exchange," and described a metallic-circuit underground system of an entirely different character from the then existing system. In referring to the estimate in his evidence, Mr. Bennett spoke of it as a working estimate intended to be carried out; stated that it was backed throughout by tenders from responsible contractors; and in describing the various plant and apparatus to be used, he drew as many distinctions as possible between the proposed system and the then existing system. The wire plant was to be different, the switchboards were to be different, and the instruments were to be different. An estimate merely intended to show "what the existing system ought to have cost" could not have been described in these terms.

Further, the evidence of Bailie John Alexander, the convener of the Telephone Committee, showed that the Council had an actual scheme in hand for a telephone system which they contemplated carrying out if a license was secured. Asked what amount the Council contemplated expending, Mr. Alexander said, "We may have to expend £100,000 or £120,000." Bailie Samuel Chisholm, a member of the Telephone Committee, also stated that the Corporation had applied for a license for establishing a telephone service over the whole area, and that the Corporation had estimates showing that the proposed system could be constructed for under £100,000.

No one can read the report of the evidence taken at the Glasgow enquiry of 1897 without coming to the conclusion that the Glasgow Corporation Telephone Committee believed that they were in possession of a definite working estimate for a Glasgow municipal telephone exchange, and were prepared to begin work on that estimate if they secured the license which they had applied for.

Before the 1898 Select Committee Mr. Bennett gave evidence regarding the Glasgow estimate of the previous year. I will quote simply the following questions and answers. I have italicised the more emphatic statements.

Q. You prepared an estimate, did not you, for Glasgow, too?—Yes, sir, I did, last September.

Q. That is in the Blue-book, is it not?—That is in the Blue-book.

Q. And there is nothing to modify the evidence you gave then?—No.

Q. It is no good repeating the evidence you gave before the Glasgow enquiry, because that is referred to us?—Yes, sir; I would like to let the committee to understand, if possible—if I may be permitted to point the matter out—that *the estimate which I prepared for Glasgow was not so much an estimate as a statement of ascertained cost*, because every item in it is covered by a tender from a competent, well-known electrical firm.

Q. Your estimate would have given a service costing about £19 per subscriber—£18. 16s. and something?

Q. Eighteen pounds sixteen shillings and threepence; and that you say now was not based upon mere theory, but upon actual tenders received?—Upon actual tenders received. The town clerk of Glasgow invited tenders from three or four firms representing the class of work done throughout, and of these tenders what was considered the best was selected from each tender, *and the tenderers (the contractors) were given to understand that they might be called upon to execute the work*, and they were all quite prepared to do that, *so that the Glasgow Corporation, if they had been in a position to accept these tenders, would have been placed in possession of a telephone exchange with* 5,000 *lines*, 5,200 *subscribers, for the sum of* £97,000 *odd*, which is about £18. 16s. 3d. per line. Perhaps I may add that the mileage of line provided for in this estimate considerably exceeded the mileage of line owned by the National Telephone Company in Glasgow at that time. They also have something like 5,200 subscribers on their system, so that this estimate represented a greater mileage than the National possesses now for the same city.

Q. Did it represent metallic circuits, too?—Yes, throughout. For many years I have not put in anything but metallic circuits.

Q. Is the National Telephone Company's service there metallic?—Not at present, except between switchrooms.

Q. Does this include every cost of installation, including the cost of taking up roads and laying them down again?—Everything. I have some of the actual tenders here, if you would like me to put them in.

Q. No; I do not think we need go into it in such detail as that. Have you anything you want to add with regard to the evidence you gave with regard to this Glasgow system before the commissioner?—I do not think so, sir. *I am prepared to stand upon it as I gave it then.*

When the license for the Glasgow municipal system was about to be issued, and work on constructing the system about to begin, Mr. Bennett made a fresh report to the Telephone Committee, dated Feb. 23, 1900. The following extracts from this report bear on the statement quoted by "W. O. T":

"I am of opinion that in the first instance a complete exchange for 5,250 metallic circuit lines—viz., 5,000 subscribers within the city and suburbs, 200 in outlying places in the telephone area, together with 50 public telephone offices—should be undertaken. *This number of completed lines exceeds by* 50 *that provided for in my* 1897 *estimate.*"

The report recommends that as regards floor space in exchanges, ultimate capacity of switchboards, size of poles, and number of conduits in the vicinity of the switchrooms, provision should be made for another 5,250 lines. The report then considers in detail changes in prices subsequent to the preparation of the 1897 estimate, and shows how it was expected to neutralise the effect of such increases of price as had taken place.

Two paragraphs in this report are interesting in view of the remark in the statement quoted by "W. O. T.," that the increased cost at Glasgow is partly due to underground distribution:

"I have good reason to anticipate that a better and cheaper method of distribution to subscribers than by the overhead standards provided for in the 1897 estimate, will be found practicable in at least the more crowded parts of the city."

"I am indebted to the Electricity Committee for having brought to my notice the fact that iron conduits now exist in most of the principal streets of the city, which, although now used for electric lighting purposes, will probably be soon in great part disused. These are quite suitable for telephone cables, and by making them, wherever possible, a part of the telephone system, very considerable economies in first cost could be effected."

After noting a possible reduction in the cost of switchboards given in the 1897 estimate, the report continues as follows:

"Allowing for all the facts, *I am strongly of opinion that the* 1897 *estimate still remains substantially correct*, and that 5,250 completed and 1,200 partially-completed metallic circuit lines can be constructed in the best style, and in conformity with the specification which the Post Office have annexed to the Corporation license, *for* £100,000. *The committee may safely assume that the exchange would be got to work for* £19 *per line.*"

This report, *in which the* 1897 *estimate is again set out in full,*

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was approved and adopted by the committee and subsequently by the Town Council.

I leave it to "W. O. T." to reconcile these statements with that on which he rests his argument.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, S.W., Aug. 15, 1904.

I understand, Sir, that you have submitted a copy of Mr. Webb's letter to Mr. A. R. Bennett for any remarks he may have to make thereon. Mr. Bennett will probably be able to reconcile his statements made at various times; at any rate, I do not see his difficulty in so doing. What I do see is that Mr. Webb is so completely satisfied with his own interpretation of Mr. Bennett's words that, as I said before, he cannot or will not see another perfectly simple and the probably correct interpretation. Once for all, I am not advocating Mr. Bennett. I want the truth. Mr. Bennett says one thing, and I believe it is so; Mr. Webb says it is not so, and I think him incorrect. In ordinary cases it would not be necessary for me to say all my remarks are my own, and there is no collusion with Mr. Bennett or anyone else. Here, then, is my interpretation of what Mr. Bennett has at various times said, restricting for the present my remarks to the quotations made by Mr. Webb and myself. Mr. Bennett, an ardent advocate of municipal telephony—which, by the way, I am not—was engaged by Glasgow. A company had vested interests there. Mr. Bennett asked himself, What ought to have been the cost to the company of the existing equipment? [Just one more aside. You, Sir, have expressly forbidden me to make any detailed comparison in your journal between what has been done in telephony by a company and by a municipality, giving as a reason the two are not working from the same standpoint, and therefore any such comparisons are misleading.] Also what would be the cost to replace the company's equipment by a similar equipment? As I read the statements of Mr. Bennett, he, with the aid of the town clerk of Glasgow, prepared an estimate, or, rather, *ascertained the cost*, in the only practicable way, by actually getting tenders for a similar equipment. The contractors, we are told, were quite prepared to do the work at the amount of their tenders, and the total sum was £97,000 odd, or £18. 16s. 3d. per line. If my interpretation is right, we can go a step farther. So long as the Glasgow committee was satisfied with the equipment similar to that which existed, so long the estimate of cost stood; the tenders were there, the contractors were there. As I read the matter, however, Glasgow was not satisfied, and wanted something different and better, hence the ascertained cost—ascertained by tenders from contractors—went by the board, and something different had to take its place. The something different Glasgow now has; the cost is greater, because what it has is better than what was. Such is my interpretation. I think it quite justified by the reports and utterances of Mr. Bennett, and to me seems the natural development of things telephonic at Glasgow.—W. O. T.

FROM MR. A. R. BENNETT.

Mr. Webb is fighting a bogey of his own creation. Turning to the Blue-book of the Glasgow telephone enquiry, we find in Mr. A. R. Bennett's evidence in chief the following, in reference to his estimate for an exchange of 5,200 completed instruments:

Q. 5,040. In preparing your estimate, had you in view the making of this system of about the same size and extent as the existing system of the National Telephone Company?—*A.* Yes, it was considered.

Q. 5,041. With a view to comparison?—*A.* Yes.

Q. 5,043. Was it also desirable to verify the estimate by obtaining tenders from responsible firms for the execution of all the most important parts of the work?—*A.* Yes, and such tenders have been obtained for practically the whole of them.

Turning to Mr. Bennett's cross-examination, we find the following:

Q. 5,356. Is it part of your scheme that there should be that number of subscribers in Glasgow?—*A.* In the event of the Corporation proceeding with the scheme, should they honour me by asking my advice, I should recommend an exchange of at least 20,000 to 25,000 subscribers.

Q. 5,359. You seem to be suggesting to the Corporation to set up a new and complete system for the citizens of Glasgow as a whole with a 5,000-line switchboard, because your system is for a 5,000-line switchboard; why do you do that if Glasgow and Stockholm are in the same position, and there is the same necessity for telephone communication per head of population in Glasgow as in Stockholm?—*A.* I think I made it clear in my evidence in chief that the estimate which I have prepared was designedly founded on a similar number of subscribers as exists at present in Glasgow, for the specific purpose of ascertaining the approximate cost of such a system as exists here. That was the object, and it was never proposed that, in the event of the scheme being given effect to, the lines should be allowed for such a small number of subscribers as 5,000 or 6,000.

Q. 5,360. That was never contemplated; suppose the Corporation got a license, how many lines do you contemplate that the scheme should be set a-going with?—*A.* I have no right to speak for the Corporation, but I should recommend them to lay out an exchange for 20,000 or 25,000.

Turning to the summing-up speeches, we find Mr. Salvesen, Q.C., counsel for the Corporation, said: "Mr. Bennett has prepared a most careful estimate as to the constructional cost of a system such as the telephone company are using in Glasgow to-day, to supply the same number of subscribers, and of the working expenses of such a system. There was a great deal of criticism upon his estimate, as not being a scheme which an independent man looking into the future would employ. He did not prepare it with that object. He said that if he were honoured by the city to perfect it, he would lay it out for 20,000 or 25,000 instead of 5,000 subscribers, but the estimate was the only way in which he could compare the system of the National Company with the system that he could at this moment construct within the same area, and which would supply exactly the same number of subscribers."

Mr. Bennett's evidence was supported by tenders from responsible firms, which showed that the scheme for 5,250 lines could be carried out for the estimated amount. Mr. Webb's statement that Bennett spoke of the estimate as being intended to be carried out is, therefore, incorrect. What Bennett did say was, that it was a working estimate that *could* be carried out *if deemed expedient*, and from this he has never swerved. The comparison, with the National Telephone Company, and especially the tenders from firms of good standing, were rendered necessary by the assertion of the company that their exchange, which in round numbers contained some 5,000 lines, had cost four or five times the amount which Mr. Bennett estimated was the proper expenditure for an exchange of that kind. So that Mr. Bennett's subsequent evidence before the Select Committee was entirely correct, that had the Corporation decided to construct an exchange of 5,250 lines, they could have got it for the sum of £97,000. When the license was obtained Mr. Bennett still recommended that these numbers should be adhered to as regards the lines to be completed out of hand, but he also recommended that immediate provision as regards floor space at the exchanges, ultimate capacity of switchboards, etc, should be made for another 5,250 lines, making provision for 11,000 lines in all. This the Telephone Committee agreed to, but subsequently, owing to the unexpectedly liberal manner in which the undertaking was being patronised by the public, and also to the grumbling occasioned by the extensive opening of streets, which made them determined to prevent reopening for a good many years to come, issued instructions for the laying of a very much more extensive scheme.

We are informed that the electric light conduits referred to by Mr. Webb were not brought into use for telephone purposes, except for a distance of a few yards only in two or three localities.

Turning to the detailed estimate printed at the end of the Glasgow Blue-book, it will be noticed that the estimate provides for overhead junction routes to the suburbs, and also for the distribution overhead of the subscribers' spurs. As a matter of fact, the committee issued instructions that all subscribers' spurs should be underground in the centre of the city as well as in the residential suburb of Pollokshields, and that all junction routes to the suburbs should be underground. This order rendered adhesion to the original estimate impossible. The distribution underground in the centre of the city proved to be very expensive, not so much from the actual electrical work, but from the stringent regulations which were made by architects and property agents as to the leading in of underground cables to their premises, and the casing in of the leads in the

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buildings, almost every architect insisting on a different design of casing.

To sum up, we contend that, allowing for the altered circumstances, and the extensive nature of the spare plant provided, Mr. Bennett's estimate has worked out with a remarkable degree of accuracy, and that although Mr. Webb's criticisms when read by themselves may appear damaging to those whose knowledge of the circumstances is but slender, they entirely lose their force as soon as they come to be dissected in the light of recorded evidence.

[We sent proofs of Mr. Webb's letter to "W. O. T." and to Mr. A. R. Bennett, as we feel strongly that this question of *bonâ fides* should be settled once and for all. The annexed replies of these gentlemen are wholly independent. Once get this bogey estimate accepted or rejected, the discussion is on a different plane, and may prove exceedingly useful and interesting It is a legitimate point for discussion, whether the system adopted as a whole is good or bad, or whether this and that detail is good or bad —ED *E. E.*]

"THE OLD 'UN'S ADVICE"

SIR,—I should like to express my appreciation of "M. M.'s" kindly approbation of my letters, and to assure him that I am entirely in accord with him in eschewing all unnecessary—*i.e.*, avoidable—work. This is only, however, because I have in the course of a varied experience laboured so hard that a little variety is pleasing. On the general principle of not putting my trust in princes, my faith in "influence" is weak—but if a prince passes my way I take care to pull off my hat. If he drops a sixpence therein, so much the better.

I am unprepared to say whether theory or practice is better. I am of opinion that it entirely depends on the temperament of each man considered. Some are practical men by nature, others theoretical. The safe rule for any man is first to get a lot of both theory and practice, and then follow his instincts.

My advice to the Young 'Un appearing this week will show how fully I am in sympathy with "M. M." on the subject of "talking."—Yours, etc., THE OLD' UN.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

IV.—ON THE USE OF THE JAW.

My Dear Young 'Un,—Your last letter contains remarks which I do not know whether to class as slothful or sly. You say, "It seems to me that working . . . is one of the ways not likely to recompense 'a young one,'" and again, " . . . throw work, like physic, to the dogs, . . . learn not so much how to *do* things as to *talk* about doing them."

Now, if a man starts talking round his hat about things he doesn't understand—particularly practical matters—he will quickly be written down an ass. Therefore, it is no good trying to squirm out of the sweaty part of the business. If you begin trying to cut corners that way, you will find yourself up some blind alley or other.

At the same time, a judicious use of the jaw will probably make the difference between success and failure to you My advice is to Advertise with a big A. You must be your own automobile—get hold of yourself, and push. If a man does a smart bit of work and then gazes dumbly up at his employer's face with an expression of trusting affection, that employer will probably regard him as an intelligent and well-trained bow-wow, and will treat him as such. If, on the other hand, he beards the employer in his den, informs him that the job is done, that it was finished in six hours under the previous record, and that certain new and unexpected obstacles had been made skittles of, the employer will begin to wonder what sort of a rise he must give in order to keep the man.

The tongue is a little member, and it is worth its keep. Only it must be kept in order. It is no good advertising as the pig advertises its shearing—much cry and little wool. Always be sure you are booming a good line, that you have got plenty of stuff for sale, and a reserve fund to cover bad debts. You can learn a lot by studying the advertisement pages of a journal. You will notice, in the first place, that a manufacturer must get into touch with his market. It is no use advertising an alternator in the *Drapers' Record*. In the same way you need not write for a job as a senior draughtsman when your experience has been exclusively mains laying. If you are disappointed, it does not mean that you are no good, but that you are in the wrong market.

Again, it is not enough nowadays merely to advertise that "Buzzem's Motors are The Best." Even a Town Councillor wants a better reason for the faith that is in him than the bold assertion of an interested party. So Mr. Buzzem goes to the trouble of printing a list of installations which use his motors, and of stating the items of excellence—cheapness, reliability, or what not—of his wares. Probably he adorns the tale with a photogravure of his motor and prints the lot on art paper. All of which is a lesson. It is not sufficient to tell people you are clever and want a chance to show it. They want proofs. If you have had previous experience at the job you are on, tell your foreman so, and give him enough particulars to make him believe in your gumption. (As a general rule, avoid jealousy by limiting such information to your *foreman.*) Work up a character for certain definite virtues—punctuality, accuracy, alertness—something good that can be summed up in a word. If ever you get an opportunity for a *tour de force*, use it. It is the illustration to your advertisement And don't forget the art paper. Always be a gentleman. A rough surface spoils a good impression, both in printing and in life.

An advertisement is no good unless it appeals to a want. This weather an enterprising fan motor maker would advertise, "Are you hot? Use Buzzem's fans!" The requirement, coolness; the remedy, Buzzem's fans; the result, worldly prosperity for Mr. Buzzem. In the same way, you have an idea. Wait till it's wanted. When circumstances point to a hitch in the existing arrangements, romp in with your suggestion and reap the *kudos*. Only be careful not to offend the chief's *amour propre*.

Many a man spoils himself by bad expression. I had to read a batch of replies to an advertisement for an engine-driver, and the letters would have made an angel weep (supposing that being so reduced in circumstances as to run an electric light station) The man who got the job had filled his page with a lot of inconsequent rubbish about locomotive driving, crude fitting, sobriety, and general respectability As an afterthought, he stuck in the top left-hand corner, where you generally fix the paper-fastener, "I was driving for eight months at —— electric light station" If I hadn't noticed that before I pinned up the paper, if I hadn't known that at —— they had the same engines as mine, the man would have had no chance. On interview he turned out to be a good man, and since then I have blessed the day I saw him.

When you are asking a man for a job, don't trouble to give your pedigree. Just tell him everything that will make him think you are the best man in the United Kingdom for that particular job, and not a scrap more. If you can schedule your information, so much the better. Carry out the same rule in all your advertising—whether by letter or word of mouth—and you'll do.

To cultivate the gift of expression, join your college engineering society and try to speak. Only don't talk rot. Have a cut at the "Questions and Answers" in the *Electrical Engineer*. Even if you don't win a prize once in a blue moon, you will reap advantage by comparing your replies with the winners!

A final word of warning! When a man begins to talk, the shop shutters are taken down and you can see right in. Many a man has a reputation for wisdom on the strength of a rigid silence. You recollect the yarn of the ass who wanted to make an impression. He togged out in a lion's skin, and for a while all the other beasts were rather nervous of him. But one day he forgot himself, and gloated over the time he was having. And everybody knows a donkey's gloat when he hears it. I could never find out what happened to that moke, but I don't think he lived long.—Yours, THE OLD 'UN.

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LONG-DISTANCE SWITCHES.*

One of the chief advantages of electric lighting as compared with other modes of lighting is the simplicity with which it can be operated from any required point. The arrangement is particularly simple and cheap when all the lamps are to be alight at the same time, but it is somewhat more involved when it is necessary to deal with each group of lamps separately, both as regards lighting and extinguishing. If, for instance, the outside lighting of a town had to be controlled direct from the station, this could be done by providing a separate set of mains for these particular lamps. This method, however, becomes too expensive when any great area has to be dealt with, and in such cases the lamps would have to be connected to the ordinary supply mains. This necessitates additional labour, and many attempts have been made to avoid this by means of automatic devices. Clockwork has often been employed to open the circuit at a particular time and close it again after a certain lapse of time. E. Ruhmer has constructed an arrangement consisting of a selenium cell actuated by the daylight and working a relay, which in turn works an automatic switch for opening and closing the circuit.

It is proposed in this article to consider the construction of certain long-distance switches which can either be operated by hand or by one of the above-described automatic methods. These switches may be divided into three classes: (1) those in which the actuating coil carries current continuously; (2) those magnetically locked; (3) those mechanically locked.

Those belonging to group 1 are generally very simple in construction, but the fact that they carry current continuously renders them expensive, especially in the case of the larger switches, even neglecting the current consumption. With groups 2 and 3 the power consumption is extremely small, as the coils are only in circuit at the instant of switching on or off.

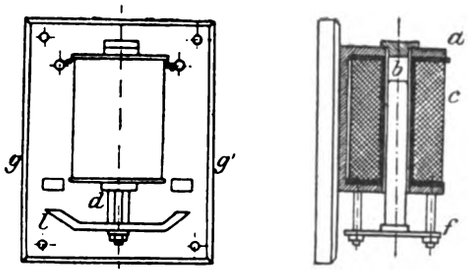

FIG. 1.

1. *Long Distance Switches whose coils carry current continuously.*—Fig. 1 shows a simple type of switch. *a* is a U-shaped piece of sheet iron which carries the exciting coil, *c*, wound on a brass tube, *b*. The contact brush, *l*, is fixed to the core, *d*. *l* is prevented from falling too low by the stops, *f*. *g* and *g'* are the terminals of the circuit to be closed. The whole is mounted on a marble or slate base, and, when placed in the open, is covered by a watertight case. Fig. 2 shows the diagram of connections of this apparatus. The arrangement shown in Fig. 3 is for the purpose of reducing the current round the coil to a minimum as soon as the circuit has been closed. In this way a considerable saving in copper can be effected, since

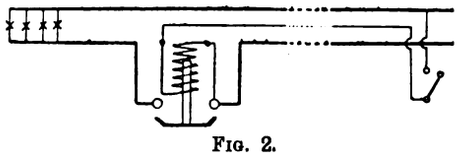

FIG. 2.

the coil may safely be overloaded to 15 times the normal just at the instant of switching on. The action is as follows: As soon as coil *a* receives current through the closing of the switch *u*, the core *b* is drawn right up, the brush *c* makes contact with 1 and 2, whilst, towards the end of the movement, the auxiliary brush *d* leaves the contacts 4 and 5, and so inserts the resistance, *w*, in series with the coil. Since the pull of a magnet varies inversely with the air-gap, the resistance can be so chosen that the current with the resistance inserted is only just sufficient to hold the core up with certainty and produce the necessary pressure at the contacts, *c*.

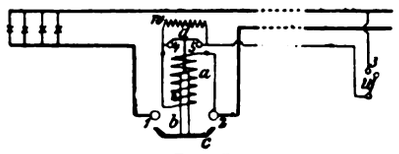

FIG. 3.

A long-distance switch, introduced by Dr. Paul Meyer, of Berlin, is shown diagrammatically in Fig. 4. On this case the actuating current flows through the coil, *a*. The main circuit is closed through mercury contacts. Though these latter are in general beset by a number of difficulties, these are in this case got over in a simple manner. A special glass tube, *c*, through which both the terminals, 1 and 2, project, is partly filled with mercury. The connections with terminals 3 and 4 are made by flexible leads.

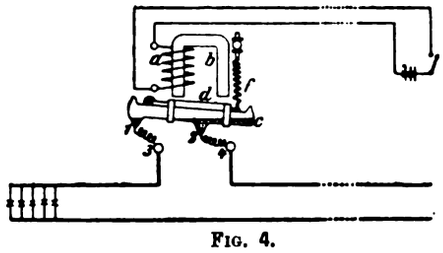

FIG. 4.

The glass tube is carried by the armature, *d*. The spring, *f*, carries part of the weight of armature and tube. When the coil, *a*, is excited the magnet, *b*, attracts the armature, *d*, and the tube, *c*, is brought into the horizontal position, so that the mercury connects contacts 1 and 2. When the current is broken, the armature drops and the mercury opens the circuit.

2. *Magnetically Locked Long-Distance Switches.*—Another type of switch works on the following principle: The exciting coil consists of two windings—a thin one, actuating the switching in and out, and a thick one (main coil), which

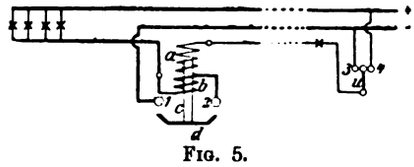

FIG. 5.

serves to hold the switch in the on position. The arrangement is shown in Fig. 5. In order to light the lamps the switch, *w*, is put on to contact 3. A current then flows from the positive pole through the lamps, through windings *b* and *a*, and through contact 3 back to the negative pole. The core, *c*, is attracted and the brush, *d*, closes the circuit. Both ends of *a* are thus connected to the same pole, and *a* carries no current, whilst the supply current flows through *b* in the same direction as on first switching on, and so keeps the switch closed. If the switch, *u*, is moved to contact 4, *a* will receive a current in the opposite direction, and will

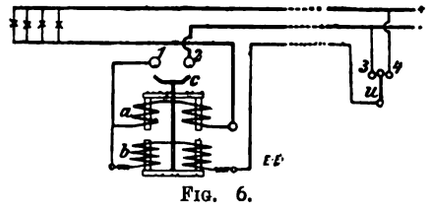

FIG. 6.

oppose *b*, so that *c* falls and opens the contacts 1 and 2. In order to see whether the switch is operating satisfactorily, a lamp can be inserted in the lead connecting the switch, *u*, with the coil, *a*. This lamp will only light up whilst switching in or out. If it burns continuously, it is a proof that the apparatus is not working correctly. Similar indicating devices can be fitted to all the following types of switches.

Fig. 6 shows a switch of similar construction to the last; *a* is a stationary coil carring the main current, whilst *b* is

* Translation of an article in *Elektrotechnische Zeitschrift* for July 28, 1904, by F. Lindenstruth and O. Forster.

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movable, and carries the contact brush, *c*. The coils are so connected that on switching in poles of opposite sign are opposite one another, whilst on switching out the movable poles become reversed, so that poles of the same sign are opposite to one another.

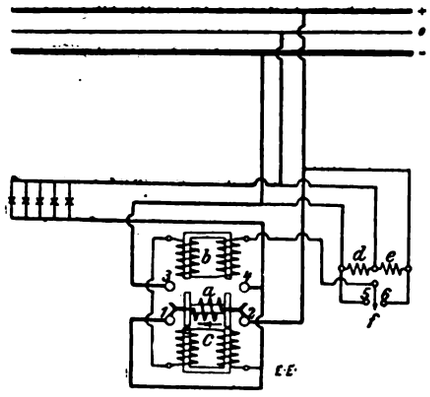

FIG. 7.

The switch shown in Fig. 7 belongs to this class, and works to a certain extent as an automatic balancer on a three-wire system. Unequal loading of the two sides of a system occurs almost exclusively through the lighting, since motors are usually placed across the outers. One or more groups of lamps are therefore connected to the main through the automatic device, and voltage equalisation occurs as follows: The differential relay (voltmeter), *f*, makes contact with either 5 or 6 when any difference in voltage on the two sides exists, and this causes the group of lamps to be connected to either one side or the other of the system. In the diagram it is shown connected between the + pole and the middle wire. When the lamps are not in circuit, *a* is still set in this position. The current flows through *a* in the direction of the arrow and magnetises the hard-steel core. The magnetism of this core passes principally through the core *c* Coils *b* and *c* are only in circuit during the switching operation as they are connected in the same way as those in the two last described cases. Suppose the voltage in the lower side of the system rises, the coil *d* will overpower *e*, and contact 5 will be closed. This excites *b* and *c* in such a way that the *b* cores exert a pull on *a*, whilst *c* pushes *a*. Since *a* has a hard-steel core, this action takes place even when no current is broken; *a* will therefore move towards *b*, and this will cause the change-over to occur at contacts 2 and 3. As soon as the circuit is closed, *b* and *c* carry no current. Should the voltage of the lower side of the system fall to a certain point the operation repeats itself, and the switch is moved to the other side. This switch can also be employed for other purposes, such as the alternate switching in of two separate lighting groups, or as a double-pole arrangement for transferring a group of lamps from one circuit on to a second quite independent circuit.

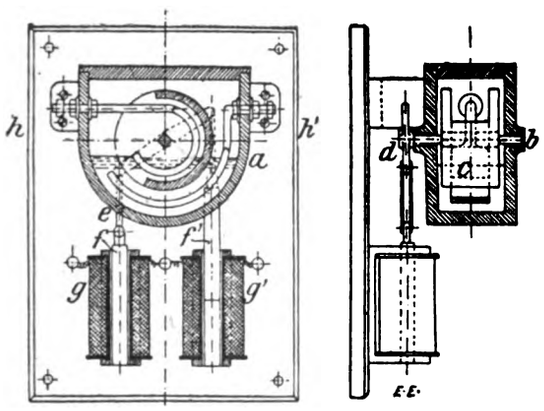

FIG. 8.

3. *Mechanically Locked Long-Distance Switches.*—Fig. 8 shows another switch with mercury contacts. The cylinder, *c*, made of insulating material, is mounted in the insulating holder, *a*, on the spindle, *b*. An extension of *b* carries the arm, *d*, which supports the cores, *f f'*, by means of the rods, *e e*. Both *a* and *c* are filled up to a certain point with mercury, into which the iron terminals, *h h'*, dip. Fig. 9 is the diagram of connections. In order to switch on, the double-pole switch, *u*, is moved to 1; coil *g* then received current through the group of lamps and pulls the core, *f*, thus turning the cylinder, *c*, and bringing the mercury in the latter into contact with that in the outer case, and so closing the circuit. As soon as this happens coil *g* ceases to carry current. In order to switch off, the switch *u* is moved on to contact 2; *g'* receives current and turns the cylinder in the reverse direction, the cylinder wall becomes interposed between the two terminals, the circuit is opened and the current through *g'* is stopped.

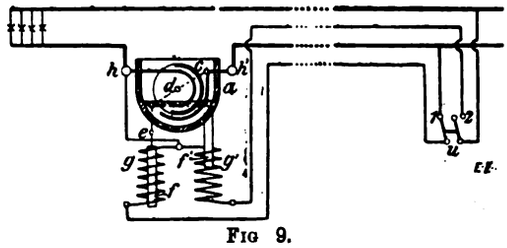

FIG 9.

(To be continued.)

CARDIFF ELECTRICITY WORKS.

The following extracts are taken from the report of Mr. Arthur Ellis, borough electrical engineer, on the working of the Cardiff electricity station for the year ended March 31, 1904.

REVENUE.

Dr. Expenditure.	£	s.	d.
Generation of electricity	6,605	14	2
Energy supplied by tramways department	6,224	14	3
Distribution of electricity	1,057	16	8
Attending and repairs to public lamps	1,003	15	0
Rents, rates, and taxes	1,105	14	11
Management expenses and salaries	1,715	5	10
Law expenses	9	14	8
Special charges, insurances, etc.	115	11	2
	17,838	4	8

Cr. Income.	£	s.	d.
From private lighting	21,783	18	0
From power and heating	1,893	19	8
Rental of meters on consumers' premises	554	10	3
Total private supply	24,232	7	11
From public street lighting	5,190	15	8
	29,423	3	7
Less irrecoverables	54	15	7
	£29,368	8	0

SUMMARY OF RECEIPTS AND EXPENDITURE.

	£	s.	d.
Sale of current	29,368	8	0
Expenditure	17,838	4	8
Gross profit	11,530	3	4
Repayment of loans	£3,359 19 7		
Interest on loans	5,774 15 9		
Interest on consumers' deposits	16 12 7		
	9,151	7	11
Net profit on year's working	£2,378	15	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			2,912,248
Quantity sold	Public lamps	647,918	2,385,472
	By contract	16,841	
	Private consumers by meter	1,720,713	
Quantity used on works			79,773
Total quantity accounted for			2,465,245
Quantity not accounted for			447,003
Total maximum supply demanded (kilowatts)			1,713

Number of public lamps: 419 arcs, 100 incandescents.

FORTHCOMING EVENTS.

SATURDAY, AUG. 20.

At 3 p.m., opening of the Tottenham to Wood-lane section of the Middlesex County Council's tramways (Metropolitan Electric Tramways Company, lessees).

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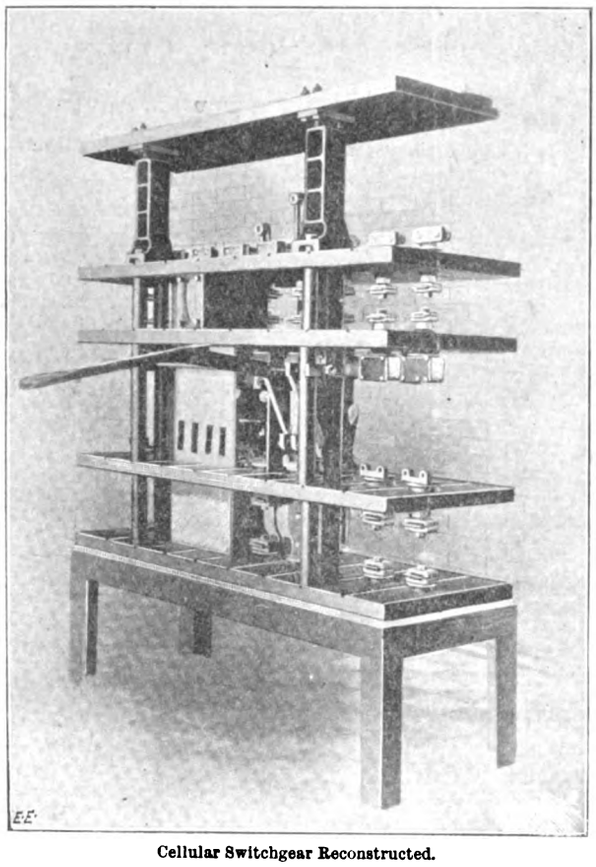
TRADE NOTICES AND NOVELTIES.

A Form of Reconstruction for Cellular Switchgears.

A good deal has recently been written and said concerning the safety of high-tension switchgear, but considering the importance of the subject, it cannot be said that too much attention has been given to it. Bearing on this question, we have some information from Messrs. Walker and Hodgetts, Limited, of Salford, who have set themselves the practical task of demonstrating improvements in the construction of existing high-tension switchgears of the type which has in the past been universally appreciated for use in central stations, particularly upon single-phase systems of 2,000 to 3,000 volts. The improvements consist of some simple detail alterations to the fuses, with several objects in view, amongst which may be mentioned the avoidance of the use of springs, the provision of a new type of flexible conductor inside the pots, and also a mechanical method of fixing the fuse wire in order to replace the existing soldered connections. In the modification of the general construction of the gear, the heavy horizontal slates are taken out of the wall, and the switchgear is reconstructed in the reverse position, so that what has been the back now becomes the front and *vice versâ*. Referring to the accompanying illustration, which represents a trial board, it will be noted that there are four sets of bolts and distance pieces holding the slates together. It is found that a very rigid self-contained switchboard can be obtained in this way, although in actual practice, on a board of the size illustrated, six or eight bolts are used; the bolts are cemented into the distance pieces, and so the construction becomes as solid as if it were mounted into the wall. It will be seen at once that by this means the switches and fuses are removed from the operator. He is shielded from any possible arcing from these by two thicknesses of slate slabs. At first sight it is suggested that this method introduces a back, which has hitherto been absent from the type of gear in question, but on afterthought and inspection it will be found that the objection to a back is practically removed, in that it is possible to see from the station any person at the back through certain portions of the gear. Moreover, the fittings at the back are now shielded in identically the same way as those visible at the front in the original design.



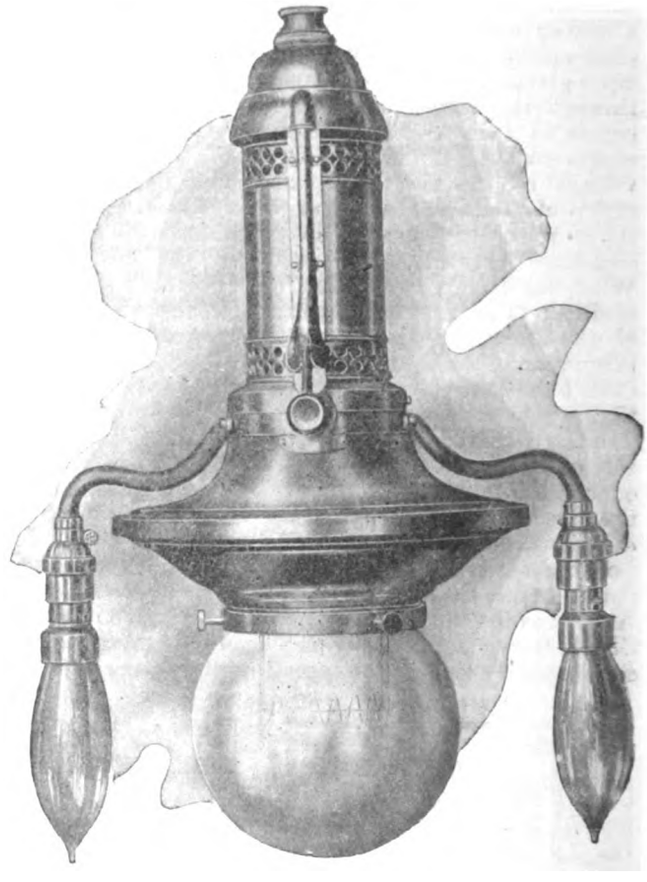
Cellular Switchgear Reconstructed.

Ferranti Alternating-Current Switchboard Integrating Wattmeter.

From Messrs. Ferranti Limited, Hollinwood, Lancashire, we have a catalogue and price-list describing the above. This switchboard integrating wattmeter works on the induction principle, and possesses many distinctive advantages, among which the following are enumerated: (1) the accuracy is independent of variations in power factor, wave form, periodicity, voltage, or temperature; (2) strong mechanical construction; (3) will stand 50 per cent. overload continuously and short-circuit without injury to mechanism or calibration; (4) low starting current; (5) design compact and portable—will stand transit; (6) low shunt current and small losses—highly efficient; (7) will not run on shunt; (8) accurate at all loads, from one-twentieth load to 50 per cent. overload; (9) dial reads direct in Board of Trade units; (10) no brushes, commutator, or moving contacts; (11) low speed of rotation—40 revolutions at full load; (12) light moving parts, reducing wear and friction to a minimum. For currents above 50 amperes and with voltages not exceeding 250 volts, current transformers, Classes A or A A, described in a separate catalogue, are used. These transformers are made in standard sizes up to 6,000 amperes. The wattmeter can therefore be had in standard sizes up 6,000 amperes, for use on circuits of voltages not exceeding 250 volts. On circuits 250-500 volts, and not exceeding 50 amperes, a potential transformer is required, but not a current transformer. On circuits of all currents and voltages exceeding 500 volts, and circuits of currents exceeding 50 amperes, with voltages from 250 to 500 volts, both a potential and a current transformer are required. The potential transformers, dealt with in a third catalogue, are made in standard sizes up to 30,000 volts, and the current transformers in standard sizes up to 2,500 amperes and 30,000 volts.

Nernst Lamps.

The A.E.G. English Manufacturing Company, of 4, New Compton-street, Charing Cross-road, who, as recently stated in these columns, have acquired the English Nernst lamp patents from the A.E.G. of Berlin, have just issued a price list which includes illustrations and particulars of the latest improved types of this lamp. The "Express" type is combined, as shown herewith, with ordinary filament lamps, which serve to give light immediately the current is switched on, thus overcoming the objection to the use of the Nernst lamp in places where instant light is sometimes required. These auxiliary lamps are cut out automatically when the Nernst burner has become conductive. It reflects great credit upon the A.E.G. that all possible objections to the lamp are being so satisfactorily met. The multiple-burner Nernst lamp is also dealt with in the list under notice. It will be remembered that we described this type in a recent issue. The many advantages claimed for these lamps are now so well known as to render repetition unnecessary.



"Express" Type Nernst Lamp.

Revolving Calendar.

The United States Metallic Packing Company, Limited, Bradford, have just issued an excellent little novelty in the form of an aluminium 25-year revolving calendar. The manipulation of this useful article is extremely simple, and the company will supply specimens on application.

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A REVIEW OF THE PRESENT STATE OF MECHANICAL CANAL TRACTION.

BY F. H. DAVIES.

The British canal system, consisting, as it does, of some 4,000 miles of waterway, is generally admitted to be one of the finest in the world—that is to say, as far as comprehensiveness goes. Maps of England published a century ago, when the canal as an institution was in its prime, demonstrate this point very forcibly, and show that the majority of towns that may claim to be industrial centres of any importance are linked up by these waterways in a manner that speaks well for the enterprise of our eighteenth-century ancestors. Before the advent of the railway, a great proportion of the carrying trade of this country was in the hands of the canal companies, and dividends that would exceed even the wildest dreams of the present-day investor were, if not the order of the day, of very frequent occurrence. How this is all changed is only too apparent even to the casual observer. In many districts canals that were once flourishing concerns now present only a spectacle of rotting locks and tumbledown banks, perhaps even dry beds, and shares in many enterprises of this nature that once stood at immense premiums may now be purchased for as many pence as they were formerly worth pounds.

The causes of this lamentable decadence are perhaps manifold, but certainly not far to seek. Primarily, the strangulation policy adopted by the railway companies that collectively own over one-fourth of the total mileage is responsible. If canal company shareholders and the public at large have not realised that water carriage of merchandise is commercially possible even in competition with the railways, the latter certainly have, and from the commencement of their existence have systematically adopted a policy of suppression of what they are aware is potentially a dangerous competitor. The apathy of shareholders and directors has in some cases been responsible for the decline in traffic over our waterways. There has been too much bowing to what was apparently deemed the inevitable, and too little enterprise in attempting competition with the railways in the carriage of non-perishable goods, for which canals are so eminently suitable. The argument has always been that existing methods of canal haulage could show little, if any, economy over railway rates, and that what they could would be more than nullified by the slowness of this form of carriage. An increase of speed from an average of 2½ to 4 miles an hour it has been admitted would be of great value in popularising canal traffic, but this speed is commonly deemed prohibitive, owing to the narrowness of most English canals, and the consequent damage to the banks by the wash.

If there is any truth in these objections, it is extraordinary that some railway companies can and do make profit out of the canals that they control while using the old method of horse traction with its speed of 2½ miles an hour. The only solution can be that they charge full railway rates, and the profit—in some cases as much as 100 per cent.—comes from the difference in the cost of the two methods. How much more, then, can this profit be increased by the substitution of mechanical traction for the inefficient horse. The subject has been thoroughly gone into, and the figures are conclusive; the greatest authorities give them as ·077d. per ton-mile for horse haulage at the lowest estimate, and ·032d. per ton-mile with an electric tractor.

These are the extreme examples, the worst and the best, but any mechanical system of traction comes out cheaper than the horse in working costs, although some that have been suggested are scarcely as convenient or reliable, and all necessarily involve a much heavier capital outlay. In the present state of affairs it would, of course, be impossible for the more or less bankrupt canal companies to obtain the capital necessary to place them on a competitive basis with the railways, and in their case State interference of some sort is the only hope. On the other hand, some of the railways, and those canal companies whose trade still warrants it, might very advantageously replace their existing primitive methods of traction by more efficient and economical means, such as are largely employed on the Continent and in America.

The problem of the adaption of such means to the requirements of English canals is interesting, and to a certain extent complicated by the varieties of gauges and general utter lack of standardisation that naturally exists. Taking an average case, the following are the leading requirements that a system must possess to be successful in this country: (1) it must not interfere with the use of horses, as they can only be gradually replaced, and must be of a kind that the ordinary barge can be adapted to with little or no alteration; (2) in the interests of the banks, the means employed must not be productive of a much greater wash than is usual with horse haulage, even at reasonably increased speeds; (3) there must be no waste of time or difficulty in barges passing one another or in going through locks, and the construction must be such as not to introduce difficulties at sharp bends, junctions, or tunnels; (4) no extra labour must be involved, rather it should be possible to decrease the number of hands, and the control of the apparatus must be well within the intelligence of the average bargemaster; (5) the operating expenses must be low, and the construction substantial and easy of repair. Such systems as are in common use or have been proposed may be roughly divided into (1) those where the barge carries its own propelling engine, and (2) those employing haulage by a moving rope or mechanical tractors on the towpath. These again may be sub-divided and examined in detail for the manner in which they come up to the above requirements

Irrespective of the power employed, those of the first class are open to many objections. Gas and oil engines have been installed on barges and used in conjunction with a screw propeller, but not with any very marked success. In the former case gas has to be stored in cylinders in a highly compressed state, which is a great disadvantage, necessitating as it does compressing stations along the line of route. However, this system has apparently been successful in France, where it is used by the Seine Maritime Cie. for their high-speed barge service between Paris and the coast. Oil-engines seem rather more suitable, as the source of power is easier stored, but they would probably take up a great deal of room, which is naturally undesirable where space means money to the extent that it does on a barge. For the same reason steam-engines do not find any great favour, and although self propelled barges of this type are to be met with on many of our waterways, being very costly they cannot be looked upon as a final solution to the problem. Canal propulsion by the aid of accumulators has been tried, and has even found its advocates, although it is difficult to see upon what points they can base their preference. Such a system suffers under most obvious disadvantages: its efficiency is low, capital cost high, repairs high, and recharging operations wasteful of time. If the discharged cells are removed in bulk and replaced by fresh ones in order to avoid the delay consequent upon charging *in situ*, the old difficulties that have been found in accumulator tramway traction arise, complicated by the fact that an ordinary barge does not afford as many conveniences for rapid changing of cells as does a tramcar. Of course, the conditions as regards deterioration of plates by vibration are more favourable, and the absence of repeated starting strains would doubtless enhance the all-round efficiency, but in the present state of accumulator manufacture a system upon such lines would, by reason of its inefficiency, stand but a poor chance in competition with almost any other mechanical means.

All such systems fall foul of the first and most important requirement, that little or no alteration to the barges must be needed. Such installations would involve a comparatively large capital outlay that would be entirely unproductive at times of loading and unloading, and in the present state of canal company finance this a matter of some importance. It has been proposed to make the engines or motors portable, so that upon a barge arriving at the end of its journey the plant could be transferred to another ready to start back, the capital expenditure in motive power being thus reduced to a minimum. Plausible in theory, such an arrangement would scarcely be successful in practice, except, perhaps, in the case of the electric

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motor, which is much more portable than any steam, gas, or oil engine. With an overhead trolley system, such as has been frequently employed in canal work, it would be possible and economical to arrange things in this manner. The propeller actuated through bevel wheels by a combination of horizontal and vertical shafts, could be fixed either to the extreme end of the rudder or its posts, and worked by a motor temporarily fixed to the deck under the tiller. It would be a simple operation of only a few minutes to change the motor from barge to barge, and the only alteration necessary would be that to the rudder. A similar arrangement to this has been tried in France, with the result that a 180-ton barge, 125ft. long, was propelled at a speed 40 per cent. higher than that attained by two horses, at an expenditure of 3·4 units per hour—a highly satisfactory result.

A trouble with the overhead trolley system is the inevitable delay that must take place when two barges meet. The collecting arrangement must necessarily be of a very different type to the familiar tramcar trolley pole, greater flexibility and length of reach being essential. It follows, then, for these reasons that the difficulties are enhanced, and this is particularly the case where the most suitable form of collecting apparatus for canal work is used—viz, the over-running trolley with a pendulum balance weight. Here, as in the old tramway system, the trolley is pulled along by the barge by aid of the cable that conveys the current to the motor. Of course, the installation of an up and down trolley line gets rid of this difficulty, but at a cost that in some cases might be too great.

The screw-propelled barge suffers under several disadvantages. Firstly, the shape of the vessel is not favourable to efficient screw propulsion. The stern is too blunt, and consequently the state of the water in which the propeller works is not such as to secure high duty. The comparatively small cross-section of the volume of water in the average canal is another source of propeller inefficiency, and on this score the paddle or stern-wheel are preferable for such shallow waters, but, being bulky and expensive, are consequently not in much use. Again, the destructive action of the propeller wash on the banks is a matter of high importance. Even at low speed it has been found that this wash, in conjunction with that caused by the movement of the boat, eats away the banks at an alarming rate.

Then upon the score of economy in capital outlay, it is obviously desirable that only a portion of the barges should be fitted with propelling machinery, such being used as tugs in addition to carrying their own cargo. But mechanically this is not an efficient arrangement by any means, for if the barges are closely coupled together, as they should be in order to reduce the tractive effort, the back wash from the propeller introduces a great resistance to the progression of the towed barge; and if, on the other hand, a long tow-rope is used, the advantages gained by close coupling are lost. Which is the greater loss can only be determined by experiment, but it has been ascertained that the propulsion of a barge by a screw propeller takes approximately double the power that would be absorbed by a tractor on the towpath, and it appears probable that in tugging either with a long or short rope the second barge will absorb an amount equal to the tug, although in the case of a long train the efficiency of the whole would rise rapidly with the number of boats if closely coupled together.

A method of mechanical barge propulsion that appears to have met with a certain measure of success is the Bovet chain-hauling system. Here a chain is laid in the bed of the canal, and the tug barge, fitted with a motor-driven drum round which the chain makes a three-quarter turn, hauls itself along in this manner. Current is taken from an overhead line by means of a trolley, and returns through the chain to earth. Such a system is installed on the Seine between Paris and Rouen, and as far as efficiency goes appears very satisfactory. An ingenious device in connection with this was introduced some years ago by M. De Bovet, engineer to the company. Up to that time ordinary methods of chain haulage had necessitated the taking aboard of large lengths of cable, in order to obtain the necessary amount of adhesion to the driving drum. This was found to be not altogether desirable, and as a consequence the magnetic pulley illustrated in Fig. 1 was introduced, which has the effect of greatly increasing the adhesion of the chain, although only a small length is taken in-board. The pulley is of mild steel, 4ft. in diameter, and is wound internally with a powerful magnetising coil after the style of the Mordey alternator. The periphery is split in a manner suitable to the form of the chain, which, in passing over, completes the magnetic circuit, and therefore adheres very strongly to the pulley face. The ends of the coil are taken to two slip rings mounted on an insulating bush on the shaft. An advantage of this arrangement is that, although increased adhesion is obtained, slip is still possible in cases of emergency, such as the chain fouling. Perfect adhesion could, of course, be ensured by the use of a pulley cut to fit the chain, but this would be at the expense of risk should anything go wrong with the towing arrangements, as is always possible with this system.

It is here that the great disadvantage of chain haulage lies. Two chains must be laid to provide for up and down traffic, the time that would be wasted in passing with only one chain in use being prohibitive. But with two chains trouble frequently arises at curves by their getting entangled, and this may possibly lead to breakages, and at any rate causes delay. From experimental trials of the Bovet system it was found that the hourly current consumption of a 200-ton barge was 3·2 units when moving at a rate of approximately two miles per hour, which result

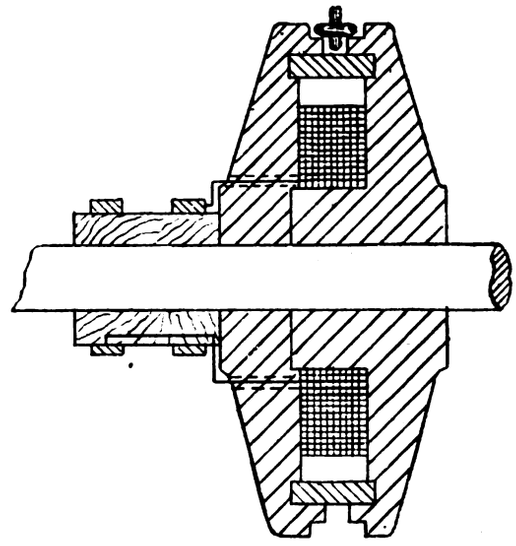

FIG. 1.—Bovet Magnetic Adhesion Chain Pulley.

is about equal to screw propulsion, and a large saving over horses. This system is eminently suitable for tunnels, has the advantage of leaving the towpath free, does not deteriorate the banks, and requires but little alteration to the barges. Its disadvantages, as stated, are chiefly the difficulties met with at bends, and the delay that would be caused by a breakage of the chain.

Turning now to Class 2, we come to some interesting examples, most of which offer economic advantages in running costs over any of the above methods. Canals and barges were originally designed for the propulsion of the latter by haulage from the towpath; and this being the case it is not surprising that such systems give the best results. Self-propulsion of any kind but that due to Bovet requires wider waterways and differently designed barges. Haulage from the banks suits existing conditions perfectly, and the only question is which is the all-round best and most convenient of the systems that have been proposed. The endless rope is the earliest and the worst of them. Its efficiency was very low, and at the best it was only suitable for short distances. The practical difficulties found in its operation were numerous: the rope was apt to break and derange the whole system, difficulty was experienced in attaching the tow-rope to it, and in the passage of the latter by the guide pulleys of the former. Also the starting effort when the rope was attached was very sudden, so much so as to frequently

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cause fracture of the tow-cable, and always severe strains on the running rope. Seeing all these disadvantages, it is not strange that this system never made much headway; at the present time it is, of course, quite outside the pale of consideration, as so many infinitely better methods are at hand. One of these, the Lamb electrical system, provides a form of aerial railway in the shape of one strong conductor upon which the motor runs, and another slighter one insulated from the former, which acts as the other lead of the circuit. Both cables are suspended upon stout posts, and the latter passes round a wheel driven through worm gearing by the motor, and thus supplies it with current.

The tow-rope is attached to the motor, which can either be controlled from the bank or the barge, in the latter case all that is necessary being a pair of small leads carried along the hauling rope. For light work this system would appear to contain the elements of success. Its operating costs, in common with all electrical methods, would be considerably lower than those of horse haulage, and in capital outlay it should be able to compete easily with any tractor system. It can be worked on a single line, the up and down barges simply changing tractors when they meet, or, if preferred, two separate wires may easily be installed on the same posts, one above the other.

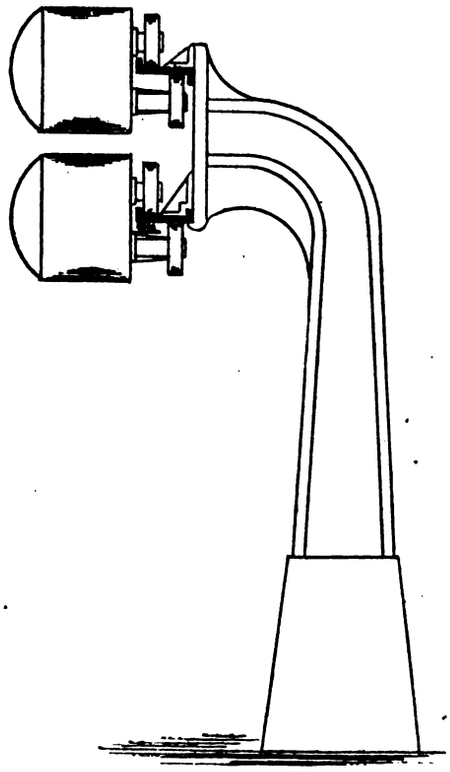

FIG. 2.—Thwaite Canal Haulage System.

Of further examples of tractor systems, the most noteworthy is the Thwaite. An interesting and complete paper was read on this method by Mr. A. H. Allen before the British Association for the Advancement of Science, Bristol, in 1898. In order to leave the towpath free, an aerial rail is used, consisting of two single up and down girder rails fixed from 6ft. to 10ft. high on substantial cast-iron brackets placed a distance of 30ft. or so apart. The details of this arrangement, which are quite unique, are shown in Fig. 2. Each tractor is simply a motor mounted on four wheels, two running on top and two underneath the rail, all four wheels being driven by the motor through worm gearing running in an oil-bath. Lateral movement of the motor is provided for by spring-controlled horizontal rollers pressing against the side of the rail. Mechanically, this arrangement is rigid and very suitable to take up the side pull of the tow-rope, and its adhesion to the rail must obviously be very high. A bare conductor consisting of angle iron or copper strip is carried on insulators fixed to a wooden batten, which in turn is attached to the underneath side of the rail as shown. A collecting brush rubs against this, and the current returns through the wheels to the track in the usual manner. The control of the tractor may be effected in various ways, according to whether the starting switch is fixed to it or placed on the barge. In the latter case a twin cable running along the tow-rope is all that is necessary, and in the former the control may easily be effected by the aid of cords attached to the switch handle. The running cost of this system is given by Mr. Allen as ·032d. per ton-mile at a speed of 2½ miles per hour, and ·041d. at four miles per hour, which figures are inclusive of depreciation, interest, and all revenue charges. The capital cost of the aerial railway is estimated at £1,800 per mile, and the total expenditure for a 30-mile canal, including all generating plant, is given as £77,500 for a low speed of propulsion, while at four miles per hour the above figures are increased to £2,400 and £99,600 respectively. The Thwaite system of haulage would appear to fulfil all the necessary requirements, and, above all, it does not call for any alteration to the existing floating stock.

Other methods of haulage from the towing path generally consist of an electric locomotive running on a narrow-gauge line on the bank, taking current from an overhead wire. Small steam-engines have been tried, but the extra attendance required, higher cost, and necessity of providing coaling stations every few miles, render them incapable of competing with electricity. In America there are several instances of electric barge haulage of this kind, the most conspicuous being the Erie Canal installation of over 60 miles, to be ultimately extended to four times that length in order to link up the towns of Toledo and Cincinnati. Large 24-ton locomotives are used on this system, which is designed for the towing of fleets, not of single barges. High-tension three-phase current is taken from an overhead line, and speed control of the two motors with which each locomotive is fitted is obtained by the well-known concatenation method. The whole length of the line is single track with turn-outs, and convoys being run to schedule time, little delay is experienced in the passing of up and down traffic. This, practically the largest system of electrical barge propulsion in the world, has been fully described in the *Street Railway Review* (U.S.A.), a perusal of which account is worth while to those interested in the problem of electrical canal working upon a large scale. There are many Continental systems in existence based upon much the same lines as the above—that is, a track (generally narrow gauge) on the towpath and electric locomotives supplied with current from an overhead wire. They mostly, however, use direct current, which is more suitable and economical for small or medium-sized work.

An examination of this interesting subject leads to the conclusion that the adaption of mechanical propulsion to English canals would, with practically no exception, be most advantageously carried out by means of electrical tractors, aerial or otherwise. Self-propulsion is not desirable on our narrow waterways, besides which it has been proved to be less efficient, although, of course, more flexible. However, where capital cost is the prime consideration, as in the present unfortunate state of canal matters is generally the case, self-propulsion with transferable motors—despite its disadvantages—would be an improvement in every way upon horses, and, what is most important, would easily lend itself to ultimate conversion into a tractor system, the trolley line being common to both. The barge motors and propelling gear being small and cheap, might be scrapped without very much loss, provided the increased trade and returns that would be sure to follow even a self-propelling system were sufficient to warrant the issue of fresh capital to find the permanent way and tractors.

In these times of tight money we can, unfortunately, expect but little advancement in this hitherto neglected direction. It is absurd, however, to suppose that the fine canal system possessed by this country will always be allowed to remain in its present disused state. Within the last few years the subject has aroused a certain amount of attention, and there appears every probability that a better state of national finances may ultimately lead to the commercial resurrection of our waterways; in view of the heavy freight charges of many of the railway companies, "a consummation devoutly to be desired."

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LEGAL INTELLIGENCE.

DAMAGE TO TELEGRAPH INSULATORS.

William Milburn was charged at Consett with damaging telegraph insulators, the property of the Postmaster-General.

It appeared that this youth was observed amusing himself by discharging stones with a catapult at the telegraph insulators near the Co-operative Stores, Leadgate. A representative of the Post Office said that within the last six months between 30 and 40 insulators had been broken in the neighbourhood.

Defendant was fined 5s. and costs.

DAMAGES FOR FATAL ACCIDENT.

At Glamorgan Assizes the action of Lily Emily Williams, spinster, against the Corporation of Cardiff for £300 damages for the loss of her father by the negligence of the defendants was heard.

It appeared that the deceased was walking along the street with his back to an advancing car. This overtook him, knocked him down, and dragged him along for some 25 yards before the car was brought to a stop. The contention was that the car must have been travelling at an excessive speed to take such a distance before coming to a standstill. Ten miles an hour is the authorised speed of the Cardiff trams. The Corporation did not plead contributory negligence.

Evidence in support of the claim having been given, counsel for the defence called evidence to prove that ample warning was given by the gong.

Finally, the jury returned a verdict for the plaintiff, awarding her £75.

COMPANIES' MEETINGS AND REPORTS

ELECTRO-PEAT COAL.

The statutory meeting of the shareholders in the Electro-Peat Coal Company, Limited, was held at the Westminster Palace Hotel, London, the Earl of Mayo (the chairman) presiding. The Press were excluded from the meeting, but the following are extracts from the official report:

The **Chairman**, alluding to criticisms which had appeared in the Press, stated that he wished to reassure the shareholders in regard to the patent. The Board would not have thought of spending the shareholders' money until they had made certain that the patent was all right. Mr. Fletcher Moulton's opinion was that the English patent should stand, but that a further claim might be lodged, following the lines of the patent recently accepted by the German Patent Office. This brought him to another important point, which was that the syndicate had sold the German patent, and that, as he understood, the purchasers had already made a cash deposit and ordered machinery from Messrs. Johnson and Phillips to start manufacturing.

Mr. Scoones, M.I C.E., then gave an explanation in regard to the calorific power of electro-peat coal. He stated that he was not aware until after the issue of the prospectus that the expression "British thermal units" referred to kilogrammes, not pounds. He then went more fully into the subject, and found that it was wrong to compare dry coal with peat holding a percentage of moisture, and that it is necessary to allow for the moisture in order to compare the two. Mr. Scoones proceeded to deal at some length with the figures given by the respective analysts, which, he maintained, fully justified the accuracy of his report. Continuing, he said: Practically, we may say with some certainty that electro-peat coal has a calorific value of about 13,000. It has been said in the papers, and it was incidentally mentioned just now, that there is a comparison with coal in the matter of calores in my report. There is nothing of the kind. There is not one word of comparison in this report, as it was necessary to come to a more practical conclusion than is given by the amount of calores, which has little to do with its practical value as fuel. In Lancashire coal—and I am quoting now from Messrs. Crace, Calvert, and Thomson's analysis, Royal Institution Laboratory, Manchester—that amount to 12,600 British thermal units, while Scotch coal varies from 7,480 to about 7,810. I think those of us who are engaged in enterprises know that the Scotchmen are not very much out of it when they come to tender. If they can carry on great industries with coal at 8,000 British thermal units, I think we are not put to any disadvantage with our electro-peat coal, which, on the lowest analysis made, comes out considerably above this figure. The only use of calores is primarily to ascertain whether, as a fuel, it has certain calorific value in order to make comparisons, in the elementary stage, with peat, wood, coal, or other fuel.

After some discussion, the proceedings terminated with a vote of thanks to the chairman for presiding.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The report of the Kalgoorlie Electric Power and Lighting Corporation, Limited, for 1903, to be submitted at the meeting on the 23rd inst., states that there has been a steady and increasing demand for power. Most of the small mines in existence when the supply from a central station was in contemplation have either closed down entirely or suspended operations, but negotiations are proceeding with some of the large mines now in operation for the sale of the power remaining at the disposal of the Company. A profit of £9,336 was earned on the other side after charging all costs of production, maintenance, and other expenses to keep the plant running in a high state of efficiency. Out of this amount, after providing for debenture interest and London charges, the directors have set aside £1,000 to reserve, written off the whole cost of issue of debentures (£2,525), and reduced the amount standing to debit of preliminary expenses by £1,063. The sum of £5,091 has been added to capital account during the year and £6,527 expended on transmission lines. Since the date of the last report 8 000ft. of new pole lines have been constructed, and some 190,250ft. of transmission wire erected, making a total at the end of April of about 35,000ft. of pole lines and 286,850ft. of overhead cable erected. Since the date to which the accounts are made up, £2,982 has been received on account of calls, reducing the amount now owing to £1,949; £7,615 has been paid off the bank overdraft, which now stands at £1,134, and off the item of bills payable £3,411 has been paid, reducing the amount now owing to £1,489. The power sales for the current year up to the date of the last return show an increase of 95 per cent. over the corresponding period of 1903.

WATERLOO AND CITY RAILWAY.

The half-yearly meeting of the Waterloo and City Railway Company was held on the 12th inst., Sir Charles Scotter presiding. Particulars of the report appeared in our issue of the 5th inst.

The **Chairman** stated that during the six months under review there had been a falling off in the number of passengers carried of 53,783, but this was more than compensated for by the increase of the number of season-ticket holders, who numbered 1,611, as compared with 1,244 in the corresponding half of last year. The number of daily journeys represented by the season tickets worked out at 502,632, as against 388,198 in the first half of 1903. That showed the large increase of 114,504, so that the apparent decrease of more than 50,000 persons turned out to be a net increase of about 60,000. In money there was a small decrease of £147, but this was accounted for by the fact that the daily fares—2d. single and 3d. return—were worth more to the Company than the season-ticket rates. Their line was not exceptional in this respect. The Central London Railway, for instance, showed a decrease of 209,000 in passengers and £2,008 in money. During the recent period of hot weather the passenger returns showed a distinct falling off. This was remarkable, for it was a fact that the "tube" during these hot weeks had been the coolest place in London. Their working expenses for the half-year worked out at 47·55, and showed that they were working at a cheaper rate than the South London Railway or the Central London Railway. A year ago their working expenses were 46 per cent., and but for an accident to a passenger their working expenses would have shown no increase.

The report was adopted.

LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting was held at Liverpool, Sir William B. Forwood presiding.

In moving the adoption of the report (which appeared in our issue of the 5th inst.), the **Chairman** remarked that the Company perhaps felt slackness of trade more than any other railway, because they were dependent entirely on the movement of passengers in connection with the trade of the port. They had also suffered from a considerable diminution in holiday traffic. About two-thirds of the line had been relaid, and they hoped to complete that work by the end of the year. They had concluded an agreement with the Lancashire and Yorkshire Railway Company, and had let the contract for making a physical connection with that line at Seaforth. Under the terms of the contract the work ought to be completed by next February, when they hoped to be running a through service to Southport in connection with the Lancashire and Yorkshire Railway.

Sir Edward Lawrence seconded the motion, which was adopted.

TYNESIDE TRAMWAYS.

The half-yearly meeting of this Company was held at the Station Hotel, Newcastle, on Tuesday, Lord Armstrong presiding.

The report showed that the receipts, which are steadily increasing, exceeded the expenditure by £1,454, which, with the balance brought forward from the previous half-year, gave a total balance of £1,533. Out of this it was proposed to pay a dividend at the rate of 2 per cent. per annum.

The **Chairman**, alluding to the inter-running question, predicted that the agreement entered into with the Newcastle Corporation would secure a material increase of revenue to both parties. The directors had received by private subscriptions £7,500 of the authorised issue of £60,000 previously approved, but did not issue the debentures until the running powers dispute was over. The issue would now be made at an early date at 5 per cent., redeemable at par in 10 years. They had still unissued authorised share capital to the amount of £80,000.

Mr. Merz seconded the resolution, and the report was adopted.

In moving a vote of thanks to the chairman, **Alderman Boyd** (Wallsend) urged the need of a liberal depreciation fund, so as to build up a strong reserve.

Dr. R. Spence Watson, in seconding the vote, commented on the happy issue of the running powers controversy.

Lord Armstrong, in reply, said the directors would consider the question of depreciation on a liberal scale before the annual meeting. The question of providing a reliable time-table would not be overlooked.

GREAT NORTHERN AND CITY RAILWAY.

The twelfth half-yearly general meeting of the Great Northern and City Railway Company was held at the Westminster Palace Hotel under the presidency of Sir Charles Scotter, chairman of the Company.

We published particulars of the report last week.

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The **Chairman**, in moving the adoption of the report, announced that the difficulties with the Great Northern Railway had been settled, and that on Monday next a working arrangement between the two concerns would come into operation. In reply to a question, he stated that the question of extending the system would be considered by the directors when financial conditions were more favourable.

The **Earl of Lauderdale** (deputy-chairman) seconded the motion, which was carried unanimously.

Sir Charles Scotter has resigned his position on the Board consequent upon his appointment to the chairmanship of the London and South-Western Railway.

NEW COMPANIES REGISTERED.

West-end Motor Company, Limited (81,789).—Capital, £3,000. Objects: to acquire and carry on the business of A. S. Ross, at 61 and 62, High-street, Bloomsbury, and 83, Hatton-garden, E.C., as the West-end Motor Company, as manufacturers of and dealers in motor-propelled cycles, carriages, omnibuses, machines, and horseless vehicles of every description.

British Meeline Company, Limited. — Capital, £50,000. Objects: to carry on the business of mechanical, electrical, and general engineers, etc. Registered office: Tokenhouse-buildings, King's Arms-yard, E.C.

Chamberlains, Limited (81,744).—Capital, £1,500. Objects: to acquire the business carried on at 149, Gray's-inn-road, London, as Chamberlains, to adopt an agreement with H. P. Clarke and H. Platts, and to carry on in the United Kingdom or elsewhere the business of specialists in gas, electric, and other methods of lighting, heating, and ventilating apparatus and appliances, manufacturers of and dealers in incandescent fittings, mantles, and accessories, etc.

Printers' Engineers, Limited (81,737). — Capital, £40,000. Objects: to carry on the business of printers' machinery manufacturers, mechanical engineers, machinists, electrical engineers, etc.

Generators, Limited.—Capital, £5,000. Object: to acquire the business carried on at 77-78, Trevelyan-buildings, 52, Corporation-street, and elsewhere in Manchester, by J. M. Wallwin, as generators, to adopt an agreement with the said vendor, and to carry on the business of electrical and mechanical engineers, electricians, manufacturers, workers, and dealers in electricity, motive power, and light, generator manufacturers. etc. Registered office: 77-78, Trevelyan-buildings, 52, Corporation-street, Manchester.

Liens Registered.

Guildford Electricity Supply Company, Limited. — Lien registered July 26 for £1,600 6 per cent. debentures (renewals), part of £15,000 issued; no trustees; charged on the undertaking and all the property, present and future, including the uncalled capital.

Yorkshire Electric Tramways Construction Syndicate, Limited, Westminster.—Debenture registered Aug. 3 for £70,000; holder, H. S. Leon, Bletchley Park, Bucks; a first floating charge on the undertaking and all the property, present and future, including any uncalled capital.

Northern Counties Electricity Supply Company, Limited, Newcastle-upon-Tyne.—Lien registered Aug. 5 for £500 5 per cent. debenture, part of £100,000; amount previously issued, £25,600; no trustees; charged on the undertaking and all the property, present and future, excluding the uncalled or unpaid capital.

British Westinghouse Electric and Manufacturing Company, Limited.—A trust deed, dated Aug. 2, 1904 (supplemental to trust deeds, dated Feb. 18, 1902, and Aug. 31, 1903, respectively), securing a further £225,000 debenture stock, created by Board resolution of July 22, 1904, has been registered. Property charged: freehold hereditaments at Stretford and Barton-on-Irwell, Lancs., lately forming part of the Trafford Park Estate, with buildings erected or in course of erection thereon (subject to certain rent charges affecting the same) and the company's general assets, present and future, including uncalled capital. The above is the same property as is charged by the trust deed of 1902. Trustees: Merchants' Trust, Limited, 63, Cornhill, E.C.

Davies, Kent, and Stewart, Limited (Electrical Accessory Manufacturers, London).—Issue on Aug. 4 of £1,050 debentures, part of a series created July 26, 1904, to secure £1,350, charged on the company's undertaking and property, present and future, including uncalled capital (if any). No trustees. No previous issue of same series

Woking Electric Supply Company, Limited.—Issue on July 16 of £500 debentures, part of a series created Nov. 2, 1899, to secure £25,000 charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £24,150.

Lien Discharged.

Metropolitan Electric Supply Company, Limited, London, W. Discharge registered Aug. 3 of charges dated July 30, 1901, Sept. 5, 1902, and Dec. 7, 1902, for securing the sum of £235,000.

PERSONAL.

On the occasion of his recent marriage, Mr. J. F. Magoris, chief assistant city electrical engineer, Hull, was presented on Friday last by the clerical, engineering, and works staff of the Hull Corporation electricity works with a handsome case of cutlery. The presentation was made in the presence of the whole of the staff, who, through their spokesman (Mr. G. Sykes), took the opportunity of wishing him and Mrs. Magoris long life and every possible happiness, and, in parenthesis, touched upon the cordiality which had always existed between themselves and their chiefs, Messrs. H. Bell (city electrical engineer) and J. F. Magoris.

The Mexborough Urban District Council have increased the salary of Mr. Senior, the electrical engineer, by £20.

Mr. R. G. Simpson, chief assistant engineer, Edinburgh Corporation, has been appointed electrical engineer of the Weymouth electricity supply department. The salary is £250 per annum, increasing by annual increments of £25 to £300 per annum.

Mr. H. J. T. Heather, formerly engineer of Moodie's Gold Mining and Exportation, Barberton, Transvaal, has been appointed electrical engineer to the Village Main Reef G.M.I., Limited.

Mr. G. H. Carter has been recently appointed resident electrical engineer to the Acton Urban District Council.

At the Norwich Electric Tramway Company's offices, Orford-hill, on Friday, Mr. W. A. Penman was the recipient of a combined spirit tantalus, cigar, and cigarette cabinet from the officers and employés of the tramway company, on the occasion of his leaving the company.

We are informed that Mr. G. A. Hughes and Mr. Adolph Wunderlick are retiring from the Charlton works of Messrs. Johnson and Phillips after 15 and 7 years' service respectively, having held the positions of works secretary and departmental manager. We understand that they are shortly to commence business on their own account as electrical manufacturers.

APPOINTMENTS VACANT.

Draughtsman. Box D 20, *Electrical Engineer* Office. See advertisement.

Switchboard Attendant, Kirkcaldy electricity works. Wages 25s. per week. Applications by 27th inst. See advertisement.

Agent, accumulator manufacturers. W., *Electrical Engineer* Office. See advertisement.

Plumber Jointers. Harland and Wolff, Limited, Belfast. See advertisement.

Resident Electrical Engineer, Willesden Urban District Council. Salary £250 per annum. Applications by Sept. 17. See advertisement.

Mains Assistant. Engineer and Manager, 27, Osborne-street, Whitechapel, E. See advertisement.

Resident Electrical Engineer, Hereford. Salary £200 per annum, and half pupils' premiums. Applications by 25th inst. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Ipswich.—The Electric Lighting Committee will shortly advertise for tenders for addition of boiler.

Pennas de San Pedro (Spain).—The Municipality require tenders for electric lighting for 20 years. Tenders by Aug. 25.

Paris.—The Posts and Telegraph Department, 123, Rue de Grenelle, require tenders for paper-insulated cables (11 lots) by Aug. 25.

Madrid.—Tenders are required by the Post and Telegraph Department for 70 tons of 4mm. galvanised iron wire and 70 tons of 2mm. bronze wire by Sept. 3.

Bucharest.—The Roumanian Government Railways require tenders for supply and erection of electricity plant and for installation for lighting several workshops by 27th inst.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

Batley (Yorks).—The Batley Working-Men's Club invite full specified estimates for the installation of the electric light on the club premises. Tenders to be sent to Mr. W. Booth, secretary, by Aug. 22.

Madrid.—Tenders are required by the Post and Telegraph Department for 9,000m. telegraph cable of 7 rubber-insulated wires, 2,000m. ditto of 28 paper-insulated wires, and 11,000m. cable of 7 steel wires by Sept. 6.

Hove (Sussex).—Tenders are invited for the supply, delivery, and laying, in the parish of Aldrington, of low-tension vulcanised-bitumen, dialite, or "leadless" paper cables, conduits, boxes, meters, etc. Tenders by Aug. 30. See advertisement.

Dublin.—The Lighting Committee of the Corporation of the City of Dublin are prepared to receive tenders for the supply of 500 alternating-current meters, single-phase and three-phase. Tenders to the Chairman, Lighting Committee, 3, Cork-hill, Dublin, by 12 noon on Aug. 23.

Madrid.—The Directorate-General of Administration ("Ministerio de la Gobernación") require tenders for the supply and upkeep for three years of continuous-current arc lamps, with a minimum of 64 lamp-posts. The total upset price is about £7,762. Local representation is necessary. Tenders by Aug. 24.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Stoke-upon-Trent.—The Guardians of the workhouse invite tenders for two 13-h.p. electric motors; one 2-h.p. electric motor; electric cable; piping or tubing; junction boxes and frames. Specifications

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may be seen at the Workhouse between 10 a.m. and 4 p.m. Tenders to Mr C. Daniel, clerk, Union Offices, Stoke-upon-Trent, by 9 a.m. on Aug. 24.

Penang.—The Municipal Council of George Town, Penang, invite tenders for the supply and delivery of tramcars, complete with motors, controllers, trolleys, etc. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by 12 noon on Aug. 24.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Manchester.—The Directors of the Manchester Dock and Warehouse Extension Company, Limited, invite tenders for the wiring (for power and light) and electric lighting of five transit sheds (now in course of erection) on the southerly side of dock No. 9, in the county borough of Salford. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Aug. 30.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

RESULTS OF TENDERS.

Wednesfield.—The tender of Mr. H. Holloway has been accepted for the construction of the extended tramway track on the Wednesfield-road at £2,752. 15s.

Hackney.—The Guardians have accepted the tender of W. Wallace and Co., 151-5, Curtain-road, E., for fitting up a system of electric fire-alarm bells at their Homerton establishments.

Bermondsey.—The Borough Council have accepted the tender of Sunderland and Co., 39, Victoria-street, S.W., at £138, for the wiring of the staircases and courtyards of the Fulford-street dwellings.

Loughborough.—The Electricity Committee have accepted the tender of Bennis and Co., at £320. 7s. 10d., for two patent double machine stokers, including driving shaft and 2½ h.p. motor for driving same.

Erith.—The following tenders have been received for tramway rails and permanent way:

Rails.

	60ft. rails.			45ft. rails.		
A. Penney and Co.	£8,029	9	0	£8,029	9	0
Bolckow, Vaughan, and Co., Limited	8,203	0	0	8,204	16	0
Barrow Hematite Steel Company	8,229	18	0	7,883	13	0
P. and W. Maclellan and Co.	8 239	3	0	7,882	3	0
H. Gielgud	8,263	7	0	8 194	2	0
H. D. Boret	8,306	6	0	7,960	0	0
L. Sommerfeld	8,306	3	0	8,203	0	6
R. W. Blackwell and Co., Limited*	8 391	10	4	8,329	3	2
Walter Scott, Limited	8,492	5	0	8,492	5	0
R. Reichwald	8 504	15	0	8,504	15	0
Macartney, McElroy, and Co., Ltd.	8,512	15	0	8 470	15	0
J. G. White and Co., Limited	8,597	12	0	8,279	5	0
W. Griffiths and Co., Limited	8 640	5	0	8,294	0	0
Dick, Kerr, and Co., Limited	8,556	13	0	8 474	3	0
Peerless, Dennis, and Co.	8.738	0	0	8 565	0	0
W. Kennedy, Limited	8 843	5	0	8,664	15	0
T. Adams	8.940	5	0	8,940	5	0
Muirhead, Grieg, and Matthews	9,059	5	0	9,059	5	0
E. Taylor (disqualified)	9 066	11	2	—		
J. Briscoe	9,584	0	0	9,487	2	6
F. Osman	9.748	6	0	9,748	6	0
Steel, Peach, and Tozer	10,000	15	0	10,000	15	0

Permanent way.

L. Sommerfeld	41,327 18 5
R. W. Blackwell and Co., Limited*	38,579 14 7
J. A. Ewart	39 427 16 6
Macartney, McElroy, and Co., Limited	39.866 15 2
G. Wimpey and Co.	40 026 0 7
W. Griffiths and Co.	41,342 18 6
J. G. White and Co.	41,452 1 1
J. H. Mollett and Co.	41,759 15 0
Peerless, Dennis, and Co.	42,118 10 0
T. Adams	42 827 3 6
Dick, Kerr, and Co.	42 828 7 9
W. Kennedy, Limited	43,128 0 0
J. Brunton	46 142 4 0
F. Osman	50,182 0 0
A. Woodhouse	51.109 10 0
Enness Bros.	57,311 3 0
Muirhead, Greig, and Matthews	58,372 13 0

* Accepted.

Law Courts.—The order for extensions to the electric lighting of the Royal Law Courts of Justice has been placed with Messrs. F. A. Glover and Co., Limited, 10 and 12, Garrick-street, Covent Garden, London, W.C.

Warrington.—The Electricity Committee have accepted the tenders of Babcock and Wilcox, Farringdon-street, London, at £957, for four mechanical stokers, and Bell Bros., Ravensthorpe, Yorkshire, at £450, for water-softening plant.

Accumulators.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E., report an order from the Bradford Corporation for 260 of their standard central lighting type cells, automatic reversible booster, and switchgear.

Cables.—Messrs. W. T. Glover and Co., Trafford Park, Manchester, have obtained from the Johannesburg Town Council the contract for supplying and laying new distrine paper lead-covered, distrine paper leadless, and vulcanised rubber cables. The total of the contract will be considerably over £100,000.

Warrington.—The Corporation have accepted the tender of R. W. Blackwell and Co., London, at £737. 14s. 8d., for the supply, delivery, and erection of steel poles, trolley wires, etc., forming complete overhead equipment for about 550 yards of double track, including special arrangements at the swingbridge over the Manchester Ship Canal.

Condensers.—The Mirrlees-Watson Company, Scotland-street, Glasgow, report the following orders for condensing plant: surface—Leeds Corporation lighting; Northampton Corporation; Bradford Corporation (repeat), per J. Musgrave and Sons; Egyptian Government; Redpath, Brown, and Co.; J. Musgrave and Sons (for South Africa), Burgh of Greenock; Whitby Urban District Council; Partick Electric; G. H. Powden, Manchester; Premier (Transvaal) Mining Company, per Fullerton, Hodgart, and Barclay; Inverask Paper Mills, per British Westinghouse Company; Folkestone Electric, per Edmundson's Electricity Corporation; Cardiff Electricity Works; Willesden Urban District Council; Madeira Electric Light Company; Bristol Corporation, per Willans and Robinson; jet—Clyde Valley Electric Power Company, per British Westinghouse Company; Kilmarnock Electric, per Aiton and Co.

BUSINESS NOTES.

TRACTION.

Wolverhampton — The new Bushbury route is being well patronised.

Ayr.—The Corporation Tramways Order Confirmation Bill has received the Royal assent.

Coventry.—The company have decided to raise a further sum of £10,000 for working capital, the loan to be charged on the company's undertaking.

Tynemouth.—The Corporation are approaching the company with a request that a line should be run down to the Fish Quay, so that the congestion of traffic may be relieved.

Tynemouth and District Electric Traction Co.—The directors have decided to pay an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum.

Cambridge.—The Town Council have received a report from Messrs. Kincaid, Waller, Manville, and Dawson, as to the various routes which should be adopted in the event of the electrification of the tramways being carried out.

Leicester.—A trial trip has been made on the Aylestone-road section, everything going smoothly. The official opening of the route will not, however, take place before the end of the month or early in September. Experiments are being carried on with a new step.

Raworth's Traction Patents.—At a special meeting of the Walthamstow District Council it was unanimously decided to ask their consulting engineer, Mr. J. Enright, to bring up a report upon Raworth's automatic regenerative control system for electric traction.

Diesel Engines.—One of the largest stations equipped with Diesel engines is that of the Kief tramways, where six engines are installed, with an aggregate output of nearly 2,000 b.h.p. Diesel traction stations in the United Kingdom include Birmingham, Dudley, Stourbridge, Rothesay, and Greenock.

South Australia.—Mr. Bradford, the electrical expert who has been engaged by the South Australian and Victorian Governments to report upon the electrification of suburban railways and on the South Australian tramways generally, has entered upon his work at Adelaide, but his report is not expected for some time.—*N.S.W. Railway Budget.*

Western Australia.—Messrs. Noyes Bros., electrical engineers, have, states the *N.S.W. Railway Budget*, entered into a contract to construct and equip electric tramways and an electric lighting system for the municipalities of Fremantle and East Fremantle, at a cost of £80,000. The contract time is 18 months, but the contractors expect to complete the work in 12 months.

Birstall.—The District Council have received a communication from the British Electric Traction Company stating that it was proposed to commence the reconstruction of the Dewsbury, Batley, and Birstall tramways at an early date, and forwarding plans, etc. A similar communication has been addressed to the General District Council, as mentioned in our note last week.

Halifax.—The traffic returns for the fortnight from the 27th ult. to the 10th inst. establish a new record for the town. The amount taken on all the routes was £4,046. 9s. 8d. The nearest approach to this

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was £3,935. 16s. 11d., collected in the fortnight ended June 3, 1903, in which period Whit-week occurred, while in the fortnight including Whitsuntide this year the takings totalled £3,593. 6s. 8d.

Wakefield.—The Wakefield and district tramcars commenced running on Monday. There will be a regular service from the centre of the town to Belle Vue and Sandal, Horbury and Ossett, and Outwood, Lofthouse, and Leeds. A branch to Rothwell will shortly be opened, and within a short time the system will couple up with Normanton, Castleford, Pontefract, and Knottingley.

Dewsbury.—The Corporation have agreed to purchase the undertaking of the Yorkshire (Woollen District) Electric Tramways Company in the borough of Dewsbury for the sum of £52,500 (less the rolling-stock), the concern to be leased for 30 years, at the expiration of which term it will belong absolutely to the Corporation. The Corporation have ordered the necessary borrowing powers to be obtained.

Rangoon.—*Indian Engineering* announces that the negotiations relative to the license for electric traction and lighting in Rangoon, of which Messrs. Darwood and Co. are the concessionaires, have now been completed. It is hoped that the work will be put in hand by November. Unusual interest attaches to the venture from the fact that the present steam tramways were constructed by the late Mr. J. W. Darwood, whose family are the concessionaires for the new system.

Dulverton-Minehead.—The Watchet Urban Council and the Williton Rural Council have passed resolutions in favour of the suggested light railway between Dulverton and Minehead, or Watchet. The Minehead Urban Council are also disposed to favour the scheme. Lady Carnarvon, as one of the landowners, has written to say that her co-operation must depend upon the valley of the Haddes being left untouched. The Dulverton Urban Council will hold a special meeting to further consider the matter.

Walsall.—The town clerk has been instructed to apply to the Board of Trade to inspect the overhead equipment of the old tramways, which has now been brought up to the present general standard, in accordance with the Board's requirements. It has been arranged with the Electricity Committee that the charge for current for tramway purposes shall be 2d. per unit up to June 30, 1904, and thereafter 1½d. per unit, irrespective of the quantity used, until such time as any new arrangement may be come to after the end of the present year.

South Lancashire Traction and Power Company, Limited.—An agreement has been registered under which the company issues to the Electric Conversion Syndicate, Limited, £47,000 prior mortgage debenture stock in exchange for a similar amount of first mortgage debenture stock; charged on shares in the South Lancashire Tramways Company and the Lancashire Light Railway Company, certain lands and hereditaments, and all other assets, including the uncalled capital, ranking in priority to the first mortgage debenture stock secured by a trust deed, dated Jan. 28, 1901.

Aberdeen.—A report was presented last week to the Tramways Committee of the Town Council on the operation of the scheme of workmen's cars. On all the routes (except Woodside) a considerable loss was shown; but it was resolved to give the arrangement another month's trial before deciding whether these early morning cars should be continued or not. The question of the fares for the ensuing year was also discussed, and it was decided to adhere to the existing rates for the present, except in regard to the Woodside route, on which the committee will recommend the Council to make a reduction.

Aberavon.—Representatives of the Highway and General Purposes Committee and of the tramway promoters have inspected the route of the proposed system. The top of Water-street would require to be widened a few inches, but there was no engineering difficulty in constructing the line, as was feared, by the narrowness of this thoroughfare. It was subsequently decided that the Council approve of the scheme and route, provided the engineering difficulties could be overcome to the satisfaction of the Town Council, and that the scheme be completed within two years after the syndicate had obtained parliamentary sanction.

Middlesbrough.—The Corporation having received numerous complaints concerning the excessive speed at which the electric tramcars pass through the town, recently decided to prosecute the offenders. As a result, three motormen employed by the Imperial Tramways Company were charged with driving their cars at a greater speed than eight miles an hour. In one case a fine of 30s. was imposed, the other two cases being adjourned for further evidence. On behalf of the company, it was stated that the motormen having been given official instructions regarding the speed of cars, they would not have their fines paid by their employers.

Belfast.—At last week's meeting of the Tramways Committee, the town clerk was authorised to communicate with the solicitors for the Belfast Street Tramways Company in regard to the appointment of an arbitrator. The city surveyor (Mr. H. A. Cutler) and the electrical engineer (Mr. V. A. H. M'Cowen) submitted their joint report on the various systems of electric traction, and recommended the adoption of the overhead trolley system on the score of cost. The committee will recommend the Corporation to adopt this system. On the assumption that the overhead method is adopted, Messrs. Cutler and M'Cowen estimate the total outlay necessary (excluding the purchase of the company's undertaking and parliamentary expenses) at £827,000.

Leith.—In pursuance of the decision of the Town Council to make enquiries respecting all systems of traction, in view of the advanced stage now reached by the Council's tramway provisional order, a party, consisting of the town clerk, treasurer, borough engineer, and consulting tramways engineer, with four members of the Council, visited Hull last Saturday for the purpose of obtaining information on tramway matters. They were met at the Hull station by the city engineer (Mr. White) and Mr. Wilkinson (the tramways electrical engineer), who conducted them over the different routes, car-sheds, and tramways power station. The Leith representatives expressed great admiration at the substantial and well-laid track, the wood-paved streets, tramways power station, and buildings. After inspecting other improvements, the party left for London.

Birmingham.—It is stated that the opening of the Dudley-road route may be expected in a month's time. The Birmingham and Midland Tramways Company have ordered 24 new cars, in addition to those already in operation on the Black Country portion of the line, and 12 are ready for almost immediate use. By the opening of this route it will be possible to travel by electric car from Congreve-street direct to Kinver, a distance of 14 or 15 miles, with only one change—at the Fish, beyond Wordsley. The new cars will be provided with a covered top, on the Bellamy principle. The directors of the company were desirous of introducing the covered top on the Bristol-road route, but objection was offered by the Corporation. It is stated, however, that the authorities have of late relaxed their attitude, and there is a disposition now to adopt a similar contrivance shortly on the municipal cars running to and from Aston.

Sydney.—It is anticipated, says the *New South Wales Railway Budget*, that the cable tramway system from King-street to Ocean-street will be superseded by electricity at an early date. Some of the steam-boilers required for driving the new machinery necessary to generate additional electricity at the Ultimo power-house have arrived, and it is expected that they, together with the new machinery, will be in working order towards the end of the year. This will permit of the cable system being finally abandoned for the speedier, more comfortable, and certain electric system. The conversion from cable to electricity will not, it is understood, involve an undue waste of existing materials and works. The conduit in which the cable runs will, of course, be valueless, but the permanent way will be utilised. The same will be the case with the tramway shed and steam power-house at Rushcutter Bay. It is quite true the engines will not be required, and it is understood the Railway Commissioners will sell them, but the whole of the building will be utilised for the housing of electric cars and carrying out repairs.

Manchester.—The Board of Trade has held an enquiry respecting the new by-laws proposed by the Corporation for the regulation of tramway traffic in the streets. A suggestion was made by Sir Herbert Jekyll that with regard to the general regulation the parties should consider how far the "model" by-law framed to suit the traffic on the London United Tramways would meet the case in Manchester. This by-law read as follows: "The driver of every car shall so drive the same that it shall not follow a preceding car at a less distance than 50 yards, except in cases of emergency, when the driver shall comply with the directions given by the authority controlling traffic on the spot. No car shall be stopped within 15 yards of another car on a parallel line of rails, nor within 15 yards of the intersection or junction of two or more streets or roads." This proposal was accepted as satisfactory by Mr. Forbes Lankester on behalf of the Horse-owners' Association. Mr. M'Elroy, general manager of the Corporation tramways department, considered that a 15 yards' interval was the right figure in general, but the Corporation were prepared to agree to 100 yards in regard to Portland street.

Devonport.—The Devonport and District Tramway Company have now completed the system of tramways for which the company and the Corporation obtained powers, the last section to be completed being examined last Friday by Major Druitt on behalf of the Board of Trade. The line runs from Milehouse to Ford, being a continuation of the St. Levan-road section. The road has been made by the Corporation, and has been laid with a single line with loops by the company. At the inspection Major Druitt was accompanied by Mr. J. C. Tozer and Alderman J. Goodman, chairman and vice-chairman of the Corporation Tramways Committee; Mr. R. J. Fittall, town clerk; Mr. J. F. Burns, borough surveyor; and Mr. J. W. Endean, general manager Devonport and District Tramways Company. A car was run over the extension, which bore the test admirably. The wires, etc., were examined by the inspector, who expressed himself as thoroughly satisfied. Permission to use the section will, it is expected, be forthcoming in the course of the next few days. Although the powers of the company and Corporation are now exhausted, it is proposed to apply for permission to extend the St. Budeaux section to the parish church.

Morecambe.—At a meeting of the directors of the Morecambe Tramways Company and the Tramways Committee several points with respect to the electrification of the tramways were discussed. The directors stated that it would be impossible to satisfactorily electrify the trams unless the road from the Midland Hotel to Albert road was widened to such an extent as to provide a road of 40ft. between the kerbs, so as to allow of a double track of rails, and before proceeding further in the negotiations the directors wished to see a plan showing how such a road widening could be effected to the satisfaction of the Corporation. The directors stated that they would not be at the expense of such road widening unless the expense was added to capital account, so that such expenditure could be allowed by the Corporation in case they at any time took over the undertaking. The Town Council have decided to prepare such plan. A communication is expected from the company shortly as to the maximum amount of current which will be required per day, and the Electric Lighting Committee are to make and submit a calculation of price for the energy to be supplied. In regard to the Bare section, the Council are to consider further the price they will be prepared to accept for same.

York.—The communications which have been passing between the York Tramways Company and the Corporation with regard to the possible acquisition of the company's lines by the municipal authority, were referred to by the chairman of the company (Mr. Joseph Kincaid) at the half-yearly meeting. Mr. Kincaid said that the Corporation had communicated with the company with regard to the taking over of the lines, but only preliminary letters had passed. The directors

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had expressed themselves as perfectly willing to meet the views of the Corporation, on fair terms, and no doubt a negotiation carried on between a willing buyer and a willing seller would prove, he hoped, to end in a satisfactory arrangement. The company would, of course, prefer that the Corporation should take over the lines sooner than go on as they were at present, because they felt their undertaking was not satisfactory to the town. At the same time the company themselves were willing, under certain conditions requiring the consent of the Corporation, to make the improvements and extensions necessary to make the undertaking satisfactory to the population of York. The company would continue to negotiate in a way that the directors hoped would satisfactorily solve a thorny question.

Bury.—Another section of the Corporation tramways has been completed and opened for traffic, the latest addition to the system being the section by Bolton-street and Bolton-road to the barracks. A trial trip on the section was run on the 9th inst., the start of the car from the Market-place and its progress to the barracks and back being witnessed by very large gatherings of spectators. A number of members and officials of the Town Council took part in the initial run, amongst those present being Messrs. W. Clough (tramway manager), A. W. Bradley (borough engineer), S. J. Watson (electrical engineer), and C. Satterthwaite (Macartney, McElroy, and Co.). After the run to the barracks the car was taken to Jericho and to Blackford Bridge for the purpose of testing the magnetic brake with which it had been fitted prior to leaving the depôt. The next morning Major E. Druitt, R.E., inspected the section on behalf of the Board of Trade. He specially examined the laying of the setts on the outside of the rails at the barracks end of the section. After traversing the route, Major Druitt expressed himself as satisfied, and fixed the following speed limits: Bolton-street, 10 miles an hour; Bolton-road, 12 miles; curves, four miles. Subsequently a service of cars was commenced to the barracks, and each car was well patronised.

Newcastle.—The annual report of Mr. A. E. Le Rossignol, general manager and engineer of the Corporation tramways, has been issued to members of the City Council. It states that the result of the working of the tramways for the second financial year shows that the total revenue from all sources is £185,027. 12s. 9d.; total working expenses of the tramways and of the arc lighting of the city £121,557. 14s. 9d., making a gross surplus of £63,469. 18s. The total working expenses per car mile were 7·19d. as against 6·35d. for the previous year, but there had been a decrease in all the items making up the working expenses with the exception of the item for rates, taxes, etc., and the item for maintenance and renewals, both of which show a considerable increase. Under the former item the department had paid this year over £5,000 in rates, whilst the increase in the latter item for maintenance and renewals was an exceptional one, which had been necessary to keep the plant from depreciating rapidly. The chief increase in maintenance this year had been incurred in connection with the permanent way and the cars. Out of the gross surplus a larger amount than last year by over £8 000 had been required for increased interest on and redemption of capital. A large proportion of this had been expended on work which had been carried out this year, but had not yet had time to produce revenue or come into use. During the 2¼ years of working just completed productive capital had been redeemed out of revenue to the following extent: redemption of capital during 15 months' working up to March 25, 1903, £19 851; redemption of capital during 12 months' working up to March 25, 1904, £20,190. In addition, the charges for interest and redemption on capital unproductive whilst used in construction of work and not yet ready to yield revenue, have all been paid out of revenue, instead of (as was done in many cases) paying these charges out of capital. The amounts paid off entirely in this way were as follows: interest and redemption incurred during the construction of the tramways prior to their opening on Dec. 16, 1901, £21,278. 11s. 11d.; interest and redemption on works constructed during 15 months up to March 25, 1903, and not productive of revenue till the next year, £9,285; interest and redemption on works constructed during 12 months up to March 25, 1904, and not productive of revenue till next year, £6,900—total, £37,463. 11s. 11d. Mr. Le Rossignol recommends the Tramways Committee to form the nucleus of a reserve fund now by devoting to it the balance remaining this year after paying off the last instalment of the loan for interest and redemption during construction advanced by the Finance Committee. He also recommends a reduction in the distance of the ½d. sections, and suggests that longer 1d. stages would be preferable to continuing the workmen's cars, which are freely used by ordinary passengers. The extension to the boiler-house is now complete, and the boiler plant is capable of supplying steam to the new 3,000-h.p. engine, which is approaching completion in the engine-house, where the necessary additions to the switchboard for the new generator have been made. In addition, a gallery has been erected at the west end of the engine-house to accommodate the switchboard for providing current at 250 volts to the municipal buildings,, and a motor-converter installed to supply current at 100 volts to the town hall, in order to avoid alteration of the existing wiring in that building. The construction of the new car-shed in the west end of the city, at Wingrove, has proceeded well, and the building is almost ready for use. Its cost will be about £11,479, or £530 less than the contract price. The following is a summary of the year's working: single miles of line open for traffic, 45; passengers, 39,715,120; population served by tramways, 257,000; average journeys *per capita* per annum, 155; car mileage run during the year, 4,059,907; total kilowatts generated, including lighting, etc., 7,757,885; average number of passengers per car mile, 9·8; average fare per passenger, 1·1d.; traffic revenue for the year, £180,630. 12s. 2d.; average traffic revenue per car mile, 10·68d.; total revenue for the year, £185,027. 12s. 9d.; average total revenue for the year, 10·94d.; total working expenses for the year, including street-lighting, £121,557. 14s. 9d.; average total working expenses per car mile, 7·19d.; average net working expenses per car mile, including proportion of costs chargeable to street-lighting, 7·00d.; percentage of net working expenses to traffic receipts, 65·5 per cent.; total capital expenditure at March 25, 1904, £1,054,492. 15s. 8d.; total number of cars in stock in March last, 165; number of cars in course of construction, 12. Since the opening of the system the total of car miles run aggregate 7,832,121; passengers carried, 77,895,183; receipts, £352,131. 8s. 5½d.; receipts per car mile, 10·79. The Tramways Committee have arranged that the relaying of the lines and repairing of the tramways generally shall be vested in the hands of Mr. Edge, the city engineer, and the Town Improvement Committee, instead of sub-dividing it, as in the past, between the Tramways Committee and the Town Improvement Committee, which had caused considerable confusion and expense.

LIGHTING AND GENERAL.

Birkdale.—The exchange for the underground telephone service will be opened at the end of the present month.

Berwick.—The lighting of the bridge by electricity has been remitted to the Lighting Committee with powers.

King's College.—The session for 1904-5 commences Wednesday, Oct. 5. Particulars will be found in another column.

Ossett.—Mr. G. Vaughan Fowler, Warwick, intends to apply for a provisional order for the supply of electricity within the district.

Carnarvon.—Sanction has been obtained to the borrowing by the Town Council of £17,315 towards erecting electric light buildings.

Change of Address.—Messrs. Edward C. Herbert, Limited, have removed their works and registered offices to Rosamond-street, East Manchester.

Frome.—The electric lighting of the streets has been started, and the contractors are being urged to complete the whole of the street lighting as speedily as possible.

Sligo.—The Corporation have passed a resolution drawing the attention of the Government to the necessity of connecting the town (the terminus of three important railways) with Dublin by the construction of a trunk line.

Ashton.—The Guardians have received a report from Mr. Appelbee electrical engineer for the borough of Ashton, relative to the cost of electric light in similar institutions to that of the workhouse, which is estimated at £1,500, exclusive of £200 for telephones.

Competition.—The Association des Industriels de Paris, Rue de Suède 3, offers a premium of £240 for the best apparatus showing at any time the actual charge of an electric conductor. The sum may be divided should the merits of the apparatus submitted warrant it. The competition closes Dec. 31, 1904.

Warminster.—The Rural District Council had to guarantee £26 before the postal authorities would extend the telegraph to Sutton Veney. There was a deficit of £2. 12s. on the year's working, which sum is paid in equal proportions by the General Post Office and the District Council, the latter body raising the money from Sutton Veney as a special charge.

Morley.—Mr. J. E. Ellis (electrical engineer) in his last report states that the output from the electricity works during the month ending June 30 was 5,895 units, as compared with 6,080 units the same period last year, being a decrease of 185 units. The number of lamps connected during the month was 34, the total number connected to date being 11,814.

Greenock.—The accounts of the electricity department of the Corporation for the past year show a deficit of £2,100, stated to be chiefly due to the Board of Trade decision in the arbitration case between the Corporation and the tramway company. The decision compels the department to supply energy at a figure much lower than they thought they were entitled to charge according to their lease.

Kirkintilloch.—The gas manager having made a call on the shopkeepers in the centre of the burgh, in which the Council propose to begin operations in electric lighting, met with good promises of support. It is proposed to erect small works on a part of the ground recently purchased for the erection of the town hall. If the venture succeeds, the plant can be removed and used when larger works become necessary.

Superheated Steam.—We are informed that Messrs. Easton and Anderson, Broad Sanctuary-chambers, 20, Tothill-street, S.W., have taken over the superheater business until recently carried on by Easton and Co., Limited, of London and Erith, and that in future all superheaters under either the Schmidt or the Easton patents will be constructed for them to their designs and under their own supervision by Messrs. John and Edward Wood, of the Victoria Foundry, Bolton.

Hove.—No further action is to be taken on notice served on th Brighton Corporation with reference to carrying out the work themselves in connection with laying the proposed electric cables along Old Shoreham-road. The suggested terms between the two authorities with regard to laying mains have been agreed to. Tenders are to be obtained for carrying out proposed works south of Hoove Lea, 4, Courtenay-terrace, and on the south side of Shoreham-road, opposite Mills-terrace.

Catalogue.—The latest catalogue of the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., contains many novelties which they stock and which are of great importance in the development of Nernst lamps. We are informed that the company have made arrangements with the patentees of these lamps in order that their customers may be fully protected against infringement of patents. By an agreement with the patent-holders and the different licensees, special discounts have been fixed which came into force on Aug. 1, and to which the respective sellers are bound to strictly adhere. This new arrangement is of mutual benefit to both sides, preventing the trade from underselling one another.

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South Metropolitan Electric Light and Power Co.—The company's preference share register will remain closed to the 31st inst. inclusive, for the preparation of dividend warrants payable 31st inst. in connection with interim dividend for the half-year ended June 30 on 50,000 7 per cent. cumulative preference shares.

Swansea.—The revenue from the electricity supply for the year ending March, 1904, was £10,871, as against £8,249, an increase of £2,621; the total revenue £10,938, as against £8,300. The gross profit was £5,876, as against £4,578, leaving a net profit, after payment of all charges, including interest and sinking fund, of £744—a highly satisfactory result. The total units sold aggregated 871,555, being 50 per cent. higher than in 1903, the average total cost being 1·38d. per unit.

St. Louis Exhibition.—We have received from the enterprising manufacturers of the "Swan" fountain pens a well-printed booklet of 15 photographic views of the various handsome structures at the St. Louis Exhibition. Each building is concisely described and cost stated. Messrs. Mabie Todd and Bard intimate that they will gladly send a copy free to all readers, mentioning this paper, who apply by postcard to any of their establishments: 93, Cheapside, London, E.C.; 95, Regent-street, London, W.; 3, Exchange-street, Manchester.

Long-Distance Telephone Extension.—On and after Sept. 1 telephonic communication will be established between East Coast towns and the following Continental centres: Amiens, Aniche, Armentieres, Arras, Bethune, Calais, Cambrai, Denain, Douay, Dunkirk, Fournies, Lens, Lille Masnieres, Montreuil, Peronne, Roubaix, St. Omer, St. Quentin, Tourcoing, and Valenciennes. The service will be worked through the Anglo-French and Anglo-Belgian telephone service. The usual fee of 8s. will be charged for three minutes' conversation.

West Hartlepool.—In the last report of the Electric Lighting Committee, the engineer (Mr. Friederichs) stated that the yearly overhauling of the electric plant had now been completed, and, taken generally, it was found in excellent condition, and although the engines had had nearly double the amount of running during the last year, their condition was really splendid. The repairs to the engines were less than what had to be done last year. Taking the engines and dynamos as a whole, their condition was better now than when handed over to the Corporation by the makers.

Hornsey.—The electrical engineer's report on the June quarter's working of the Council's electricity undertaking shows that the total costs, as compared with the corresponding quarter of last year, are over ¼d., or about 16 per cent. less. The repairs and maintenance item is very heavy this quarter, but this is accounted for by all the plant having been overhauled, and the first instalment of accumulator maintenance having been paid. The coal item is especially satisfactory, showing a drop of ·49d., or about 45 per cent. Seven hundred and thirty-three additional 8-c.p. lamps were connected up during the month of June, making a total of 27,223 for the 499 private consumers.

King's Lynn.—The accounts for the year ended March 31, 1904, with regard to the electricity fund revenue account, shows that the income for that department amounted to £6,497. Sale of current per meter brought in £3,270, and by contract £24. Public lighting revenue amounted to £1,991, rental of meters £155, and sale and repairs of lamps, etc., £1,054. The items of expenditure consisted of generation of electricity £1,466, distribution £874, public lamps £227, rents, rates, and taxes £170, management expenses £373, law and parliamentary charges £13, and insurance £15, a total expenditure of £3,141, leaving a balance of £3,355 to be carried to net revenue account. Out of this amount £1,285 was paid for interest, and £1,580 went in instalments for the reduction of principal.

Saffron Walden.—The application of the National Telephone Company to run telephone wires along the Little Walden-road to connect Little Chesterford Park with Saffron Walden exchange has been granted under the following conditions: "That the wires be placed underground for a distance of about 1,200ft. in a northerly direction from Bryd's Farm-lane; also along the frontage of the property of Mr. E. B. Gibson; and also at the junction of Westley-lane with the road, if, in the opinion of the surveyor, this was necessary. That the poles be painted black and capped with turned finials. That a rent of 1s. be paid in respect of each pole, which shall be removed on three months' notice from the Council." The Council intend to proceed with the application for the electric lighting loan as soon as practicable.

Surbiton.—Messrs. Talbot and Stevenson having reported that the provision of a third boiler and engine at the electric lighting works was absolutely necessary to ensure the proper supply, the extension, which is estimated to cost £4,400, has been approved by the Council. It appears that on Friday and Saturday nights last winter the maximum load on the station reached 109 kw. There were at that time about 6,500 8-c.p. lamps fixed. The total number now fixed is about 9,000, and it is expected that by January next there will be about 1,200 more, and to supply these the load will probably reach 190 kw. The two sets now in use are each capable of developing 100 kw., so that unless the extension is made before the coming winter the two sets would be called upon to work together at full load, and it was unwise to work an electricity station without a reserve engine.

Whitworth.—The various local authorities interested in the question of the supply of electricity recently discussed the subject. All the Councils represented, except Littleborough, who have already obtained their electric lighting order, have received notices from the Lancashire Electric Power Company, Limited, and Messrs. Foote and Milne, Limited, of their intention to apply for electric lighting orders, but all have not adopted the course taken by the Whitworth Council—viz., in giving notice that they should oppose any application by those firms. Some of the districts seemed to think that the cost of applying for their own orders would be prohibitive, but the general opinion was that it was highly desirable for district councils to apply for orders themselves. Subsequently the District Council passed a resolution affirming the desirability of applying for a provisional order. In view however, of the fact that no provision has been made in the year's estimates for the cost of such order the matter stands deferred until next year.

London Gazette.—The last day for receiving proofs in the estate of the Warrington and District Electric Light and Power Company, Limited, 115, Sankey-street, Warrington, Lancaster, is Aug. 26, 1904. Edwin Bradshaw, 4, Egypt-street, Warrington, and Edward Johnson, 78, King-street, Manchester, have been appointed liquidators. The partnership between James Mitchell Hewitt and William Gould Rhodes, carrying on business as consulting engineers at Tower-chambers, Brown-street, Manchester, under the style of Hewitt and Rhodes, has been dissolved by mutual consent. The partnership between James Hall and Arthur Hackblock, carrying on business as electrical engineers at 1, Arcade-street and St. Matthew's-street, Ipswich, and at Lowestoft, under the style of Hall and Hackblock, has been dissolved by mutual consent. A general meeting of the members of the British Electromobile Company, Limited, will be held on Sept. 21, 1904, at 12 o'clock noon for the purpose of having an account laid before them showing the manner in which the winding-up of the company has been conducted and the property disposed of. P. D. Leake, liquidator.

Lowestoft.—The accountant has submitted the following report of estimated and actual income and expenditure for the half-year ending June 30 last: Expenditure—generation, estimate £2,180 (actual, £2,792); distribution, £100 (£31); public lamps, £110 (£173); rates and taxes, £100 (£105); management, £468 (£507); insurance, £54 (£19); interest and sinking fund, £2,010 (£1 277)—total, £5,022 (£4,904). Income—private lighting, estimate £2,200 (actual, £2,089); slot meters, £7 (£8); power, £160 (£264); traction, £1,200 (£1,401); public lighting, £600 (£678); meter rents, £95 (£110); sundries, — (£5)—total, £4,262 (£4,555). To be provided from rate, £349. It has been decided that as from April 1 last, being the date on which the Council's new financial arrangements started, this committee should take over the undertaking as a going concern, and be responsible for all liabilities incurred, and take the advantage of all assets of the undertaking as from that date. The resident engineer's last report shows that there are now connected to the mains 534 consumers, representing 26,945 8-c.p. lamps. During the month 11 new consumers have been connected, representing 1,347 8-c.p. lamps. The engineer reported that he had received an application from the proprietor of the Hippodrome for permission to place a direction plate "To the Hippodrome" on the arc lamp post at the corner of Suffolk-road. The committee recommended that the application be granted at a rental of £1. 1s. per annum, the design and size of the plate to be approved by the engineer, and to be subject to a month's notice of removal, and to a proper agreement being entered into.

Ipswich.—Messrs. Kennedy and Jenkin in a recent report stated that they have investigated, with Mr. Ayton's assistance, the probable demand for power in connection with lighting, motors, and tramways likely to be dealt with by the generating station in the coming winter. They say that it appeared necessary to allow for the equivalent of 30,000 8-c.p. lamps connected to the lighting mains. Allowing for about 60 per cent. of these alight at once, 900 i.h.p. must be available to supply the current. With 36 cars they would have to provide at least 600 i.h.p. to supply power to them. The total for the lighting supply and for the tramways which must be available next winter was, therefore, about 1,500 i.h.p. As regards engines and dynamos, the power available was ample, as allowing a proper proportion of spares they would have something like 1,790 i.h.p. available in the station. The boiler power, however, was not as great as that of the engines and dynamos, as allowing one boiler to be laid off, they would have the equivalent of 1,560 h.p., supposing the engines were running condensing. Should the supply of condensing water fail, or any other such cause make it necessary to run non-condensing for a time, the three boilers would only give sufficient steam for about 1,300 h.p. This was not sufficient to supply the 1,500 h.p. required for the lighting and tramways. No doubt, with the help of the fourth boiler, they might be able to get through the winter, but it was undesirable to run matters so close as this, as any failure in the supply would mean a very serious check to the prosperity of the undertaking. As consumers were coming on so rapidly, they advised the order of an additional boiler. The cost of the boilers originally supplied (including all pipes, valves, and mountings) was at the rate of £1,255 each. The Council supply now an equivalent of 21,612 c.p. Tenders for an additional boiler are to be invited.

Mansfield.—At an enquiry last week into the application of the Town Council for sanction to borrow £15,000 for the purposes of the electricity undertaking, the town clerk explained that under the provisions of the Mansfield Corporation Act the Council had borrowed £50,000 for the purposes of the electrical undertaking, and they were now applying for an additional £15,000 in order to make up the total estimate of the undertaking, which was £65,000. The works were practically complete, and the current was being supplied, the formal opening taking place on June 17 last year. Mr. R. Hammond, consulting engineer, stated that during the first quarter after the works were opened the number of lamps connected was 5,512, at the end of the second quarter 7,282, at the end of the third quarter 7,854, at the end of the fourth quarter 9 154, and up to date 9,700, the number of customers having increased from 60 in September, 1903, to 112 up to date. Combined with the electrical undertaking were also works for the burning of refuse. He said the £50,000 estimate had been drawn up at an early stage of the undertaking, but after working out the details it was considered wise to make amplifications, especially with reference to the refuse destructor, which was capable of destroying about 50 per cent. more than was originally intended. During a recent test of the refuse destructor the electrical plant had been worked solely on the boilers of the refuse destructor, the steam being raised by the

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fumes from the burning refuse, and for 15 hours a set of generating plant had been driven entirely from the refuse, that generating plant supplying the town with electricity. It was originally intended that refuse destructor cells should be provided to deal with 33 tons, but at a recent test they got 52 tons, they having put down six cells instead of four. Four out of the six cells had dealt with 52 tons, so that practically they had a capacity of 98 tons of refuse, and practically 50 per cent. more than was originally intended.

Ormskirk.—The Urban District Council have approved the National Electric Construction Company's electric lighting scheme under which the Council will borrow the necessary money for the works, which will be constructed by the company. The latter will run the undertaking, and guarantee all repayments of loans and interest. All excess of profits over 3 per cent. go to the Council for the first 10 years, and afterwards for five years will be equally divided. Prices for current must not exceed 2¾d. per Board of Trade unit for public lighting, 5d. on the flat-rate system for private lighting; on the maximum demand system 7d. per Board of Trade unit for the equivalent of one hour's use per day per quarter, and 3d. per Board of Trade unit for all current consumed afterwards. Power on the maximum demand system 4d. per unit for the equivalent of one hour's use per day per quarter, and 1½d. for all current afterwards. The company will reimburse all expenditure in connection with provisional order, raising the loan, preparing the agreement, and fees of consulting engineers. The Council may after seven years, upon payment of 10 per cent. on the capital expenditure, take over the undertaking; after 10 years upon payment of 7½ per cent.; and after 15 or 20 years without any premium upon the Council paying all moneys to the company. The company will find the capital for a free wiring scheme under which consumers may have installations put in at a rental of 4½d. per lamp (up to 32 c.p.) per quarter. All losses will be made good by the company, who, in addition to the security afforded by their share capital, are prepared to allow the Council to retain 10 per cent. of the total contract price, reduced to 6¼ per cent. at the end of the second year, to be extended for five years. On the works paying, the retention will be refunded, with the exception of £250 to be held by the Council for five years. If the estimates of the cost of carrying out the works exceed £15,000, the Council have the right to reconsider their position, and to terminate the contract. The agreement contains the proviso that it is subject to the Local Government Board sanctioning the loan, and becomes null and void if such sanction be not obtained.

Dumbarton.—The following letter from Messrs. Crompton, of the Electric Supply Corporation, Limited, has been remitted to the Bills and Electric Committee, with powers: "With reference to the agreement between this company and your Council for the establishment of electric lighting in Dumbarton, my directors, at their meeting on the 25th ult., ordered the work for the establishment of the electric lighting undertaking to be proceeded with forthwith. Meanwhile, however, the directors have been approached by the promoters of a Scotch water-power scheme, having for its object the generating of electricity from falls at Loch Sloy, and delivering electrical energy in various places. The promoters of that scheme have asked that this company do make an agreement with them to take current at high pressure at the Dumbarton boundary, the company transforming the current into a lower pressure for the purpose of distributing the same to the consumers in the burgh. My directors are favourably considering this scheme, and if they can obtain proper financial guarantee, they will be disposed to go further into the matter, but inasmuch as to do so would involve a serious departure from the agreement with your Council of April 22, 1903, whereby this company is bound to establish a generating station for generating and distributing electrical energy, and that such station shall be established within the burgh of Dumbarton, I am to ask the views of your Council on the proposal. You will understand that by the agreement with your Council they are empowered at certain intervals to acquire the electric lighting undertaking from this company on the terms set out in the agreement, but if the proposals of the Scotch water-power promoters be adopted there will be no generating station within the burgh of Dumbarton—there will simply be a receiving, transforming, and distributing station, which will entail a very much smaller amount of capital expenditure. In this case your Council would be prevented from ever acquiring a generating station from the company, but they would be entitled to acquire the undertaking with its transforming station and mains, which would involve to your Council a very much smaller outlay of capital. The matter is thus one of much difficulty, requiring full consideration before anything definite is done. Another point which would have to be considered is that the water-power promoters are not in a position yet to deliver current, and to arrange terms with them would be to involve a greater delay than if the company carries out the original scheme. It would, therefore, follow if your Council approve of the suggestion, and providing the company are satisfied with the guarantees offered by the promoters of the water-power scheme, we would have to ask your Council for an extension of time, say six or nine months, for the completion of the works. I shall be glad at your early convenience if you will favour me with the views of your Council on this important matter."

PROVISIONAL PATENTS, 1904.

AUGUST 8.

17243. Improvements in and relating to fenders for electric cars and other vehicles. Frederick Reuben Keith, Old South-buildings, Boston, Massachusetts, U.S.A. (Complete specification.)

17248. Improvements in accumulators. John Byrom, 57, Renshaw-street, Liverpool.

17268. Improvements in or relating to electrical indicating apparatus for a range finder or the like. Thomas Kirkland and David Ling Capper, 111, Hatton-garden, London.

17285. High-tension current insulator. Franz Gustav Kleinsteuber, 52, Chancery-lane, London. (Complete specification.)

AUGUST 9.

17339. An improved electric switch. William George Heys, 51, Deansgate-arcade, Manchester. (The Meyrowitz Manufacturing Company, United States.) (Complete specification.)

17359. Improvements in apparatus for cleaning telephone and like switchboards. Frederick Louis Bronaugh and the British Compressed-Air Cleaning Company, Limited, 55, Chancery-lane, London.

17364. Improvements in means for preventing the breaking of an electric circuit. Edward George Paul Bousfield and the Ozonised Oxygen Company, Limited, 4, South-street, Finsbury, London. (Complete specification.)

17374. Improvements in wave telegraphy. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17375. An improved terminal for electric cables. John Livingstone Sardy, 19, Holborn-viaduct, London.

17377. Wave indicator for wireless electric telegraphy. Gustav Engisch and the "Deutsche Erfinder-Genossenschaft," 26, Luisenstrasse, Berlin, Germany. (Complete specification.)

17378. Improvements in induction apparatus. Gustav Engisch and the "Deutsche Erfinder-Genossenschaft," 26, Luisenstrasse, Berlin, Germany.) (Complete specification.)

AUGUST 10.

4556B. Improvements in and relating to condensible elastic fluid generators and superheaters. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, Feb. 24, 1904.)

17393. Improvements in lifeguards for electric tramcars and motor-driven vehicles. Fred Butterworth, 4, Corporation-street, Manchester.

17399. Mechanical contrivance to control the tramline point and overhead trolley wire point. Francis Stephen Hollister, Sunnyside, Seldown, Poole, Dorset.

17423. Improvements in self-regulating dynamos. Heinrich Rosenberg and Emanuel Rosenberg. 111, Hatton-garden, London.

17430. Improvements in the electrolytic refining of copper. The Metals Corporation, Limited, and Sherard Cowper-Coles, 70, Chancery-lane, London.

17434. Improvements in and connected with electric lamps for medical purposes. Alfred Lloyd, 6, Lord-street, Liverpool.

17442. Improvements in electric controllers. William Harding Scott, 47, Lincoln's-inn-fields, London.

AUGUST 11.

17469. Improvements in electric alternate-current motors. Silvanus Phillips Thompson, Morland, Chislett-road, West Hampstead, London.

17478. Improvements relating to electric light fittings. James Marsden, 18, Southampton-buildings, Chancery-lane, London.

17483. A receiving system for wireless communications. Walton Harrison, 1, Broad-street-buildings, Liverpool-street, London. (Date applied for under Patents Act, 1901, Aug. 27, 1903, being date of application in United States.) (Complete specification.)

17484. A receiving system for wireless communications. Walton Harrison, 1, Broad-street-buildings, Liverpool-street, London. (Date applied for under Patents Act, 1901, Feb. 8, 1904, being date of application in United States.) (Complete specification.)

17493. An improved transmitter for electric telegraphs. Mejer Gerschkow Potiewski, 70, Chancery-lane, London. (Complete specification.)

17501. Improvements in "cow catchers" for electric and other cars. Walter Thomas Eastwood, 37, Chancery-lane, London.

17523. Improvements in liquid starting resistances for continuous-current motors. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

17527. Improvements in commutators for dynamo-electric machines. Siemens Bros. and Co., Limited, and Hereford Berry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17532. Improvements in electric filters. Frank Benjmine Hinkson and Samuel Henry Hey, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21939A. Improvements in and relating to signalling through submarine and like cables. Sir Oliver Joseph Lodge and Alexander Muirhead, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, Oct. 12, 1903.)

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17534. An improved construction of mechanical ear for trolley wires or the like. Thomas Ernest Raymond Phillips, 1, Broad-street-buildings, London.

AUGUST 12.

17553. Improvements relating to electric dynamos, motors, and the like. Edwin Ernest Kelsey, Cardium, Lingfield, Surrey.

17562. Improvements in printing telegraphs. James Dundas White, 50, Clanricade-gardens, London.

17595. Improvements in bends, elbows, and other angle pieces for electric conduits. Conduits and Fittings, Limited, David Musgrave Edwards, and Ernest Argyle Brown, 4, South-street, Finsbury, London. (Complete specification.)

17601. Improvements in rotors of alternating-current machines. Arnaldo Paolo Zani and Dick, Kerr, and Co., Limited, 18, Southampton-buildings, Chancery-lane, London.

17605. Improvements in insulating electric cables on the conduit system. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

17611. Improvements in electric imitation candles. Messrs. Drake and Gorham, Limited, Bernard Mervyn Drake, and John Marshall Gorham, 66, Victoria-street, Westminster, London.

AUGUST 13.

17620. Improvements in or in connection with trolley poles (used on electric tramcars) for changing from one wire to another. John Bennett and Harry Grundy Crompton, Back-lane, Penwortham, near Preston, Lancs.

17621. Improvements in electric arc lamps. Veritys, Limited, and Frederic Stanhope Worsley, 11, Burlington-chambers, New-street, Birmingham.

17627. Improvements in regulation or graduation of the electric light of an incandescent lamp. Pedro Cardoso de Azenedo, 7, Tenison-street, York-road, Waterloo, London.

17632. Improvements in and connected with means for operating the points of electric tramways and the like, and also the overhead points or trolley switches, and in devices for actuating such operating means. Nehemiah Norris, 5, John Dalton-street, Manchester.

17639. Improvements in connection with electrolytic cells. William Thomson, the Royal Institution Laboratory, Manchester.

17650. An improved electrolytic rectifier. Max Büttner, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 13, 1903, being date of application in Germany.) (Complete specification.)

17662. Wedge chock for securing a door in a partly open position and turning on electric light and bell. Julius August Schneppe, 77, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 1, 1904.

1903.

10468. Sound reproducers or intensifiers applicable to phonographs, gramophones, telephones, and the like. Parsons.

17632. Manufacture of trolley poles and means for connecting them to trolley standards in trolleys used for electric tramcars or vehicles propelled by electric traction. Munro, Brecknell, and Rogers.

17633. Electricity meters. Harrison.

17643. Arrangement of steel magnetic armatures for electromagnetic pairs. Oerebotani and Silbermann.

18536. Means and apparatus for controlling electric motors. Imray. (Bullock Electric Manufacturing Company.)

20027. Electrical switches. Smith.

21669. Electro-deposition of metals upon aluminium. Creswick and Shaw.

21650. Connections or terminals for electric battery plates and other articles or structures composed of lead or lead alloys. Jackson.

25114. Coin-freed electric meters. Allan.

1904.

1414. Telephone relay. Gati.

2279. Trolley heads or collectors for electricity. Hadfield.

3211. Electric railway signalling systems. Bradley and Bowen.

7825. Twin sockets for electric incandescent lamps. Fairweather. (Benjamin Electric Manufacturing Company.)

8992. Telephone systems. Gleeson and Hamilton. (Date applied for under International Convention, May 1, 1903.)

9815. Method of charging storage batteries without the aid of auxiliary or special apparatus. Kraft.

10391. Electrical time switches for controlling railway barriers and the like. Neugebauer.

10837. Fuse-heads for electric blasting. Render.

10896. Electric motors. Johnson. (Elektrizitäts-Akt.-Ges. vorm. W. Lahmeyer und Co.)

13379. Mercury electric current interrupters. Schwedler.

13865. Means for transforming the energy of alternating currents. Weintraub. (Date applied for under International Convention, June 18, 1903.)

14521. Track sanders, brakes, and controller handles for electric tramcars and the like. Lintern.

14543. Thermo-electric couples. Bristol.

14544. Thermo-electric couples. Bristol.

14767. Nipple for use in connection with electrical conduit tubes and fittings. Hirst and Gunner.

15360. Electrolytic circuit breaker. Kölling.

15391. Surface-contact electric railway systems. Brown.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅜-½ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5⅜-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	101-103
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	–	2⅜-3¼
—— 4 per cent. Mortgage Debenture Stock	100	–	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	–	¾-1
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	96-99
—— 4½ per cent. 2nd Debenture Stock	100	–	71-76
Callender's Cable Debentures	100	–	101-105
—— Ordinary	5	–	9¼-10½
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	3	–	1¼-2
—— 5 per cent. Debentures	100	–	94-97
Edison and Swan United, "A" Shares, 1-89,261	3	–	¾-1
—— "A" Shares, 01-017,139	5	–	1-1⅜
—— 5 per cent. Debentures	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	11-12
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-19¼
—— 4 per cent. Debentures	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	35-38
—— 5 per cent. Bonds	100	–	99-102
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	–	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	–	102-106
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	–	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary	5	–	10⅜-11¼ xd
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	–	7-7¼
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	106-109
Charing Cross and Strand, Nos. 1-70,000	5	–	7⅛-8
—— 4½ per cent. Cum. Pref.	5	–	5⅛-5⅜ xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	106-109
City of London, Ordinary	10	–	10¼-10⅜
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	102-105
County of London Electric Supply, Ordinary	10	–	7⅛-8⅛ xd
—— 6 per cent. Cum. Pref.	10	–	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	101-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	6 6¼
—— 6 per cent. Cum. Pref.	5	–	5⅜-6
—— 4½ per cent. First Mort. Deb.	100	–	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	99-102
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
—— per cent. Debenture Stock Red	100	–	102-105
Kensington and Knightsbridge and Notting Hill	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	3	–	1¼-1¾
—— 6 per cent. Pref.	5	–	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	96-99
Metropolitan Ordinary	10	–	15¼-16¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	–	109-113
—— 5½ per cent. Mortgage Debenture, Red.	100	–	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	100-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310	5	–	5¾-6¼
—— 4 per cent. Debenture Stock	100	–	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2¾-3¼
—— 4 per cent. Debenture Stock	100	–	83-88
South London, Ordinary		–	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	14-15
—— 7 per cent. Pref.	5	–	8-9
—— 5½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¾-5¼
Westminster, Ordinary	5	–	12¼-12¾
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	5-5¼

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Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100 –	87-89 xd
—— 4 per cent. Pref.	100 –	100-102 xd
—— ,, ,, deferred	100 –	80-82
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 –	106-109
City and South London, Consolidated Ordinary	100 –	41-43 xd
—— 4 per cent. Debenture Stock	100 –	105-108
—— 5 per cent. Pref. Stock '91	100 –	121-123 xd
—— ,, ,, ,, '96	100 –	118-121 xd
—— ,, ,, ,, '01	100 –	117-120 xd
Liverpool Overhead, 5 per cent. Pref.	10 –	10-10¼
—— Ordinary, 1-50,000	10 –	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— –	99-101
Waterloo and City, Ordinary	100 –	87-90 xd
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 –	5¼-5½
—— Permanent 6 per cent. Debenture Stock, 1888	100 –	137-141
Blackpool and Fleetwood Tramroad	10 –	13¾-13⅞
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 –	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 –	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 –	86-101
British Columbia Electric Railway Co., Ord. Def.	100 –	99-102
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 ..	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 –	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 –	97-100
British Electric Traction Ord. 1-500,000 & 60,001-80,000	10 –	8¾ 9¼
—— 6 per cent. Cm. Pf., 50,001-60,000	10 –	10½-11 xd
—— 5 per cent. Perpetual Debenture Stock	100 –	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	2¼-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 –	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 –	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 –	105-108
—— Prov. Cert., all paid	100 –	101-104
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅞-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10 –	9¼-10
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18-19
—— 6 per cent. Cum. Pref.	all –	14-14½
—— 4½ per cent. Deb Stock	100 –	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 50,001-60,000	5 –	3¼-4
—— 4 per cent. Debenture Stock	100 –	88-91
Kidderminster and District Lighting and Traction, Pref.	5 –	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10¼-10⅝
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	103-105
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,01	1 –	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 –	1-1
New General Traction, Ordinary	5 –	⅛
—— 6 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 –	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12¼
—— 6 per cent. Cum. Pref.	10 –	9¾-9⅞
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 –	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	8¼-8¾ xd
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,132 6 per cent. Preference	1 –	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. –	100 p.c.
Telephones.—		
National Telephone, Preferred	100 –	104-106
—— Deferred Stock	100 –	86-89
—— 5 per cent. Cum. First Pref.	10 –	12-14
—— 6 per cent. Cum. Second Pref.	10 –	11-13
—— 5 per cent. Non-Cum. Third Pref.	5 –	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 –	97-99
—— 4 per cent. Deb. Stock, Red.	100 –	103-105
Oriental Telephone and Electric Company	1 –	5/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 6	1,664	1,378	+ 285	+14,755h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Aug. 13	38	—	[illegible]	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 14	1,057	1,057	—	+ 197	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 13	5,082	4,823	+ 259	+11,579	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 12	1,141	1,108	+ 33	+ 1,811	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 11	2,588	2,507	+ 81	+ 2,616	17½	17½	,, 31	211,168	6,169,121	784,443	1·62	10·8	—	—
Blackpool-Fleetwood Trams.	,, 13	1,910	2,071	– 161	– 202	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 14	1,385	1,809	+ 76	+ 277	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 3	1,713	1,664	+ 49	+ 1,302	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 1	4,800	4,011	+ 789	+13,997	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 11	1,369	1,234	+ 135	+ 1,767h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 12	5,212	4,977	+ 235	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 13	1,235	924	+ 311	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 14	418	443	– 25	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 6	2,813	2,596	+ 216	+ 1,162	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 13	219	227	– 8	+ 301	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 13	5,386	5,538	– 152	— h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City & South London Railway	,, 14	2,214	2,332	– 118	— h	6⅝	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 11	571	646	– 75	– 1,805	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 12	243	254	– 11	– 108	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 13	317	299	+ 18	– 235	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 12	141	191	– 50	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 12	4,172	4,072	+ 100	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 12	1,205	1,189	+ 16											
Dundee City Tramways	,, 3	876	872	+ 4	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 13	790	715	+ 75	+ 1,359	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 13	14,218	12,795	+1,422	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 10	353	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 10	4,045	3,630	+ 416	+ 2 287	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 13	1,429	1,392	+ 37	—	34	34	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·32
Hull Corporation, E. S.	,, 13	2,190	1 845	+ 345	+ 5,504	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	6,004	5·0
Ilford Corporation	July 9	528	552	– 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Aug. 11	151	194	– 43	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 10	240	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 13	5,834	5,728	+ 106	—	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,383	—
Leicester Corporation	,, 13	1,727	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 6	11,764	11,762	+ 2	+11,082	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 14	1,705	1,647	+ 58	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	July 2	13,329	11,475	+1,854	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Aug. 6	499	459	+ 40	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 13	13,594	11,715	+ 879	—	131½	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 13	135	104	+ 31	+ 918	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corpn.	,, 12	3,563	3,431	+ 132	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 13	545	485	+ 60	+ 2,016	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,026	+ 465	+ 3,051	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Aug. 11	490	583	– 93	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 15	4,021	3,817	+ 204	+ 6,239	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 13	476	—	—	—	7⅞	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 15	4,698	—	—	—	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	July 28	1,031	1,109	– 77	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Aug. 3	805	659	+ 146	+ 851	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 12	590	511	+ 79	+ 5 055	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 14	1,424	1,405	+ 19	+ 654	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,943	6·4
Wallasey U.D.C.	,, 13	927	827	+ 100	—	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,583	7·03
West Ham Corporation	,, 11	1,178	—	—	—	1⅜	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 10	704	599	+ 105	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Penetrating Rays of Radium.—Mr. F. Paschen deals with this subject in the *Annalen der Physik*, demonstrating that the γ-rays from radium are like the β-rays in that they carry negative electricity with them. The former, however, are absorbed to a much smaller extent, and so the velocity of the γ-radiation is probably greater than that of the β-radiation. The highest velocity hitherto deduced for the latter has been about one-eighteenth that of light, and it is, therefore, possible that the case of electricity moving with the velocity of light may be realised in the γ-rays.

Another Use for the Telephone.—Our American contemporary *Telephony* describes the first long-distance telephone marriage that took place in New York State. The young pair, accompanied by a friend, went to the Iroquois Hotel in Buffalo, while a rural pastor, at whose church the bride had worshipped for some years, attended, with his wife, at the village telephone exchange. All the five were placed in communication, each being supplied with a receiver. The clergyman, recognising the voices of the principals, had no hesitation in pronouncing them husband and wife, the friend at Buffalo and the clergyman's wife being the witnesses. Another ceremony of the sort was performed in Kansas State.

London Engineering Degrees.—Now that the University of London has founded a degree in engineering (with a choice of mechanical, electrical, and civil subjects) without any residence or attendance qualifications, it is possible for the engineer, pupil, or apprentice who has not graduated at college to do so, as external student, by working during his leisure time. It also affords the students of colleges which are not part of any other university, the opportunity of obtaining a degree. The University College of Nottingham has been remarkably successful at the degree examinations recently held. The list of successful external students contained six names—no fewer than five being from the Nottingham college, and four of these took honours. The engineering laboratory equipment at Nottingham University College, already very extensive, is being added to and brought up-to-date for the coming session.

Automatic Shunt Regulator.—We learn from the *Zeitschrift für Elektrotechnik* that Messrs. Brown, Boveri, and Co. have recently patented an arrangement for automatically regulating the voltage of a dynamo running at variable speed on to a battery. The dynamo is shunt excited, and the amount of resistance in the shunt is regulated by means of a small electric motor mechanically coupled to the switch arm. This auxiliary motor has two field windings in opposition—the armature in series with one winding is connected across the battery terminals, whilst the other winding is in series with the main dynamo and battery. With normal current on the dynamo the two motor windings just neutralise one another, and the motor armature remains at rest. If, however, the current changes, the motor becomes excited in one or the other direction, and either increases or reduces the resistance in the main dynamo field. In this way the charging current is kept constant independently of the dynamo speed.

Good Performance by a Storage Battery.—The *Electrical Review* of New York chronicles a remarkable run on the part of an electric car manufactured by the Rhode Island Electromobile Company, which did the journey from Providence to Boston and back, a distance of over 100 miles, on one charge. The trip from Providence to Rhode Island was covered in 3½ hours, giving an average rate of 15 miles an hour. Three consecutive hills, covering a distance of nearly 1½ miles, were traversed in 10½ minutes. The current rose to 65 amperes, and on the heaviest part of the incline to 76 amperes for about half a minute on each hill. The average demand for the hills was from 50 to 55 amperes, the average on the level being from 22 to 25 amperes. The battery stood at two volts per cell at the end of the trip, so that the current remaining would probably have sufficed for a further 15 or 20 miles. The battery, composed of 42 cells, weighs 1,219lb., and the battery and carriage together a trifle less than 2,000lb.

Wireless Telegraphy Act.—The Postmaster-General has issued an order with reference to the Wireless Telegraphy Act, 1904, which states: "It is provided by the Act that a person shall not establish any wireless telegraph station or instal or work any apparatus for wireless telegraphy in any place in the British Isles or on board any British ship in territorial waters abutting on the coast of the British Isles except under and in accordance with a license granted in that behalf by the Postmaster-General. Wireless telegraphy is defined by the Act to mean any system of communication by telegraph, as defined in the Telegraph Acts, 1868 to 1904, without the aid of any wire connecting the points from and at which the messages or other communications are sent or received. Companies or persons requiring a license for any wireless telegraph station should make application to the Postmaster-General on or before Oct. 1, 1904. Forms of application may be obtained from the secretary to the General Post Office."

New Publications.—"Electro-Chemistry," Part I. (London: Longmans and Co., 5s.), by R. A. Lehfeldt. This is one of the series of text-books on physical chemistry edited by Sir Wm. Ramsay. It treats of the general theory of electro-chemistry, giving the relations between quantity of electricity and quantity of chemical action, and between E.M.F. and intensity of chemical action, reserving for a future volume the important applications of the theory to primary and secondary cells, electrolysis, and the solution of chemical problems. The author discusses the subject very thoroughly, and provides students with a highly useful treatise. "The Centrifugal Pump, Turbines, and Water Motors" (London: Simpkin, Marshall, and Co.; Manchester: The Technical Publishing Company; London and Manchester: John Heywood; 4s. 6d.), by C. H. Innes, M.A. This, the fourth edition, has been supplemented by descriptions of centrifugal pumps for high lifts, fans capable of producing considerable pressures, and other matters, and is profusely illustrated.

Model Telephone Exchange.—It is claimed that the new exchange to be erected at Columbus, Ohio, for the Citizen's Telephone Company will be unique in several respects. The building is to be as impervious to fire, from surrounding premises as well as from the interior of the exchange itself, as it is possible for a structure to be. With this idea in view, all window framework is to be of metal, and all glass, except on the Third-street front, is to be wire glass. The fourth storey, which is to contain the new telephone equipment, will have no windows at all except on the Third-street front, but will be lighted by skylights, which are to be constructed of steel frames and lighted through heavy wire glass. The floors of the building will be constructed on the Columbian fireproof system, which calls for the use of concrete. The entire framework of the building will be of steel, which is to be thoroughly fireproofed at every point. The partitions of the building will be of hollow terra-cotta tile, and the entire building will be equipped with the most modern appliances in the way of plumbing, heating, and ventilating. Brick and terra-cotta will be used exclusively for the exterior. The telephone equipment to be installed in this exchange will

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be of the modern American type, by which operators are entirely dispensed with. It is expected that the exchange will be ready for use by December.

Nottingham Guild of Mechanical and Electrical Engineers.—A large party of this guild inspected the Digby Collieries at Kimberley last week. Arriving at the New London pit about 2 p.m., the visitors first inspected the machinery on the pit bank, which included the winding engines, Guival fan, dynamo-house, and conveyors, together with the screening apparatus. They then descended the pit, which has a depth of 220 yards, and after seeing the electrical pumps and stables, made their way to the coal face in No. 6 working. The journey from the pit bottom to the coal face and back was about 2½ miles, but the members were fully repaid for their trouble by the interesting features they witnessed. Upon returning to the bank the party were entertained to tea by the colliery officials, and afterwards a descent was made of the Digby pit, where the electrical coal-cutting machines were working. These, of course, were in great contrast to the more antiquated method seen in the New London pit. As this company has been using electrical coal-cutting machines with great success for a considerable time, the work was of much interest to the visitors. Upon again returning to the bank a vote of thanks was accorded to the colliery officials for the instructive and enjoyable time spent by the party.

Engineering Standards Committee.—We have received from the committee reports No. 7 and 8, which refer to "British Standard Tables of Copper Conductors and Thicknesses of Dielectric" and "British Standard Specifications for Tubular Tramway Poles" respectively. These documents are described as interim reports, but it should be understood that they are final as far as the tables and specification themselves are concerned, and are only of an interim character in so far that all reports are so regarded until such time as the final report, combining all specifications of the committee, is issued. The first of these reports states that the accepted standards of the Cablemakers' Association, the members of which rendered great assistance to the committee, were largely used as a basis for dielectrics. On the question of standards for conductors the report of the committee of 1900 and the work of Matthiessen were reviewed. The report in regard to tubular tramway poles recommends three classes of pole—light, medium, and heavy—the over-all length of each class to be 31ft., and the length of the telescope joint in the sectional poles to be 18in. The thickness of metal in any pole is not to be less than ¼in., and tests are prescribed for 5 per cent. of each class of pole a maker turns out. The committee express the hope that the standards laid down by them, which embody their own views and those of representative makers, "will be universally adopted by all engineers engaged in designing and installing electrical tramways throughout the British Empire."

The Destruction of Harmful Insects by Electricity.—In a recent number of the *Elektrotechnische Zeitschrift* particulars are given of some experiments carried out by the Russian Technical Society of Odessa on the destruction of insects, larvæ, and grubs on agricultural land by electrical means. A small dynamo was arranged on a wagon, drawn either by horses or by a petrol motor, and was driven by spur gearing from the wagon axle. Its terminals were connected through a Wehnelt interrupter to a sparking coil. The high-tension secondary of this coil had its negative terminal connected to earth through the wagon, and its positive terminal to a number of metal brushes fixed under the back part of the wagon and arranged to be vertically adjustable. A broad body of sparks was in this way made to pass from the brushes to earth, and killed any insects lying on the surface. It was observed that in the case of certain classes of insects—*e.g.*, beetles—the high-tension current acted on the nerve system first and disabled single limbs. In the case of grubs an electrolytic dispersion of the fluids seemed to take place simultaneously. Insects which were not killed instantly, but could still move one or more limbs after the passage of the wagon, died in a short time from the after effects. It is proposed to drive the wagon immediately behind the plough, as the turning up of the earth naturally exposes countless insects and larvæ. The practical value of the apparatus is hardly established yet, but the experiments are to be continued in the spring with a view to exterminating the turnip-fly found so plentifully all over Russia. The fight with these insects absorbed over 4,000,000 marks in the year 1901-2 in the Government of Kiev alone, and in South Russia an annual expenditure of from 10 to 20 marks per hectare is made for the same purpose. These figures show that the apparatus, which only costs about 5,000 marks, would soon pay for itself should it prove effective in practice.

The "Telagirl" System.—Our American contemporary, *Telephony*, describes a new business enterprise which has been inaugurated in Cleveland, Ohio, and which opens up an entirely new field for the development of the telephone industry as applied to everyday business affairs. The system is called the "Telagirl," and it consists of a plan by which business men may dictate their correspondence to a stenographer in a central office, the work being promptly executed and returned to the office of the subscriber. Private telephones are installed at the desk of each subscriber without expense, and enough stenographers are employed to take care of his work at any time he may call. The stenographer takes his dictation either by notes or on the typewriter as preferred, using his personal stationery, which is kept on files. The finished work is then enclosed, without folding, in a large envelope, sealed, and delivered by expeditious messenger service. The monthly statements rendered to clients of the company are of particular value, as they are itemised in every detail, thus forming a valuable reference index of correspondence to the business man. Complete privacy is secured, each stenographer having a small room of her own so that messages can be repeated back to the client without being overheard by others. In addition, a business man who has no one to leave in the office may have his telephone connected up with the "Telagirl" office when he steps out, inform the girls when he will be back, and leave instructions for anyone who may call him up. In that way all enquiries will be answered, and the new concern will take the place of an "office girl." Arrangements will also be made to take care of business at night, on Sunday, and at other odd times when employés of all offices are out. Graphophones will also be installed in the offices of those who desire them, and records of dictations will be called for by messenger. The charges will be moderate, and it is probable that the service will be broadened from time to time to take in other branches.

Live-Rail Dangers.—The Board of Trade has issued reports upon three fatalities resulting from contact with live rails. In one case, investigated by Major Druitt, a man named Patrick Flood was killed by contact with a live rail while trespassing on the Lancashire and Yorkshire Railway at Formby, where there are railings 4ft. to 5ft. high. The shock appears to have been accentuated in his case by the fact that his boots were almost worn out, so that he stepped on to the rail practically barefooted; and as it had been raining just previously all the conditions were conducive to a severe shock. Another trespasser who accompanied him survived the shock. There were

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warnings at all level crossings and at places where people might be liable to trespass, such as alongside golf courses. Major Druitt, in exonerating the company, states, "As far as experience goes at present, it does not appear necessary to provide boarding for the live rail for the whole length of the line in order to protect the men employed in working the traffic, repairing the line, etc., or the passengers." The other two cases were investigated by Lieut.-Colonel von Donop, who reports in the case of Joseph Innes, a porter who was killed at Manors Station on the North-Eastern Railway, that where the body was found the rail was not protected, and he suggests that a guarding should be provided to all live rails where they pass through a station, as is done on the North-Eastern main line. The company is now taking precautions which Colonel Donop considers satisfactory. In the third case a lad climbed a 5ft. wall near St. Peter's Station on the North-Eastern Railway, and his bare feet came in contact with a live rail. Colonel von Donop is not prepared, at the present time at all events, to recommend the Board of Trade to call upon railway companies to guard their live rails continuously, but as the spot where this accident occurred is one at which trespass appears to have been common for some time past, he considers that some steps should be taken by the company to prevent access being so easily gained to the lines at that and any similar places. He also recommends that the guarding of the live rails be continued throughout the whole length of St. Peter's Station. Mr. A. P. Trotter, electrical adviser to the Board of Trade, concurs with these three reports. It will thus be seen that the company emerges scathless in the first instance, and practically so in the third, both accidents being, in fact, due to trespass; but in the second case the report attaches a certain degree of responsibility to the company. On the question of guarding the whole length of live rail, both inspectors, contrary to the opinion recently expressed by Dr. J. A. Fleming, consider that such a step is not necessary, though it is not without significance that this view is qualified by the words "at present." Apropos of live-wire dangers, an international congress is to be held at Paris in June of next year, under the auspices of the Association des Industriels de France Contre les Accidents du Travail, for the purpose of investigating apparatus for ensuring the greater safety of workmen employed on high-tension conductors. The device will be expected to indicate safely and plainly whether a conductor is alive or not. It must be applicable to direct and alternating currents of all voltages, and incapable of doing damage to itself, the conductor, or distribution system. A prize of £250 will be awarded to the exhibitor whose apparatus best satisfies the conditions, the system remaining the property of the inventor.

Electrical Progress in Canada.—The returns lately compiled by Mr. George Johnson, Dominion statistician, illustrate the advance in electricity made by our great Transatlantic colony. At the end of last year there were 647 miles of electrical street railways, of which 455 miles were single track and 192 miles double track. The aggregate mileage at the end of 1900 was 555 miles, so that the last three years have witnessed an increase of some 16 to 17 per cent. The distance run last year totalled 39,721,153 miles, against 36,711,130 in 1902, and 34,547,975 in 1901, the passengers numbering 167,703,958, 145,609,993, and 132,885,258 respectively. The paid-up capital stood approximately at £6,000,000 last year, £5,200,000 in 1902, and £5,000,000 in 1901, the gross earnings for those years being £1,620,275, £1,430,397, and £1,309,097, against gross expenditure of £1,045,579, £863,435, and £770,684 respectively. An analysis of the electric lighting returns shows that at the end of June last year the Dominion had 14,780 arc lights and 1,212,861 incandescent lights in use, which shows an increase in the aggregate of over 21 per cent. in 12 months. Since 1898 there has been an increase of 42 per cent. in the number of arc lights and 161 per cent. in incandescent lights. The chief user of electric light is the Province of Ontario, which has considerably more than half the total of arc lights and 47 per cent. of the incandescent lights. Thirty-four municipalities in the province supply themselves with electric lighting. Quebec stands second, but it is a long way behind Ontario, though during the period referred to it has shown a greater proportionate increase. In point of actual percentage of increase, however, British Columbia is at the head of the list, its increase of arc lights by 377 representing an increase of 82 per cent., and the increase of incandescent lights by 74,297 signifying an increase of 257 per cent. There were 324 electric lighting plants in the Dominion at the date of the returns, of which Ontario has no less than 203, Quebec being credited with 53. Statistics are given in regard to the manufacture of electrical appliances and supplies in establishment having five hands and over. From these it appears that during the decade 1891-1901 the invested capital of £350,000 at the former date increased by 246 per cent., the number of employés by 346 per cent., the wages by 434 per cent., and the output, which in 1891 was represented by finished products to the value of some £165,000, increased by 278 per cent. In addition to this, the smaller works, for which no comparative tables are available, have also made great strides, as far as can be ascertained. It is noteworthy that in the Canadian census for 1881 there is no mention of electrical industries. In the matter of telegraphy, Canada has 36,780 miles of line and 96,728 miles of wire. The messages dispatched during 1903 numbered 5,313,800, representing rather over a message per head of population. The decade 1893-1903 saw great telephonic progress. At the former date the Dominion had 44,000 miles of wire and 33,500 instruments, the messages sent during that year numbering 72,500,000. In 1903 the instruments had increased to 81,500 and the messages to 253,970,000, an increase of 144 per cent. in instruments and 250 per cent. in messages. On the population shown by the last census the Dominion has one instrument to every 65 persons. In electrical developments generally Ontario is the leading province, with Quebec a fairly promising second. The imports of electrical appliances and supplies during the last two years show heavy increases. The Dominion statistician concludes his report with a highly optimistic prediction for the development of electricity in all its Protean forms.

London's Telephone Service.—Some interesting information on the Post Office telephone arrangements in London is contained in the report of the Postmaster-General, issued last week. It states that two telephone circuits have been provided between London and Brussels, and are working in a satisfactory manner. The service between England and France, which is only limited by the electrical conditions, will be extended as they are improved. Experiments have been conducted during the year with a view to the establishment of telephonic communication between London and Holland. The results were such as to show that it is not at present practicable to construct at reasonable cost a cable which would enable direct telephonic communication to be established and maintained satisfactorily. The number of telephones in connection with the Post Office London telephone system increased during the year from 9,122 to 15,632; and additional subscribers are being connected at the rate of from 100 to 200 a

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week. Three new exchanges have been opened during the year. The accommodation at the central exchange will be nearly exhausted in the course of the financial year 1904-5; and the construction of a second exchange with a maximum capacity of 18,000 lines is in progress. The working of the trunk system has been materially improved by the modifications introduced in the new switchboard. The length of the underground pipes laid in the London area on March 31 last was 1,146 miles, and cables containing 125,717 miles of wire have been provided, including 32,248 miles provided for the use of the National Telephone Company on rental terms. Owing to the great extent of the London exchange area, and the number of its local exchanges, the proportion of junction lines required is probably greater than in any other local exchange system in the world. The average cost of construction has increased since the last report from £18. 11s. 4d. per mile of double wire to £18. 16s. 10d. Including the cost of installation of telephone instruments and of exchange apparatus, the total cost of each subscriber's line has increased from £38 6s. 4d. to £41. 9s. 8d. This does not include the cost of the spare wires which are necessary for the maintenance of an exchange system in an efficient state. The account of receipts and expenditure shows a balance of £33,515 available for meeting the charge for interest on capital and for making provision for depreciation of plant. The capital expenditure to March 31 last was £1,514,300. It must, however, be remembered that a large part of the plant which has been constructed has not yet been brought into use, and is earning no revenue.

British Association.—The ceremony of conferring honorary degrees of the University of Cambridge upon some of the distinguished members of the British Association was performed on Monday afternoon with the customary formalities. The senate house was well filled with the friends of the candidates, and there was a good attendance of Doctors and Masters of Arts. Mr. Balfour, who was arrayed in scarlet, was received with loud applause. Sixteen members were admitted as Doctors in Science and one to the degree of Doctor in Letters. They were introduced by Dr. Sandys, the public orator, separately in a Latin address, enumerating, in concise and felicitous terms, the claims of each to recognition as an honorary graduate of the university. The following are brief references to some of the members selected for distinction, whom we have much pleasure in congratulating upon their well-merited recognition: Prof. Henri Becquerel, professor of physics in the Ecole Polytechnique, Paris, was welcomed as a distinguished member of the French Academy of Science, special reference being made to his remarkable discovery of the radioactivity of uranium. To recapitulate the achievements of Sir Wm. Ramsay and Sir Norman Lockyer would be to undertake a superfluous labour. Major P. A. MacMahon, late of the Royal Artillery, and formerly professor of physics at the Ordnance College, Woolwich, was one of the general secretaries of the British Association, and has published many works on mathematics. Prof. Arthur Schuster, professor of physics in the Victoria University of Manchester, worked at Cambridge with Clerk-Maxwell and Lord Rayleigh. Prof. Vito Volterra is one of the foremost mathematicians in Italy, and has composed works on the laws of light and theoretical dynamics. Sir David Gill will be remembered for his efforts in the cause of astronomy. The historic city of Heidelberg was doubly honoured in the persons of Profs. Bruehl and Albrecht Kossel, both distinguished in chemical science; and another representative from across the Channel was Prof. Paul von Groth, professor of mineralogy in the University of Munich, who has contributed more than any other Continental scientist to the general adoption of the crystallographic notation first proposed by Prof. Miller, of Cambridge. He founded, and has edited for 25 years, a journal on mineralogy and crystallography. We take this opportunity of stating that the association has accepted the invitation of the Corporation of York to hold its 1906 meeting in that city. It will be remembered that the first meeting of the committee was held in York. Again, the fiftieth anniversary of the founding of the association was marked by another meeting in York, and we gather that the mayor, in presenting the invitation to the committee, expressed the hope that the centenary also will be held in the Northern city.

Edison and the U.S. Patent Office.—The United States Assistant Commissioner of Patents has given his decision with respect to the charges brought by Mr. Thos. A. Edison against two officials of the Patent Office. The accusations had reference to the patent No. 738,110, granted on Sept. 1, 1903, to Mr. E. W. Jungner, and Mr. Edison alleged: "(1) That the examiners allowed the Jungner patent to issue when they knew, or should have known, that such issue was fraudulent; (2) that the examiners allowed the said patent to issue containing claims which they knew were unpatentable, and which, in fact, they had declared to be unpatentable, and which Jungner himself admitted were unpatentable; and (3) the examiners granted the said patent for an inoperative invention, which fact had been previously brought directly to their attention and acknowledged by them." The matter was referred by the Secretary of the Interior to the Commissioners of Patents, who held that the charges did not merit an enquiry. Mr. Edison appealed to President Roosevelt, who ordered a full investigation into the case. The case presented on behalf of the complainant was that Jungner based his claim on an application for a patent filed in the spring of 1899; that he tried two years afterwards by amendment to include certain chemical and mechanical features; that this was refused by the Patent Office on the ground that the amendments embodied new matter; and that in June, 1902, Jungner filed an application for a patent which was represented as being a division of his original application of 1899, but that this divisional application contained the same features of "new matter" as those which he had been unable to embody in his original patent by way of amendment. In his report on the case the assistant commissioner finds that "the disclosure in the patent is a different invention from that originally disclosed by him in his parent application, and, therefore, there is no basis in the original disclosure for the disclosure of his patent, and that, therefore, the examiners erred in allowing the patent as a division of the earlier application, as the patent is not, in fact, a division, for the reason that it not only contains new descriptive matter relating to its mechanical structure, but the invention disclosed is so changed as to be, in fact, a different invention from those originally disclosed in the earlier application; and that the patent, therefore, as to this new matter is effective only as to its new filing date." Judicial phraseology on the other side of the Atlantic appears to be not less involved than that associated with our own tribunals, but the practical effect of the finding is that the examiners erred in their judgment, though there was no evidence whatever to support the suggestion of *mala fides*.

Telephonic Progress in Japan.—The progress of the Japanese in regard to telephony is illustrated by the following report, recently issued by the United States Consul-General at Yokohama. Telephones were introduced into Japan in 1877, but those then in use were principally short-distance telephones, and they did not form

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an important factor in business even in the large cities. At that time the telephone business was left to private enterprise, but later it was undertaken by the Government in connection with the telegraph, and it has since been under the control of the department of communications. The Government assumed the business during the fiscal year of 1890-91, and at June 30, 1891, there were two telephone exchange offices and 16 telephone call offices open to the public; the length of the lines was 122 miles; length of wires, 808 miles; number of subscribers, 343; and the number of messages which had been sent was approximately 264,988. For some years the increase was slow, but gradually the service became better appreciated, and at June 30, 1902, the number of exchange offices was 25 and the number of call offices 179, making 204 public offices, which during the next year increased to 318. At the latter date the length of the lines was 2,340 miles, the length of wires 105,770 miles, and the number of messages sent during the year was about 111,597,714. The number of subscribers at the end of 1902 was 24,887. In Tokio the ratio of the subscribers to the population is as 1 to 139, but in some cities it is much greater, being as 1 to 48 in Otaru. The telephone has now become so popular that the Government is not able to instal the instruments and connect the wires rapidly enough to keep pace with the demand, and in consequence the number of unconnected subscribers at the end of 1895 was 4,000, and six years later this had increased to more than 22,000. In 1902 the value of telephones imported was 97,022·82dol., of which more than half came from the United States; France, Belgium, and Germany ranking next in the order named. There has also been a constantly increasing excess of receipts over disbursements, and the profits received by the Government from telephones in 1901 amounted to 315,945dol. When the Government first took charge of the work naked overhead copper wires were used, but several changes have since been made to suit varying conditions. Underground cables are used on trunk lines in Tokio, Kyota, Osaka, Yokohama, Kobe, and Nagoya. Both iron and earthenware conduits have been tried, McRoy conduits having been imported from America to some extent. There are also some lead-covered underground cables, containing from 200 to 400 centres. Where the overhead wires still exist, they may be naked, as in most suburban lines; coated with zinc, as in districts where heavy snowstorms occur; or protected by rubber in places traversed by many electric wires. In some instances the same wires are utilised for both telegraph and telephone service. The circuits are on the duplex telephone system. Several types of instruments have been imported, and at present subscribers are furnished with either the solid-back or the Derville. The solid-back is usually provided for public offices and automatic call offices. Leclanché and Fuller batteries have been adopted, and the No. 12 arrester made by the Western Electric Company has superseded the Hibberd fuse apparatus.

Electricity in New Zealand—The enterprise undertaken by the Waipori Falls Electric Power Company, Limited, is the subject of an article in the *New Zealand Mining, Engineering, and Building Journal*. The company is constructing a power station at the Waipori Falls, with a transmission to Dunedin of 29 miles. The Waipori Falls consist of the whole volume of the Waipori River, the minimum flow of which has been found to be 80 sluice heads of water (4,800 cubic feet per minute). By means of dams this flow could be increased 50 per cent. The weir diverting the river into the flume is 75ft. long at Cust, 14ft. in height, and constructed on the rock-filled crib principle. The intake is in the form of a tunnel 25ft long, through a projecting spur of rock, the latter also giving an excellent key for the weir. The tunnel is 8ft. wide at invert, and the flume is 6ft. wide in the clear, built into the outlet end. The whole length of the aqueduct will consist of fluming, except when it passes through the tunnels. The flume rests upon a bench 10ft. wide, and 70 per cent. of the benching is in solid rock. When the flume passes gullies it is carried over on masonry piers. The flume has a uniform gradient of 8ft. per mile, and from experiments has been found to carry 117 sluice heads of water when running full, with a surface velocity of 7ft. per second. As only 80 heads are calculated on, a very safe free-board has been allowed. There is a space of 6in. between the top board and the transoms to enable an extra board to be put on when it becomes necessary to run 120 sluice heads in the flume. The total length of the aqueduct from intake to penstock is 1 mile 67 chains. The tunnels are six in number, ranging from 75ft. to 290ft. in length, and are through solid rock. The tunnels are somewhat larger than the flume in order to avoid lining. This timber is obtained from the company's own sawmill, which is driven by a Pelton water-wheel developing 25 h.p. The penstock is being constructed on solid rock foundations, and will be of concrete and masonry construction, 15ft. in depth. From the penstock two lines of pipes, 1,825ft. in length, will convey the water to the Pelton wheels. They will be equipped with all necessary air valves and air receivers, according to latest practice. At frequent intervals the pipes will be set on concrete saddles, and the whole will be covered, protecting them from sudden changes of temperature. The lower end of the pipe lines will be cemented into a rock tunnel through a spur which projects just above the power-house site. The hydrostatic head is 673ft., and as each pipe line will carry four sluice heads of water, the hydraulic head has been calculated as 665ft. Provision is being made for a third pipe line, to meet all increase of power demanded as the full volume of the company's resources are brought into requisition. Each pipe line will work two double-disc Pelton type wheels—that is, 20 sluice heads for each unit, passing through two deflecting nozzles, which will be regulated by Lombard type Q governors, electrically controlled from the switchboard. Each wheel will be mounted on opposite ends of the shaft of a 1,000-kw. generator, which will deliver at the power-house 1,333 h.p., and as 80 sluice heads will provide power for four units, the total power delivered in the power-house will be 4,000 kw., or 5,332 h p. The power-house will be erected on a natural river flat at the foot of the pipe lines, well above flood level, and on a rock foundation. The structure has been designed for erection in reinforced concrete, and will be fireproof. The machinery in the power-house will consist of Pelton wheels, generators, exciters, step-up transformers, switching and measuring instruments, and all necessary accessories. From the power-house the electrical energy will be transmitted to the sub-station near Dunedin. A probable feature of the transmission line will be the use of towers in place of the usual pole. A simple tower 60ft. in height has been erected in the Dunedin railway station yard, and is a model of lightness, strength, and durability. The sub-station will contain the necessary plant for step-down transformers, and necessary apparatus for the control and measurement of the current in connection with the important work of distribution, which will take place from this point. The efficiencies of the various machinery and apparatus have been guaranteed as follows: pipe line, 98·5 per cent.; Pelton wheels at full load, 80 per cent.; generators, 95 per cent.; step-up transformers, 97 per cent.; transmission line, 94 per cent.; step-down transformers, 98 per cent. From this it is calculated that some 4,100 e.h.p. will be available for distribution in Dunedin.

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ELECTRICITY FROM WATER POWER.*

BY A. A. CAMPBELL SWINTON.

It should be gratifying to our national pride to know that probably the very earliest example of the production of electricity by means of water power on a practical scale, and its transmission to a distance, was the installation put up for the purpose of lighting at Cragside, Northumberland, by the late Lord Armstrong in the year 1882. This plant, which was still in daily use in 1884, when the author saw it in operation, consisted of a Siemens continuous-current dynamo, which was driven by means of a belt off an 8-h p. water-turbine operating with a fall of 30ft., the electricity, which was delivered at 90 volts pressure, being carried by bare overhead wires attached to porcelain insulators on poles to the house, about a mile distant. It is an interesting fact that when the installation was first put to work it was designed to operate with only a single wire, connection being made to the hydraulic power pipes at the one end and to the ordinary household water-pipes at the other, the earth being expected to form a sufficient return in the manner employed in telegraphy. This plan, which was adopted on the advice of the late Sir William Siemens, was found to be quite ineffective, as, owing to the low voltage employed and the exceedingly rocky nature of the ground, no useful amount of electricity could be transmitted, until the earth return was done away with and a second metallic conductor substituted.

Though this 22-year-old English example of electricity developed by water power and transmitted to a distance was, as already mentioned, probably the first such installation in existence in the world, the great development of such installations has, up to recently, taken place almost exclusively abroad. No doubt, up and down this country a very considerable number of small electric plants operated by water power have been put up for private house lighting and such like purposes, and there are even towns—such as, for instance, Salisbury and Keswick—where water power has for long been employed to assist steam power for electrical production for public and private lighting, the water power being in these instances found of great value for the purpose more especially of maintaining the supply during the periods of minimum load. A few hundred horse-power will, however, probably cover the whole of the plants of this character at present running in Great Britain, which is an altogether insignificant amount compared with the much larger corresponding figures for the continents of Europe, America, and other countries.

To obtain accurate statistics as to the amount of water horse-power at present employed for electrical production throughout the whole world is a very difficult matter, as in many countries no figures are available, while in others such as are obtainable are not up-to-date.

The following table, giving an aggregate horse-power of nearly one and a half millions, comprises all the hydraulic electricity works of which the author has been able to obtain particulars. He has, however, no doubt that there must be many others in existence to which he has not been able to find any reference; while again, in the case of a number of the installations which have been included, the horse-power now employed is greater than that in use at the time that the statistics were made out.

WATER-POWER ELECTRICITY INSTALLATIONS.

	Horse-power.
United States of America	527,467
Canada	228 225
Mexico	18,470
Venezuela	1,200
Brazil	800
Japan	3,450
Switzerland	133,302
France	161,343
Germany	81,077
Austria	16,000
Sweden	71,000
Russia	10,000
Italy	210 000
India	7,050
South Africa	2 100
Great Britain	11,9.6
Total horse-power	1,483 330

* Paper read before the British Association at Cambridge.

It, therefore, seems reasonable to suppose that the total amount of water power actually used for electrical production throughout the world at the present time must exceed 2,000,000 h.p., which is about double the total steam power at present devoted in Great Britain and Ireland to the same purpose.

It is interesting to calculate what would be the amount of coal required to produce this large amount of horse-power were it generated by steam-engines in the ordinary way. In other words, what is the saving of coal that the adoption of this amount of hydraulic power entails. Many of the hydraulic plants, particularly those which are used for chemical processes, operate at full power continuously night and day, but others work for shorter hours. Assuming, however, that the whole 2,000,000 h p. is in use for 12 hours per diem—in other words, is employed on the average with what engineers call a 50 per cent. load factor—and assuming, as is reasonable, that were the energy produced by means of coal, at least 3lb. of this fuel would be required on the average per horse-power hour, we get 5·86 tons of coal per horse-power year, or 11,720,000 tons of coal saved annually on account of the two million water horse-power utilised. Though this may appear a large figure, it amounts to less than 2 per cent. on the total output of coal in the world, which, on the average of the last five years, was 632,000,000 tons per annum. Assuming, however, an average cost of coal of 10s. per ton, this 11,720,000 tons represents £5,860,000 yearly, an amount which it would take over £100,000,000 of capital earning 5 per cent. per annum to provide.

Apart from mere magnitude, many of the more recent examples of hydro-electric engineering abroad, especially in America, are interesting by reason of the enormous distances over which the electric energy is being economically transmitted, and the very high electric pressures that in numerous cases are being successfully employed.

The longest distance over which transmission has so far been commercially effected is probably the 232 miles of line belonging to the California Gas and Electric Corporation, which stretches from the de Sabla power-house, *viâ* Cordelia, to the town of Sausalito, which is situated on the opposite side of the Golden Gate Straits from the city of San Francisco. What this transmission means will be realised when it is stated that the distance covered is about equal to that which separates Cambridge from Newcastle-on-Tyne. The same Californian company also owns the Colegate and Oakland transmission line, which runs 142 miles from the Colegate power-house, where 14,000 h.p. is developed from a head of water of 702ft.

Another very long line is that which reaches from the electric power-house *viâ* Stockton and Mission San José to San Francisco, a distance of 147 miles, over which 10,000 h.p. is being delivered regularly. This line belongs to the Standard Electric Company, who have 217 miles of power line, with a capacity of 27,000 h.p. in operation. The voltages employed, as is to be expected having regard to the distances covered, are very high, ranging from 55,000 to 67,000 volts, 60,000 volts being apparently the standard figure for many recent installations, of which the following are some examples:

PLANTS RECENTLY INSTALLED BY THE STANLEY ELECTRIC MANUFACTURING COMPANY, PITTSFIELD, MASSACHUSETTS.

Name.	H.P. capacity.	Voltage.	Transmission distance. Miles.	Head of water.
Quanajuato Power and Electric Company, Mexico	8,000	60,000	101	300ft.
Washington Water Power Company, Spokane	12,000	60,000	110	68ft.
Kern River Power Company, Los Angeles, California	16,000	67,500	110	—
Pierce Company	26,000	55,000	40	—
Mexican Light and Power Company, Mexico	—	60,000	110	1,500ft.
Winnipeg General Power Company	10,000	60,000	60	40ft.
Canadian Niagara Power Company	—	60,000	93	—
Electric Development Company of Ontario	—	60,000	93	—

For these particulars the author is indebted to Mr. C. C. Chesney, chief engineer of the Stanley Electric Manufac-

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turing Company, who have recently installed these and numerous other similar plants.

Mention should also be made of the 50,000-h.p. and the 125,000-h.p. plants for the Canadian Niagara Power Company and the Electrical Power Company of Ontario, contracted for by the Canadian General Electric Company, both of which will employ pressures ranging up to 60,000 volts; while to pass to another quarter of the globe, the Cauvery Falls electric power scheme in India has now been at work for over two years, and transmits 5,000 h.p. to the Mysore gold mines, a distance of 92 miles, using a pressure of 35,000 volts.

Turning now to the British Isles, the only large-scale plant for the production of electricity by water power at present in operation in this country is the well-known installation of the British Aluminium Company at Foyers. This installation, which was originally designed by the late Mr. Birch and carried out by Mr. W. Vaux Graham, has been at work ever since the year 1896, and the whole of the power is employed for electrochemical purposes on the spot. A small percentage of the power is utilised for the production of calcium carbide, but the bulk is, and in the near future the whole of the power will be, used for making aluminium. At present the gross horse-power of the plant is 7,000 h.p., but plant for a further 2,000 h.p. is at the present moment being installed, and will be working in about a month's time.

The water is derived from the River Foyers, which has a catchment area of upwards of 100 square miles. Storage is effected by means of two lakes, which have been joined together by the raising of dams and embankments, the result being a continuous lake of about 5½ miles long by about half a mile in width. The storage thus obtained is sufficient to run the entire plant continuously day and night for about 50 days.

From the River Foyers the water is first passed through a tunnel 8½ft. in diameter, cut through the solid rock, to the penstock chamber, from which the water is delivered by separate cast-iron pipes to the turbines, which are installed on the shore of Loch Ness, and into which the water is finally discharged, the available head of water being 350ft.

The British Aluminium Company have obtained parliamentary powers for a further large water-power installation on Loch Leven. It is their intention to commence immediately the development of this scheme, which is capable of giving 17,000 gross horse-power. The reservoir is artificial, and will contain about 150 days' storage of the full power, the head of water at the turbines being 964ft. It is anticipated that the whole of this power will also be taken up in the manufacture of aluminium on the spot, no distant transmission being, at present, at any rate, contemplated.

Another interesting water-power scheme of considerable dimensions is at the present moment being developed in Wales by the North Wales Electric Power Company, who have obtained parliamentary powers for this purpose. Their first installation is at present being erected under the superintendence of Messrs. Harper Bros., the company's engineers, and derives its power from Lake Llydaw, on Snowdon. This lake, into which runs the water from Lake Glaslyn, is about 1⅛ miles in length and about a quarter to half a mile in width. Its area is 5½ million square feet, and it derives its water from a catchment area of about 1¾ square miles, including the summit of Snowdon. Being in the track of the Atlantic depressions, this area has one of the heaviest rainfalls in Europe, amounting on the average to 180in. per annum. In 1903 it reached the phenomenal figure of 250in. The prevailing winds are from the sea, and the atmospheric moisture is driven up the sloping side of the mountain, and on being condensed at the summit is discharged in the form of rain or snow on the eastern side over Lakes Glaslyn and Llydaw. The fall of the year gives the wettest months, and it happens that the quantity running from the lakes in spring is averaged up by the snow melting on the sheltered eastern side.

By means of a dam about 100ft. in length, the level of the lake is to be raised 20ft. The water will be drawn from the lake by means of a tunnel 600ft. in length at a point 30ft. below the present level, or 50ft. below the level when the dams are completed, with the result that there will be sufficient storage for meeting a 90 days' drought. The total fall utilised will be about 1,150ft., and the total horse-power available, on the basis of a nine hours' working day, is calculated at 8,200. The first installation consists of two steel pipe lines and four 1,000-kw. sets, each consisting of a double tangential waterwheel coupled to a three-phase alternator giving 11,000 volts at 40 periods per second.

The company will develop the full horse-power of Lake Llydaw before proceeding further, but they have also acquired a further water power at Llyn Eigiao, in the Conway Valley, where a fall of 800ft. is obtainable, and where it is calculated there will be nearly twice as much horse-power available as there is at Llyn Llydaw.

One of the first objects of the North Wales Electric Power Company, as soon as their installation is completed, will be to supply energy for the working of certain light railways which they control in the district. It is, however, in addition, intended to supply electric energy throughout a large area, comprising the whole of the counties of Carnarvon, Merioneth, and Anglesea, and also a portion of the county of Denbigh.

Three-phase currents are to be used, and the transmission lines will be of bare copper wires, ·324in. in diameter, carried on insulators triangularly placed on wooden poles. A large proportion of the transmission lines will be carried along the track of the above-mentioned light railways. Lines are to be laid to the principal slate quarry districts of Nantlle, Llanberis, Penrhyn, and Festiniog, where a considerable demand for power exists. The distances from the power station to these places range from six to twelve miles.

The latest water-power electric scheme in the United Kingdom is that of the Scotch Water-Power Syndicate, who have by agreement obtained from Lord Breadalbane and the trustees of the Colquhoun estate of Luss important water-power concessions. These agreements have been negotiated by Mr. E. Ristori, who, it may be mentioned, was one of the original founders of the Falls of Foyers installation, while the engineering and electrical details have been worked out by Mr. William Vaux Graham and the author.

The first power that it is proposed to develop is one connected with Loch Sloy, which is situated some five miles north of Tarbet, on the side of Ben Vorlich, between Loch Long and Loch Lomond. Loch Sloy, which is situated some 757ft. above Loch Lomond, which, in turn, is some 26ft. above the sea-level, is fed from a catchment area of about 3,801 acres, which includes one side of Ben Vorlich, which, with its 3,092ft., is one of the highest mountains in Scotland. The district has the very heavy rainfall of some 74in. per annum, of which it is calculated that 60in. will be collectable.

A dam will be constructed at the eastern end of the loch, which will raise the height of the latter by some 60ft. This will impound some 240 million cubic feet of water, capable, with a calculated net fall of 700ft. to Loch Lomond, of maintaining some 6,000 e.h.p on a 25 per cent. load factor for the maximum possible periods of drought, which are calculated at 100 days.

From the loch the water will be taken in the first instance along an open conduit 3,650 yards in length, which will follow the contour line round Ben Vorlich till a point is reached almost immediately above the position where the power-house will be constructed on the shore of Loch Lomond at a spot called Inveruglas. From the end of this conduit to the power-house the water will be coveyed in steel pipes, the length of the pipe line being about 600 yards and the height of fall 700ft.

From the power-house an overhead transmission line is to be constructed in duplicate for the purpose of conveying the electric energy to the industrial areas of the Vale of Leven and the Clyde, which comprise the towns of Dumbarton, Helensburgh, Renton, and Alexandria, and includes shipbuilding yards, engineering and dye works, calico printing works, and factories of various descriptions, many of whom have already intimated their desire to be supplied. The transmission line, for which private wayleaves have been obtained throughout, will be overhead on poles, starting from the generating station at Inveruglas, and continuing

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across country for a distance of 22 miles to a sub-station which will be situated at Renton, about mid-way between Dumbarton and the foot of Loch Lomond, in the centre of the Vale of Leven industrial area. At this sub-station the voltage will be reduced from the 40,000 volts which it is proposed to employ for the long overhead transmission to some 6,000 to 10,000 volts, it being the intention that the distribution from the sub-station to the various works shall be underground.

The following are the efficiencies which it is calculated will be obtained:

	Full-load efficiency. Per cent.
Open conduit Pipe line Turbines	75
Three-phase generators	94
Step-up transformers	97
High-tension transmission line	93
Step-down transformers	97
Underground distribution (say 6,000 volts average)	95
Total efficiency	58·6

This is on the assumption of the energy being delivered to customers at 6,000 volts. If, as is probable in most instances, it will be delivered at lower voltages, there will be a further transformation, the efficiency of which will be 95 per cent. in the case of transformation in pressure only, and 86 per cent. in the transformation of continuous current, making a total over-all efficiencies: 55·6 per cent. for three-phase current delivered, and 50·3 per cent. for continuous current delivered.

So soon as a market has been found for the total power procurable from Loch Sloy, it is intended to utilise a further water power—for which the rights have also been obtained—at Ardlui, about two miles further up Loch Lomond. This power is also fed by a small loch with an available fall of 800ft., the horse-power obtainable being about half that available at Loch Sloy. The Scotch Water-Power Syndicate have, in addition, obtained the rights to still further water powers on the Breadalbane estate that exist further north, and these will be utilised as soon as the demand for power justifies the capital expense. It is because of these additional powers, which will considerably extend the length of the transmission, that it is proposed from the start to employ so high a pressure as 40,000 volts.

It is estimated that the total cost of the Loch Sloy scheme, including the transmission line and the distribution to the various factories, will not exceed £200,000, which, on a basis of 5,000 h.p. delivered, works out at about £40 per horse-power, everything included. Seeing that many of the existing electric generating stations worked by steam have cost almost this amount for land, buildings, and generating plant, this does not appear to be an excessive figure, and it may be pointed out as an interesting fact that the 20 miles of overhead transmission line only accounts for some £24,000, or about 12 per cent. of the total expenditure. This, coupled with the fact that the calculated loss on the transmission line at full load will only amount to about 7 per cent., and the step-up and step-down losses to another 6 per cent., making 13 per cent. in all, will give some idea of the extent to which the length of the transmission line is but a comparatively unimportant factor in schemes of this description. It may be pointed out, further, that the above-mentioned line loss of 7 per cent. is upon the basis of only one of the two duplicate transmission lines being in use. When both are employed the line loss will be reduced to $3\frac{1}{2}$ per cent., and the total transmission loss at full load will be only a little over 10 per cent.

The main transmission will be on the three-phase system over two sets of three copper conductors, each about $\frac{3}{10}$in. in diameter, the possibility of conveying as much as 5,000 h p. over a distance as great as 22 miles with only $3\frac{1}{2}$ per cent. loss by means of such comparatively small wires being, of course, due to the high pressure employed. Indeed, using pressure as high as 40,000 volts, when it is a matter of transmitting comparatively small amounts of power, as, for instance, the 600 h.p. or thereabouts that under the present scheme it is expected will be required for the supply of the town of Helensburgh, the interesting point arises that the minimum size of conductor allowable is limited, not by electrical conditions, but by considerations of mechanical strength.

On the main transmission line the conductors will be carrried at a minimum height of 40ft. from the ground, while at all crossings over roads they will be enclosed in a wire cage to meet the Board of Trade requirements for ensuring public safety.

The application of water power in the United Kingdom can, of course, never attain the dimensions that it has already reached in America and elsewhere; still, the above brief account of what is at present being done in Scotland and in Wales shows that there are possibilities even in this old country of which till recently but few were aware.

As regards the economies of electrical generation by water power, no general rule can, of course, be enunciated, and every case must be dealt with on its merits, according to local circumstances. This, notwithstanding it is possible to give an indication of what is generally involved, having regard more especially to the fact that with water power, as a rule, interest on capital plays a much greater part in determining the cost than do labour or upkeep.

Avoiding, on the one hand, small powers where the costs are likely to be abnormally high, and on the other very large powers such as we do not possess in this country, it may be taken generally that interest on capital, depreciation, upkeep, and working expenses in this country will amount to about 12 per cent. on the capital expenditure.

On this basis it is easy to see that to be economically sound the capital involved must not exceed $8\frac{1}{2}$ times the annual price which can be got for the whole of the energy. For instance, if 5,000 h.p. is available for sale, and £6 can be got for each horse-power on the average per annum, the capital involved must not exceed £52 per horse-power, or £260,000 in all.

To conclude, it has been said that the greatest benefactor to the human race is he who makes two blades of grass to sprout where only one grew before. On this principle, the utilisation of natural water power is obviously to the public advantage. When mechanical or electrical energy is generated by the burning of coal, it is a matter of the consumption, not of interest, but of capital. On the other hand, every water horse-power that is put to use is something added, mundanely speaking, for all time, to the permanent resources of mankind.

Discussion.

Sir W. H. Preece said, in opening the discussion, that the use of water power was largely one of finance; for instance, Prof. George Forbes had worked at a scheme for using the water power of the Nile and transmitting it to Cairo. It was found on investigation that it would be cheaper to ship coal from Cardiff to Cairo and produce the electrical power from this coal.

Mr. C. Hawksley pointed out the difficulty in all water-power installations within the British Isles due to the intermittent nature of the water supply.

Mr. W. M. Mordey said that last year he had investigated several power schemes for Natal, but had found that in all cases the cost of supply from the water power available would be more than if coal was used. Switzerland was an exception as regards regularity of water power available, owing to the glacier storage. The water in summer was actually greater than in winter, as the lake level at Geneva was much higher in the summer, when the ice was melting. Even in Switzerland steam had to be used as a stand-by in certain cases, owing to the frost in winter reducing the water power available.

Mr. McClellan remarked that, although Buffalo was only 18 miles away from Niagara, a steam stand-by was used in Buffalo to get coal for the peak. He was interested in Mr. Campbell Swinton's proposed supply of power in Dumbarton from Loch Lomond. The price of coal in Dumbarton is only 5s. per ton, and hence the competition with the power consumer would be keen.

Mr. Campbell Swinton, in reply, quite agreed with the important financial considerations brought forward. He had gone carefully into the figures of the Loch Lomond supply. Their best consumer was at the present using gas, but he had no doubt that he could supply this consumer cheaper than he could produce power at present.

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ENERGY LOSSES IN MAGNETISING IRON.*

BY W. M. MORDEY AND A. G HANSARD

That this subject has a good claim to the consideration of the engineering section of the British Association, will be admitted when it is pointed out that not less than 25,000 tons, perhaps as much as 50,000 tons, of coal are burnt every year in this country to keep alternate-current transformers magnetised.† This waste must be multiplied by at least three or four, if it is to include the alternating magnetising losses in dynamos and motors.

The magnetising loss is partly due to hysteresis and partly to eddy currents. When testing iron for electrical purposes, many engineers are satisfied to measure the hysteresis only, and for this purpose Ewing's well-known tester is generally used. This ingenious instrument, introduced by Prof. Ewing to avoid the slow and laborious test by the ballistic method, directly compares the torque produced by revolving a small sample between the poles of a permanent magnet, with that produced by samples, the hysteresis loss in which has been tested by a ballistic galvanometer. This instrument gives a result for one magnetic density only, and must therefore be used for other densities by reference to results otherwise obtained. These methods aim only at measuring hysteresis, which, as a cause of loss, is not more important than eddy currents. The determination of hysteresis is of great interest to physicists, but for engineering purposes what we want to know is the sum of the two losses at various densities and periodicities; how this total is made up is usually of minor importance.

These considerations led one of the authors in 1890, when faced with the necessity of getting iron for transformers of definite quality, to adopt the plan, previously advocated by Mr. Swinburne, of measurement of the total loss by a wattmeter, if possible under the actual conditions of working. For workshop convenience a fixed point of comparison was chosen, at which all iron was tested. This was stated as follows: "The loss in iron sheets or stampings ·014in. thick made up in the form of a transformer and tested by a wattmeter should be 0·38 watt per pound at a magnetisation of 2,500 B and at 100 periods per second."‡ At that time the custom was to order "best soft Swedish charcoal iron carefully annealed," but such iron varied in its losses under the defined conditions from little more than ·3 watt per pound up to about ·6, causing serious engineering difficulties.

Although further lamination was recognised as desirable, it was found to be difficult to get sheets thinner than ·014in. (0·35mm.), so that was adopted for all purposes. The low magnetisation of 2,500 B was chosen as a point for comparison, because it was desired to keep down the no-load losses and the heating of 100-period transformers. For lower periodicities, higher densities may, of course, be used.

The only manufacturers to take up this specification energetically were Messrs. Sankey and Sons, of Bilston, with whom an arrangement was made by which the price paid them was increased or reduced as the iron showed less or more than the standard loss.

A few pounds of iron were tested in this way out of each delivery, and the corresponding bonus or penalty ascertained. The result was that within a year large variations of loss had ceased, and it soon became possible to design transformers with something like certainty as to what the magnetising losses would be. This improvement in quality and regularity which affected the whole industry is mentioned here, because it is not generally known how much is due to the efforts of these manufacturers.

We have continued to use the wattmeter method as the only one that tells us what we want to know, and we advocate its advantages over any other plan. It has only one drawback, that it is necessary, or, at least, desirable, to use a rather large quantity of iron for the tests.*

The Curve I. (Fig. 1) is an average from the results of a great number of wattmeter tests made before 1898 in carrying out this arrangement.

Better iron is now obtainable. Fig. 2 shows the total losses at 50 and 100 ⌒⌣ for good ·014in. iron that can be got regularly. It will be seen that it loses about one watt per pound at 5,000 B, 100 ⌒⌣, and ·32 watt at 2,500 B. At 50 ⌒⌣ it loses one watt per pound at about 8,500 B. It is not safe to rely on getting better iron than this for large quantities, although occasionally better results are got in small quantities.†

The separation of hysteresis and eddy losses by calculation is based on the assumption that hysteresis varies directly as the periodicity, and as $B^{1.6}$, the latter or

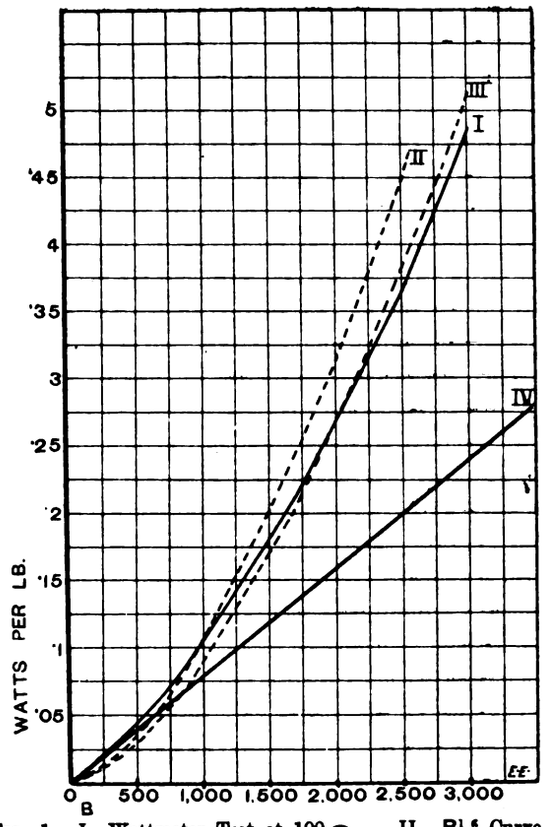

FIG. 1.—I., Wattmeter Test at 100 ⌒⌣. II., $B^{1.6}$ Curve through B 1,000. III, $B^{1.6}$ Curve through B 2,000.

Steinmetz ratio being the value which Mr. Steinmetz, working from Prof. Ewing's results and from observations

* Paper read before the British Association at Cambridge.

† Estimated as follows: Transformers in use, fully 300,000 kw.; average magnetising loss, 1·5 per cent. for 12 hours a day = 19,700,000 Board of Trade units a year, at 5lb. of coal per unit = 43,750 tons. Or to put it another way: at ·5 watt magnetising loss per pound of iron—a moderate estimate—each ton of transformer iron continuously used consumes 9,811 Board of Trade units a year, which at 5lb. a unit involves the consumption of 22 tons of coal.

‡ Watts per pound at 100 ⌒⌣ may be converted to ergs per cubic centimetre per cycle by multiplying by 1,700.

* These tests and those of the curves given in Figs. 2 and 4 have been made with a wattmeter designed some years ago by Prof. J. A. Fleming for the special purpose of such measurements. In this instrument, of the dynamometer type, every care has been taken to avoid the presence of any metal likely to cause eddies, and to avoid errors due to self-induction or capacity in the circuit of the pressure coil, which consists of few turns, and is used in conjunction with a non-inductive resistance and a separate variable-ratio transformer. In order to increase the range of the instrument, the current in the pressure coil is varied, and is read by a separate Siemens dynamometer. This not only largely increases the range of the instrument, but also enables the same reading to be taken under two or more instrumental conditions. The E.M.F. was read by a Kelvin multicellular electrostatic reflecting voltmeter. The alternator used had practically a sine curve.

† It is often convenient to use an empirical rule even if it has no relation to physical realities. This may excuse our pointing out that most curves of total magnetising loss in iron are very closely satisfied by a division into two portions, one directly proportional to B, the other proportional to B^2. The Curve I. in Fig. 1 may be so divided by the straight line, IV. It is only necessary to remember that this line cuts the total loss of ·48 watt per pound at 3,000 B into two equal parts to construct the whole curve. A similar division will be found to apply to the curves of Fig. 2, which go through a much longer range. The points of equality in the two portions being 2,500 B for the 50 ⌒⌣ and 4,000 B for the 100 ⌒⌣, in both cases the point corresponding to a loss of ·32 watt per pound.

In order to show the similarity of a $B^{1.6}$ curve and a $B+B^2$ curve, Fig. 3 has been drawn, in which the curve marked with round dots is a $B^{1.6}$ curve, and that with crosses is a $B+B^2$ curve drawn through two points on the other curve (having abcissæ 3 and 6). The straight line is the B component of the $B+B^2$ curve.

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of his own, found to express the relation between hysteresis and density. The eddy currents are always assumed to vary as the square of the magnetisation, the square of the periodicity, the square of the thickness, and inversely as the resistance of the iron. As the eddies in ordinary thicknesses of plates are by no means negligible, it becomes a matter of some difficulty to reconcile these assumptions with the facts, especially when the total loss curve is found to be a $B^{1.6}$ curve, as often happens.

For example, the Curve I. in Fig. 1 within its very limited range seems to show that the total loss increases with the density in a less ratio than $B^{1.6}$. The dotted curves, II. and III., represent $B^{1.6}$ values drawn through

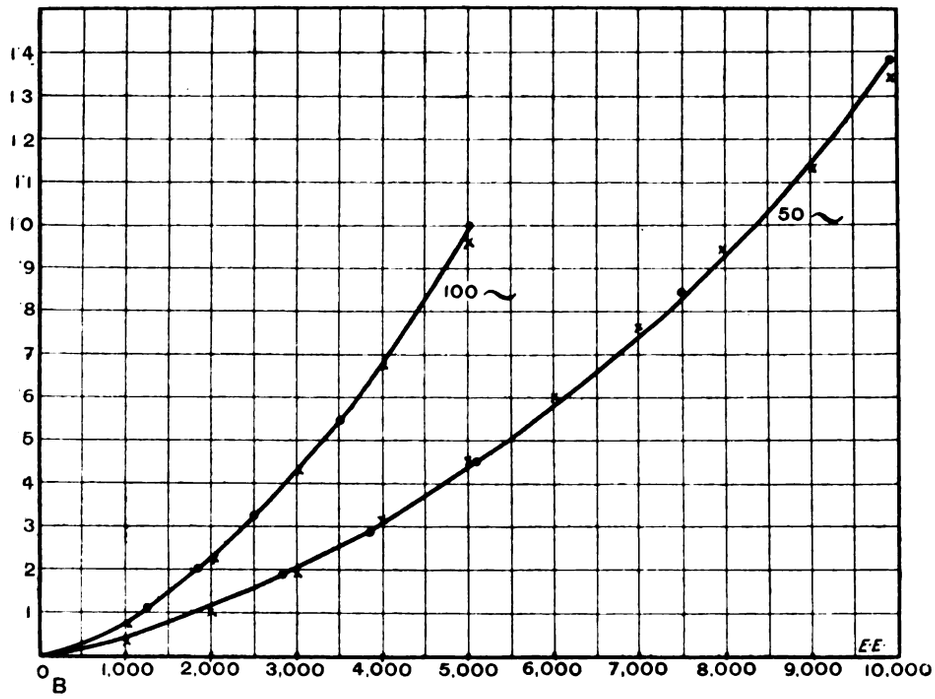

FIG. 2.—Magnetising Loss in Watts per Pound in Iron 0·014in. thick at 50 ~ and 100 ~.
• • Wattmeter tests. x x $B^{1.6}$ values.

1,000 B and 2,000 B respectively. Curve I. is inconsistent with the above assumptions, for if eddies varying as B^2 have to be added, the total losses should rise more steeply than the $B^{1.6}$ curve, instead of less steeply, as shown.

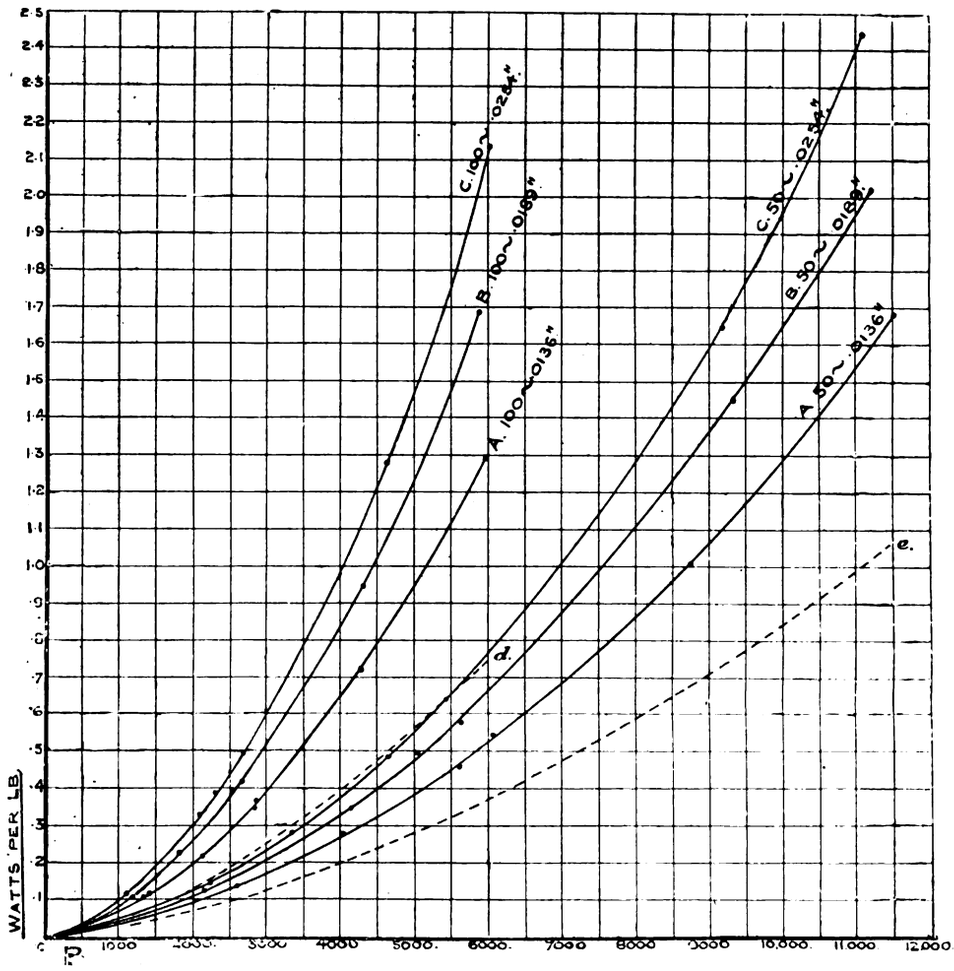

FIG. 4.—Magnetising Loss in Iron of different thicknesses at 50 ~ and 100 ~ ; *d* hysteresis at 100 ~ ; *e* hysteresis at 50 ~.

The curves of Fig. 2 afford another illustration of this difficulty. The round points on these two curves are the wattmeter readings. The points thus x are $B^{1.6}$ values

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calculated from 4,000 B. It will be seen that these $B^{1.6}$ values correspond almost exactly with the total loss curves, and therefore no room is left for eddies on the ordinary assumptions for hysteresis and eddies. That eddies are present in a considerable amount is shown by reference to numerous ballistic tests of hysteresis of similar iron which are always much lower than the total losses of these curves. Further, the 50 and 100 ⌒ curves are not in the ratio of 1 to 2, as they would be if there were no eddies, and if hysteresis were proportional to the periodicity. In such cases as this, if we admit that the hysteresis is proportional to $B^{1.6}$, the eddies also must follow nearly the same law.

The authors find that the curves given in Kapp's "Transformers" (1896, p. 23), which are carried up to between 6,500 and 7,000 B, have the same characteristics with regard to $B^{1.6}$ curves as the authors' (Curve I., Fig. 1). Whilst we are all prepared for considerable differences in the amount of the losses in iron, even of the same thickness and make, it is disturbing to find such difference not only in the amount, but in the character of the curves; and it shows how necessary it is, with such a material as iron, to base conclusions only on a large number of different observations.

In order to examine the effect of increase of thickness of iron sheets, the authors have tested some transformer stampings made from sheets of three different thicknesses of the same quality of iron kindly supplied by Messrs. Sankey and Sons. The thickness of the three samples, A, B, and C, calculated from the weight, is given below. Gauging with a micrometer showed a variation of about ·001in. in the actual thickness of the plates. Samples of these plates were tested on a Ewing hysteresis tester by a very experienced experimenter, who obtained the results ·39, ·38, and ·40. Another experienced experimenter, on a different Ewing instrument, made the loss ·44 in each of the

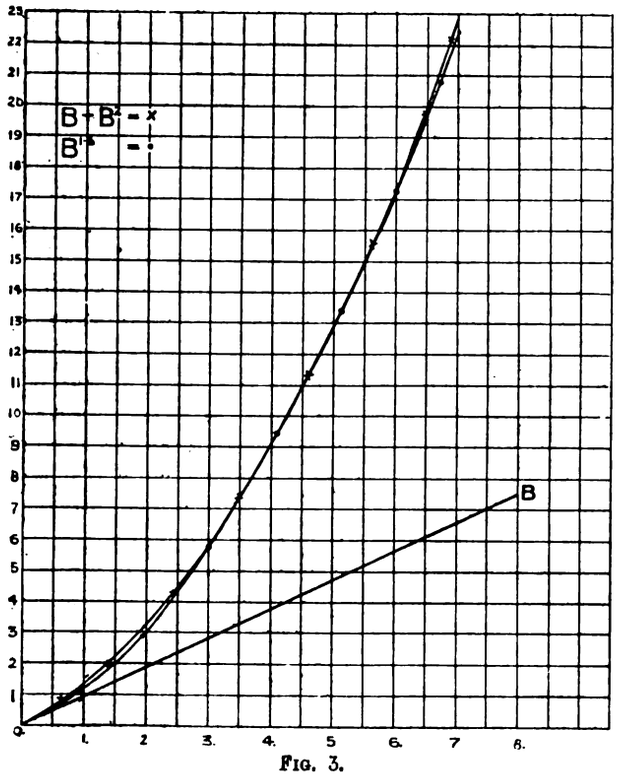

FIG. 3.

three samples. We have adopted the former figures for purposes of comparison.

	Thickness. Inch.	Mm.	Watts per lb. at 100 ⌒ 4,000 B.
A	·0136	·34	·39
B	·0189	·47	·38
C	·0254	·61	·40

The stampings were made up in transformer form, about 11·7lb. being used in each case, and wattmeter tests of the total loss were made at 50 and 100 ⌒, at six values of B in each case. After deducting the losses in the winding, the iron losses were found to be as shown in the six curves of Fig. 4, which, unlike those of Figs. 1 and 2, are all steeper than $B^{1.6}$ curves, and therefore do not present the same difficulty.

The following table, based on these curves, gives results for eddies and hysteresis at various densities. The hysteresis is based on the values ·39, ·38, and ·40 at 4,000 B, 100 ⌒ by the Ewing tester, the other values of hysteresis being calculated as proportional to $B^{1.6}$ and directly proportional to periodicity.* This procedure seems justified by the form

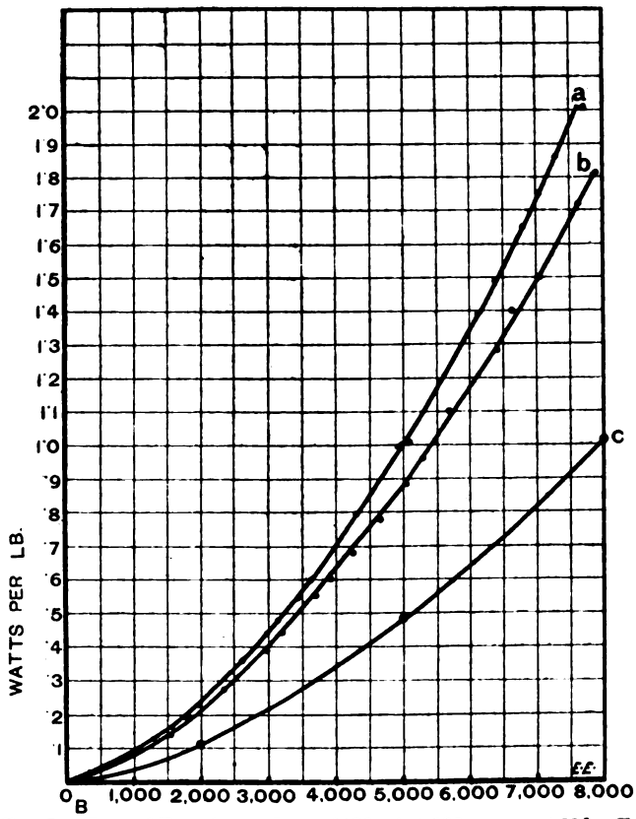

FIG. 5.—Tests of Transformer Iron (·0124in.) at 100⌒; *a* at 40deg. F. and *b* at 167deg. F. by wattmeter, *c* by ballistic galvanometer at about 70deg. F.

of these six curves. The total losses are by the wattmeter readings. The 10,000 B results are only for 50 periods, the 100 ⌒ tests not having been carried higher than 6,000 B.† Results at 2,500 B are worked out only for 100 ⌒. Judging from the thinnest sheets the iron is of excellent quality.

Losses in Watts per Pound of Iron at 50 and 100 Periods.

Thickness.	Hysteresis. 100 ⌒	50 ⌒	Total loss. 100 ⌒	50 ⌒	Difference due to eddies. 100 ⌒	50 ⌒	Percentage of eddies. 100 ⌒	50 ⌒	B.
A ·0136in.	·183	—	·285	—	·102	—	35·8	—	2,500
B ·0189in.	·179	—	·37	—	·191	—	51·5	—	2,500
C ·0254in.	·188	—	·44	—	·252	—	57·2	—	2,500
A ·0136in.	·39	·195	·635	·26	·245	·065	38·6	25	4,000
B ·0189in.	·38	·19	·83	·322	·45	·132	54 2	29·8	4,000
C ·0254in.	·40	·20	·99	·37	·59	·17	59 5	46	4,000
A ·0136in.	·746	·373	1·30	·52	·554	·147	42·6	28·3	6,000
B ·0189in.	·727	·363	1·76	67	1 03	·307	54·5	45·8	6,000
C ·0254in.	·766	·383	2·12	·76	1·35	·377	63·7	49·6	6,000
A ·0136in.	—	·845	—	1·33	—	·475	—	35 8	10,000
B ·0189in.	—	·822	—	1·64	—	·818	—	50	10,000
C ·0254in.	—	·867	—	1·95	—	1·083	—	55·5	10,000

These results show very clearly that even with these thin sheets and moderate densities the eddy loss is of the same order of importance as the hysteresis.

* The two dotted curves in Fig. 4, *d* and *e*, show the hysteresis loss, assumed to vary as $B^{1.6}$, for 100 ⌒ and 50 ⌒ respectively, taken from the mean of these three values—viz., ·39 watt per pound at 100 ⌒.

† An objection may be made to this analysis that the results obtained with the Ewing tester—namely, ·39, ·38, and ·40—on samples weighing only about ½ oz. each are possibly not representative of the average of each of the 11·7lb. samples tested by the wattmeter. We admit this, but that is one of the uncertainties inseparable from the small scale of the operation. It may also be objected that the higher and uniform value of ·44 got on the same three test pieces by another experimenter would alter the figures somewhat. That is true, but the main broad results and conclusions would not be appreciably affected.

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Examining the result to find what light they throw on the assumptions that eddies are proportional to the square of the thickness, the square of B, and the square of the periodicity, we get the following values:

EDDIES AND THICKNESS.

		A.	B.	C.
(Thickness)²		1	1·93	3·5
	B.			
100 ~	2,500	1	1·87	2·47
	4,000	1	1·84	2·4
	6,000	1	1·86	2·44
50 ~	4,000	1	2·04	2·52
	6,000	1	2·09	2·56
	10,000	1	1·72	2·28
Average			1·903	2·445

EDDIES AND MAGNETISATION (B).

At 100 ~.			
B	2,500	4,000	6,000
B²	1	2·56	5·76
A	1	2 40	5·43
B	1	2·36	5·40
C	1	2·34	5·36
Average		2·37	5·40
At 50 ~.			
B	4,000	6,000	10,000
B²	1	2·25	6·25
A	1	2·26	7·31
B	1	2·32	6·20
C	1	2·24	6·37
Average		2·27	6·62

EDDIES AND PERIODICITY.

50² and 100² ~ = 1 : 4.

B		50 ~	100 ~
A	4,000	1	3·77
	6,000	1	3·77
B	4,000	1	3·40
	6,000	1	3·36
C	4,000	1	3·47
	6,000	1	3·58
Average			3·46

These three comparisons lead to the following conclusions: For the ·0136 and ·0189 sheets the increase is practically proportional to (thickness)²—that is, the loss with the latter is nearly double that with the former. But as between ·0136 and ·0254 the average increase is less than (thickness)² by about 30 per cent. It is about 2 5 instead of 3·5 times greater.

As regards the relation between B and eddies, the tests on the whole do not indicate any marked departure from the B² assumption. As regards periodicity, the averages show that the increase is as 1 to 3·46, instead of 1 to 4.

We suggest that the result showing that eddies increase less quickly than (thickness)² and (periodicity)² may be reasonably explained by assuming that the eddy circuits have self-induction. If this is so, it prevents the possibility of dealing with them simply by Ohm's law, as hitherto seems to have been the practice.

Effect of Temperature on Eddies.—It might be possible to ascertain the total eddies, and to separate eddies from hysteresis, by measuring the total loss at two temperatures, assuming hysteresis to be constant within the range of the temperatures, and comparing the result with the assistance of the ascertained temperature coefficient. Fig. 5 shows a wattmeter test made of some ·0214in. transformer iron (by Sankey) at 40deg. F. and 167deg. F. for this purpose, together with a ballistic galvanometer determination of the hysteresis of the same iron. The latter test was made without special reference to temperature, which, however, is believed to have been about 70deg. F. The iron was found to have a temperature coefficient of ·248 per cent. per 1deg. F. (reckoning from 32deg. F.) based on observation taken at 72deg. F. and 154deg. F.

The ballistic test was made at three points respectively—8,000, 5,000, and 2,000 B. It is important to note that these points lie on a $B^{1.6}$ curve, as do also the wattmeter curves of this figure. As in Fig. 4, the eddies bear a very large ratio to the hysteresis, being about 50 per cent. of the total loss at the higher values of B. The effect of change in temperature is very marked, the increase of 127deg. F. giving a reduction of total loss—at 7,500 B, for example—of 0·28 watt per pound = 14·4 per cent. of the total loss, or 27·3 per cent. of the eddy loss.

An examination of the curves at 40deg. and 167deg. F. shows that the eddy currents, at least at the higher densities, apparently increase rather more rapidly than the fall of the resistance, suggesting the possibility that the hysteresis decreases under working conditions at these higher values of B. The authors, however, only wish to put the experiment forward as a further proof of the importance of the eddies, and as possibly affording a means of useful investigation of the relation of eddies to hysteresis.

The considerable decrease in the total loss with rise of temperature must not be taken as a reason for working transformers hot—the increase of copper resistance would do much to counterbalance any saving in the iron. At one time the effect of continued heating at such a temperature as 167deg. F. would have been to cause a slow increase in the hysteresis, but this effect has now been overcome in this quality of iron, at least for such temperatures as this.

It may be thought that there is a remote possibility of explaining the increase of eddies—as judged by the curves of total loss—being less than the received theories would require, by assuming that there may be a decrease in hysteresis with B, as has been shown to take place under certain conditions by Prof. Baily's very interesting experiment, which lent support to Prof. Ewing's magnetic theory, and confirmed a prediction of Mr. Swinburne.* Such an explanation, however, would receive no support from our analyses, in which, on the whole, the eddy loss appears to be nearly proportional to B².

Although these results refer particularly to transformer conditions, they are applicable to a good deal of dynamo, alternator, and motor work, in much of which the periodicities are as high as for transformers, even for direct-current work, for instance, turbine-driven dynamos; a four-pole machine at 1,500 revolutions per minute works at 50 ~ per second. With such machines it is very necessary to work at as high B as possible, and under such circumstances the eddy losses are very large—especially as there is probably a greater tendency to eddies in dynamos than in transformers on account of the less even magnetic distribution in the former. Even in ordinary dynamos working at 8 to 16 ~, with about 15,000 or 16,000 B in the core and 20,000 B or more in the teeth, the eddy loss will be found to account for an appreciable proportion of the total loss. As to the practical aspect of the question of thickness, it has been already stated that it is difficult to get iron thinner than ·014in. (·35mm.). Perhaps a practical limit will be reached at ·01in. (·25mm.). This would save nearly half the eddies, as compared with ·014, and in some cases this would justify a considerable increase in the price of the iron. For example, the saving in one ton of ·01in. iron used continuously at 15,000 B 50 ~, as compared with ·014in., would be more than 10,000 Board of Trade units a year. There is, however, some ground for believing that on the average the hysteresis loss with a given iron is rather higher when it is rolled very thin. The difference, however, is not likely to be so much as to counterbalance the considerable saving in eddy loss under many practical working conditions. Until some iron or steel has been discovered having a higher specific resistance combined with high magnetic qualities, the only way to reduce eddies is to use as thin iron as possible.

The authors would summarise their conclusions as follows: (1) in determining the magnetic quality of iron sheets, eddy-current losses, though often neglected, are by no means negligible, and are often as important as hysteresis; (2) the simple laws generally assumed to be followed by hysteresis and eddies are found, as often as not, to be rather widely departed from; and (3) consequently, with such a variable material as iron, the only satisfactory method of predicting losses is to make wattmeter tests of samples, as nearly as possible under the working conditions.

The authors wish to thank Mr. L. W. Wild, of the Westminster Electrical Testing Laboratory, for his able assistance in some of the experiments.

* See Ewing's "Magnetic Induction in Iron and other Metals," third edition, p. 327.

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ON LARGE-BULB INCANDESCENT ELECTRIC LAMPS AS SECONDARY STANDARDS OF LIGHT.*

BY J. A. FLEMING, M.A., D.Sc., F.R.S., PROFESSOR OF ELECTRICAL ENGINEERING IN UNIVERSITY COLLEGE, LONDON.

The importance of possessing a secondary standard of light which shall be at once portable, convenient, and constant is generally acknowledged, and the choice lies between some form of flame standard and some form of incandescent standard. For the last eight years the author has employed as a secondary standard of light a type of large-bulb carbon-filament electric incandescent lamp, which was first devised by him in 1895 in connection with photometric work carried on in the Pender Electrical Laboratory of University College. These lamps were made by the Edison and Swan Electric Light Company, and a large number of them have been issued to the public under the name of the Fleming-Ediswan photometric lamp, together with a certificate of the author as to the photometric value. The principle underlying the construction of these lamps is as follows: It is well known that some types of carbon-filament glow lamp, when worked at constant voltage, slightly increase in candle-power for the first 50 hours or so of their life. After that time a stationary period is reached, and then a progressive drop in candle-power takes place. The initial rise in candle-power is due to a gradual consolidation in the filament with use, which reduces its resistance, and the subsequent decay in candle-power is chiefly due to the deposit of carbon upon the bulb.

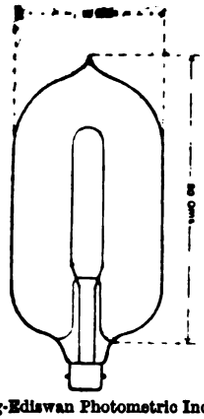

FIG. 1.—The Fleming-Ediswan Photometric Incandescent Lamp.

The surface of an ordinary incandescent lamp, 16 c.p., is approximately equal to that of a sphere 3cm. in radius, and may be taken, roughly, as 120 square centimetres. Accordingly, an ordinary small-bulb incandescent lamp is not very suitable as a standard lamp. The writer found, however, that by enclosing the filament in a bulb of much greater diameter, say in a cylindrical bulb 12cm. in diameter and 20cm. in length, giving a total bulb surface of nearly 800 to 1,000 square centimetres, the deposit of carbon upon the bulb was greatly diminished: first, because the glass is further removed from the filament, and, therefore, the chances of a carbon molecule getting on to the glass are reduced; and, secondly, because the carbon that is deposited is spread over such a much larger area of glass that its effect in interfering with the passage of light is greatly diminished. Again, it was found that by subjecting the carbon filament to a certain process of ageing in another bulb before transferring it to the large bulb, the rise in the resistance of the filament was, so to speak, anticipated. Accordingly, lamps were made to the following specification: Well-selected carbon filaments of the single-loop type of 10 c.p. or 16 c.p. were aged and adjusted to an efficiency of 3·5 watts a candle. These filaments were then transferred to large cylindrical bulbs of very clear glass and finished in the usual manner (see Fig. 1).

Such a large-bulb lamp may be called a photometric lamp. A mark is placed on the glass or on the collar of the lamp in such a position that when the lamp is mounted in the photometer with this mark facing the photometer disc, the axis of the lamp being vertical, the plane containing the horseshoe filament is perpendicular to the line joining the lamp with the photometer disc. These lamps are intended to be used in the following manner by a process of photometric "double weighing." Each standard lamp is marked with the voltage at which it will give a certain candle-power in the above-mentioned direction and position. A lamp is then used, as follows: Assuming it to be marked, say, 16 c.p. at 98 volts, the lamp is placed in the photometric gallery at a distance from the photometer disc of 4ft.—viz., the square root of 16—and by means of a potentiometer and variable resistance, the electric pressure on the terminals of the lamp is adjusted to be 98 volts. Under these circumstances the illumination on the photometer disc is *one candle-foot*. This is balanced by placing on the other side of the photometer disc another incandescent lamp worked at about the same watts per candle, the distance of this last lamp (called the comparison lamp) being adjusted until a photometric balance is obtained. The standard lamp is then removed from the photometer, and its place is taken by any lamp the candle-power of which it is desired to ascertain at a certain voltage. The voltage having been adjusted, this last lamp is then moved to or from the photometer disc until it photometrically balances the comparison lamp. Let us imagine that it balances the comparison lamp at a distance of 50in. The candle-power of this last lamp is then equal to 17·36 candles, being to the standard lamp in the ratio of the square of 50 to the square of 48. Such an operation has been called by the author a photometric double weighing, because it resembles the process by which the exact weight of an object can be ascertained by means of good weights with an imperfect balance. By following the above method no want of symmetry in the photometer vitiates the process of measurement, neither are we concerned with the exact value of the comparison lamp as long as it remains constant during the experiment. All that we are concerned with is the exact value of the standard lamp used for setting the comparison lamp, and with the ratio of the distance of the standard lamp from the photometer disc to that of the measured lamp. Hence, if the distances are correctly measured, we have the exact ratio between the candle-power of the standard lamp and that of the lamp being measured.

It has been found by large experience that this process is more accurate than the usual plan of placing the photometer between the two lamps and moving the photometer to and fro until the balance is obtained. In this last method we are liable to error in consequence of any want of symmetry in the photometer itself, and also by reason of the fact that the continnal moving of the photometer varies the value of the absolute illumination on the photometer disc. It has been found that even when using the best Lummer-Brodhun photometers there is a certain asymmetry in the instrument or the disc. If a photometric balance is obtained between two lamps, one on each side of the photometer, then on reversing the disc the balance is no longer obtained, but the photometer has to be moved to a further position. This difference is not apparent when the photometer is simply turned over, prisms and discs moving together, but differences amounting to 5 per cent. in the value of the readings of the candle-power of a lamp have been found in some instances when the disc alone is reversed.

These large-bulb lamps are not intended to be used as working standards and kept incandescent for any length of time, but merely as secondary standards for a few minutes to adjust the distance of the comparison lamp and from the photometer disc. In this manner it may be used many thousands of times without being in a state of illumination altogether for more than a few hours. By employing a number of these lamps and checking them one against the other, and never allowing the voltage on the lamp to exceed the marked volts, a means is provided of determining and preserving a standard of light with very considerable accuracy.

In connection with the construction of these large-bulb lamps, the following points are important. The filament should preferably be in the form of a single loop or horseshoe, and should be mounted in the large cylindrical bulb with great care so that the plane of the loop lies in the axial line of the lamp, filaments being selected with the two

* Paper read before the British Association at Cambridge.

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sides of the loop in the same plane and not distorted. In some cases it is desirable to anchor the filament by a loose loop of platinum wire, sealed into the bulb, but such loop of wire should not touch the filament or constrain it when the lamp is at rest or in use. Owing to the fact that the 16-c.p. 100-volt filament is about 9in. in length, it is desirable, if possible, to employ a 10-c.p. 60-volt large-bulb photometric lamp as a standard. The 16-c.p. 100-volt lamp of this type is much used, and the 16-c.p. 200-volt lamp has been made, but is not recommended. It is not desirable to employ two filaments in parallel, as they may then be at different temperatures, but they can be placed in series, one loop within the other, and both lying in the same plane. In setting the lamp in the photometer, great care must be exercised to adjust the lamp axis perfectly vertical, and a plumb line should be employed to mark the position of the mean line of the filament as read on the scale of the photometer bench.

In the use of these lamps the following precautions should be taken: (1) the lamp should never be raised above the voltage marked upon it by the manufacturer; (2) in the next place, great care should be taken that good contact is made between the socket and the sole-plate on the lamp. It is better, therefore, to solder a pair of wires to each sole-plate of the lamp collar, one pair being employed as the leads for the current to the lamp, and the other pair as potentiometer or voltmeter wires to ascertain the exact potential difference between the sole-plates of the lamp. This adjustment of potential is best effected by means of a variable rheostat and a potentiometer. In the certificate issued with each of the Fleming-Ediswan photometric lamps, a statement is made of the exact voltage and current at which the lamp gives a certain candle-power at a certain temperature If used with the above precautions, experience accumulated during the past eight years has shown that these lamps are capable of preserving an exceedingly constant candle-power, and that as standards of light they are more portable and require none of the corrections necessary in the case of flame standards.

The great objection which may be urged against the use of all flame standards is the degree to which their candle-power is affected by moisture in the air and changes in barometric pressure. It has been shown by researches made at the Reichsanstalt on the Hefner lamp that the light emitted decreases about 0·5 per cent. with every additional litre of water vapour present in the atmosphere above a certain normal value. Taking the average variations of moisture in the air from month to month, we find that this implies a variation of about 4 per cent. in the light emitted in the Hefner lamp between the wet and dry seasons of the year; this variation greatly exceeds the limits of possible error in photometric observations. With very little care photometric comparisons can be made within 1 per cent., hence comparisons with a flame standard are not sufficiently definite unless the value of the flame standard has been corrected for moisture and barometric pressure. The authorities of the Berlin Reichsanstalt take the standard state of the atmosphere with regard to moisture to be that in which it contains 8·8 litres of water vapour per cubic metre of dry air. The atmosphere of Berlin, however, is distinctly drier than that of London, and the author has been informed by Dr. Glazebrook, F.R.S., director of the National Physical Laboratory of England, that he considers for Great Britain it will be better to take as a standard state 10 litres of water vapour per cubic metre of dry air as more nearly representing the average state of the British atmosphere.

Dr. Glazebrook has made a prolonged study of the Harcourt pentane 10-candle lamp in regard to variation of candle-power of the latter with atmospheric moisture and pressure, the results of which he will no doubt make known in due time. Meanwhile he has privately communicated to the writer information which shows that the correction of the candle-power in the pentane lamp, due to moisture in the air—or, rather, deviations from the standard state of moisture—is at least as great as that of the Hefner lamp. There seems reason to believe that this correction would be about the same for all flame standards. Dr. Glazebrook has been so kind as to communicate to the writer a formula for the correction of the pentane lamp for variation in illuminating power due to atmospheric moisture and pressure which he has obtained, but it must be considered as merely privately and unofficially furnished, and, therefore, subject to any future correction by him * Taking the Harcourt 10-candle pentane lamp to emit a light of 10 c.p. when the barometric pressure is 760mm. and the atmospheric moisture 10 litres per cubic metre, then the candle-power corresponding to a barometric pressure of b millimetres and a hygrometric state of e litres of water vapour per cubic metre, he finds that candle-power can be expressed as follows: candle-power of the Harcourt pentane lamp $= 10 + 0{\cdot}066\,(10 - e) - 0{\cdot}008\,(760 - b)$. The water vapour present may often reach 15 or 16 litres per cubic metre. This variation alone will decrease the candle-power by 3 per cent. or rather more. Hence, if the correction is not applied, and the pentane lamp is then used directly to standardise an incandescent lamp, and assumed to be 10 c.p., the candle-power of the electric lamp may be marked as much as 3 per cent. too high. In other words, an error of nearly 0·5 c.p. may be made in marking a 16-c.p lamp. This source of error only presents itself in comparing a flame standard with an incandescent lamp. When two flame standards such as coal gas and pentane are being compared, the atmospheric moisture affects both flames about equally.

The writer has recently had careful tests made to ascertain if these large-bulb incandescent lamps gave the same candle-power at the same voltage and current, irrespective of variations in the temperature of the surrounding atmosphere. With this object an experiment was made by Mr. G. B. Dyke in the photometric gallery of the Pender Electric Laboratory, at the suggestion of the author. A large iron box was provided, having an oval hole in front, about the size of one of the large-bulb lamps. A lamp of this description was mounted on a socket and suspended in this box with its axis vertical. At the bottom of the box were placed some coils of iron wire which could be heated by an electric current. In this manner the temperature of the air in the box was gradually raised and the lamp was surrounded by an atmosphere of warm air. The temperature of this air was taken by four thermometers placed in the box. The readings of these thermometers were taken together with the candle-power of the lamp, and the values ou nd to be as follows:

Atmospheric temperature in centigrade degrees.								Candle-power of large-bulb lamp.
(I.)		(II.)		(III.)		(IV.)	Mean	
23°·6	...	24°·4	...	22°·8	...	22°·8	23°·4	13·84
27°·4	...	27°·7	...	28°·0	...	26°·4	27°·4	13·81
42°·0	...	44°·4	...	46°·9	...	37°·5	42°·4	13·81
67°·2	...	69°·4	...	77°·2	...	53°·3	66°·8	13·77

Hence it is clear that there is practically no change in the candle-power of the lamp with change of temperature of the surrounding atmosphere.

These lamps, therefore, present the following valuable features when employed as secondary standards of light: (1) The candle-power does not vary with the atmospheric moisture, barometric pressure, or atmospheric temperature. (2) If the lamp is properly prepared and used as described, the candle-power given by it depends on nothing but the current passing through the filament, and this last can be measured to within 0·1 per cent. or less by means of a potentiometer, and the candle-power, therefore, known to within 1 per cent. The experience so far gained shows that if a number, say six, of these standard photometric lamps are kept and compared with one another at intervals, the observer has always the means at his disposal of determining the candle-power of an incandescent lamp within 1 per cent. (3) Great portability as a standard. The lamp is very portable, and there is no difficulty in sending these lamps suitably packed to the other side of the world. Anyone with secondary cells as a source of current and a potentiometer as a measuring instrument has the means of setting up a standard of light at least as accurate and constant as a good flame standard. These lamps, in fact, afford the best means of determining the variation of flame standards with barometric pressure and atmospheric moisture, and

* An account of these researches was given in a paper read before Section G of the British Association immediately after the present paper by Mr. C. C. Paterson, who conducted the experiments at the National Physical Laboratory on this subject.

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photometric comparisons between a large-bulb lamp as devised by the writer and a flame standard is, in fact, a checking of the latter by the former and not the reverse.

In equipping an electrical laboratory with the means of preserving a standard of light, the author recommends the following procedure as the result of eight years' experience of it. A stock, say, of 12 of the large-bulb photometric lamps is provided. Those of the writer's pattern issued by the Edison and Swan United Electric Light Company are each sent out in a stout millboard box. These lamps should all have their candle-power carefully determined at a marked voltage, so chosen that the efficiency is about four watts per candle. The current at this voltage should be measured. This candle-power current and voltage should be marked on the box. If this calibration is made against a flame standard, then the greatest care should be taken to correct the value of the flame standard for atmospheric moisture and pressure. The candle-power ratios of these lamps should be taken, and six of them should be preserved as ultimate standards of reference for the adjustment of the other six. These last may be used for setting the comparison lamp in the photometer, and they should be compared at intervals with the first six lamps which are reserved as prime standards of reference. If the six working lamps are used turn-and-turn about, and inter-compared with the reference standards, they may be used thousands of times without being actually burning for more than a few hours, and the tradition as to the unit of light or illumination can be transmitted without risk of change.

As an instance of the utility of these lamps in the comparison of flame standards, it may be mentioned that the author recently sent three of these large-bulb standard

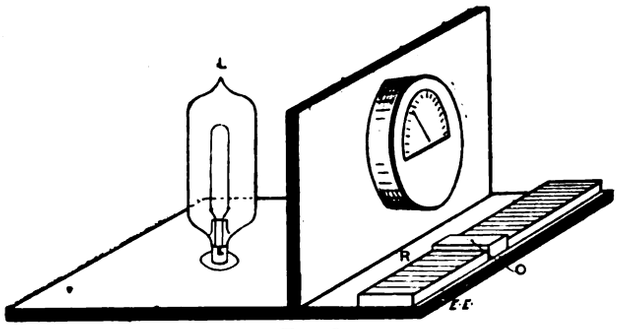

FIG. 2.

lamps to Berlin by his assistant, Mr. W. C. Clinton, and they were photometrically measured in the Physikalisch Technische Reichsanstalt at Charlottenburg. The same lamps were subsequently taken to the National Physical Laboratory, Bushy House, Teddington, and measured independently. In Berlin the standard of comparison was a Hefner lamp, and at Bushy House it was a Harcourt 10-c.p. pentane lamp. The ratios of the certified readings gives us the value of the Hefner unit in mean British candles, and it is close to the value usually assumed. These three lamps are called Pender IV., Pender VI., and Pender X. respectively. The results are tabulated below:

Lamp mark.	Value of the illuminating power in Hefner units assigned at the Reichsanstalt. H.U.	Value of the illuminating power in British candles assigned at the Nat. Phys. Lab. C.P.	Value of the Hefner unit in British candles.
Pender IV.	15·1	13·41	0·888
Pender VI.	12 6	11·12	0 883
Pender X.	15·9	14·07	0·885

The mean value of the ratio is 0·885. The lamps were all measured at 96 volts, and the current values obtained at the Reichsanstalt agreed with those obtained at Bushy House within 1 part in 1,000. Hence we may take it that the above fraction (0 885) represents very nearly the ratio between the Hefner unit as employed at Berlin and the mean British candle as employed in London as a standard of illumination.

In connection with these large-bulb lamps, the author has arranged a simple apparatus, consisting of a large-bulb lamp, a rheostat, and an ammeter, the range of which comprises merely the ordinary lamp currents. The ammeter is, however, not graduated to read amperes, but graduated to read candle-power, so that if the rheostat is adjusted to make the ammeter needle point to any part of the scale, that scale reading would at once, without further calculation, give the candle-power of the lamp in the normal direction. Although this apparatus is not accurate enough for laboratory purposes, yet for workshop or generating station purposes it is a convenient arrangement for obtaining a fairly accurate standard of light without the complications involved with the use of the potentiometer. The arrangement of the apparatus is shown in Fig. 2.

In conclusion, the author has to record his thanks to Mr. W. C. Clinton, B.Sc., for much laborious and careful work during many years in making numerous photometric comparisons, but the experience so gained has every year tended to confirm the opinion that these large-bulb incandescents, when used as described, form a most convenient and constant standard of light.

THE RELUCTANCE OF THE AIR-GAP IN THE INDUCTION MOTOR.

BY N. PENSABENE, A.I.M. (BELGIUM).

In a preceding article* we have studied the reluctance of the air-gap in induction motors having open slots in the stator, and totally enclosed slots in the rotor. In that which follows we propose to consider the case of semi-enclosed slots in stator and closed slots in rotor, and the other case in which both, stator and rotor, have semi-enclosed slots.

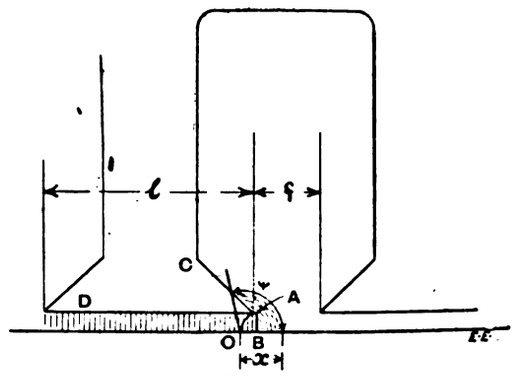

FIG 1.

I. For the sake of simplicity let us suppose that the shape of the stator slots is as shown in Fig. 1, in which the portion A C has been represented by a straight line instead of a curve, as is generally the case in practice. Starting from the same hypothesis as for the case already studied—that is, supposing the lines of the magnetic field consisting of circles with their centres in O, so that O B = d—and using the same notation as before, we have for the permeability of one tooth

$$P = \frac{L\,l}{d} + 2\,L \int_{d}^{d+\frac{f}{2}} \frac{d\,x}{x\,\psi}.$$

The angle ψ, shown in Fig. 1, is a function of x. With sufficient accuracy for the purpose, we may say

$$x\,\psi = (\pi - \alpha)\,x - C,$$

where $\alpha \times \overline{C\,A\,D}$, $C = \sin\alpha\,(1 + \cot\alpha) = \sqrt{1 + \sin 2\,\alpha}$. So we get

$$P = \frac{L\,l}{d} + \frac{2\,L}{\pi - \alpha} \log\left[\frac{\pi - \alpha}{2\,(\pi - \alpha - C)}\,\frac{f}{d} + 1\right]. \quad (1)$$

We see, then, that the permeability, P, varies with the angle α. For $\alpha = \frac{\pi}{2}$ (open slots), $C = 1$, and

$$P = \frac{L\,l}{d} + \frac{4}{\pi}\,L \log\left[1{\cdot}38\,\frac{f}{d} + 1\right],$$

which is the formula already found for open slots.

Formula (1) is not suitable for practical applications, being too complicated. We can simplify it, if we notice

* The *Electrical Engineer*, June 17, p. 922.

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that in practice the angle α does not vary much from the average value of 35deg. In this case

$$C = \sqrt{1 + \cdot 94} = 1 \cdot 4,$$

and

$$P = \frac{L\,l}{d} + \cdot 8\,L \log \left[1 \cdot 12 \frac{f}{d} + 1 \right].$$

From this formula we get as before:

$$A_a = P\,d\,S = \times L \left[l + \cdot 8 \log (1 \cdot 12 \frac{f}{d} + 1)\,d \right],$$

and if

$$\epsilon = \cdot 8 \log \left(1 \cdot 12 \frac{f}{d} + 1 \right),$$

we have

$$A_a = L\,S\,(l + \epsilon\,d) \quad . \quad . \quad . \quad . \quad (2)$$

In Fig. 2 we have plotted the curve 2 which gives the different values of ϵ according to the ratio $\frac{f}{d}$. Curve 1 is the curve already found for open slots.

II. We now come to the most general case, where the slots are semi-enclosed in both stator and rotor. The problem which we have seen is a simple one for the two preceding cases here becomes complicated because the reluctance is not any more constant, but varies with the relative position of the stator and rotor teeth. We prefer not to enter into long and elaborate calculations which lead to a formula of no practical value. For the accuracy needed in practice it seems quite satisfactory to calculate A_a with formula (2), using the curve 2 (in Fig. 2) and denoting with S, l, f, the average values of these elements corresponding to the stator and rotor.

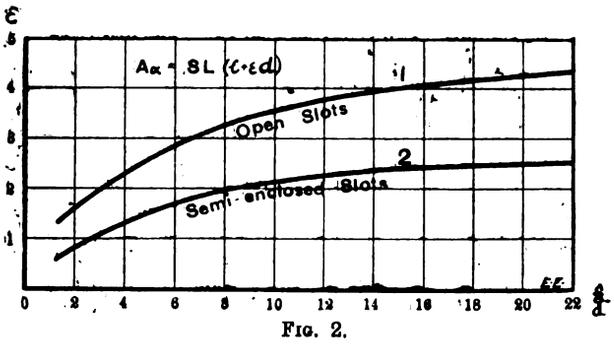

FIG. 2.

In conclusion, then, for all the cases formula (2) is to be used; for open slots in stator and enclosed slots in rotor, ϵ is given by the curve 1 in Fig. 2; for semi-enclosed slots, ϵ is given by curve 2. The following experimental corroboration of above refers to the common case of semi-enclosed slots in stator and rotor. The way of proving the accuracy of the formula found is the same as the one already used for open slots. The correction for the iron reluctance has been done by increasing the air-gap length by 10 or 15 per cent., according to the saturation of the iron. The formula is

$$i' = \cdot 44 \frac{e\,p\,d_1}{n^2 \cdot \sim A_a} 10^8.$$

The following data refer to 10-b.h p. and 20-b.h.p. motors made by the General Electric Company. The tests on these motors were carried out at the works of this firm by Mr. R. W. Weekes and Dr. W. E. Sumpner, with a new method suggested by the latter.* In designing these motors for the above firm, the writer has estimated the air-gap reluctance with the exposed method; it will be seen that the errors incurred are about of the same order as the errors in commercial testing machinery.

1. The data for the 10-b.h.p are (average values for stator and rotor elements): S = 10·5, f = ·35, l = 1·13, d = ·065, n_1 = 216, d_1 = ·075†, p = 6, L = 11·8, and the test was made with e = 134 V, $\sim$ = 40·6.

We have then $\epsilon = 1 \cdot 6$,

and $A_a = 10 \cdot 5 \times 11 \cdot 8\ (1 \cdot 13 + 1 \cdot 6 \times \cdot 065) = 151$,

and $i' = \frac{\cdot 44 \times 134 \times 6 \times \cdot 075}{216^2 \times 40 \cdot 6 \times 151} 10^8 = 9 \cdot 5$ A.

* See the *Electrical Engineer*, June 17, "A Hopkinson Test for Multiphase Induction Motors," by R. W. Weekes, M.I.E.E.

† The maximum inductions are: for the narrowest points of stator teeth 18,000 lines per square centimetre and for the core 7,000 lines per square centimetre.

It is easy to see that, the two 10-b.h.p. motors being identical, they have the same admittance at open secondary, then the currents given in the test made by Mr. Weekes in Table I., columns 3 and 4, reading No. 11, are double the light current of each motor, so

$$i' = \frac{20\,6 + 21}{4} = 10\,5.$$

2. In the same valuable article published by Mr. Weekes, we find another test of two motors, 25 b.h.p. and 30 b.h.p., belted together.

Taking in consideration the 25-b.h.p., we have S = 12, f = ·35, l = 1·42, d = ·075, d_1 = ·085, n_1 = 90, L = 21·6, p = 6, e = 138 V, $\sim$ = 41. Then

$$\epsilon = 1\,5,$$

and $A_a = 12 \times 21\,6\ \{1 \cdot 42 + 1 \cdot 5 \times \cdot 075\} = 400$,

and $i' = \frac{\cdot 44 \times 138 \times 6 \times \cdot 085}{90^2 \times 41 \times 400} = 23 \cdot 5$ A.

From columns 6 and 7 of Table III., reading No. 13, we have i' = 24 5 A.

3. The following examples have been taken from the motors described by Mr. Hobart,* who gives in his article the actual observed light currents. The saturation being low, we take $d_1 = 1 \cdot 1\ d$.

Motor A.—S = 16 5, f = ·3, l = 1·1, L = 33, p = 12, d = 15, d_1 = ·165, n_1 = 180, e = 290 V, $\sim$ = 50.

We have $\epsilon = \cdot 90$,

and $A_a = 33 \times 16 \cdot 5\ (1 \cdot 1 + \cdot 9 \times \cdot 15) = 670$,

and $i' = \frac{\cdot 44 \times 290 \times 12 \times \cdot 165}{180^2 \times 50 \times 670} 10^8 = 23 \cdot 5$ A.

The test gives i' = 23 A.

4.—Motor C.—S = 19 5; f = ·25; L = 75; l = 1·45; p = 30; d = ·175; d_1 = ·193; e = 2,900 V; $\sim$ = 25; n_1 = 1,200.

We get $\epsilon = \cdot 75$,

and $A_a = 75 \times 19 \cdot 5\ (1 \cdot 45 \times \cdot 75 \times \cdot 175) = 2{,}300$,

$$i' = \frac{\cdot 44 \times 2{,}900 \times 30 \times \cdot 193}{1{,}200^2 \times 25 \times 2{,}300} = 9 \text{ A.}$$

The test gives 9·3 A.

LONG-DISTANCE SWITCHES.†

(*Concluded from page 275.*)

The diagram of connections of a long-distance switch introduced by the Siemens-Schuckert-Werk is shown in Fig. 10. If the switch u is put on to contact 1, coil a becomes excited, pulls its armature up, and, by means of an ingenious handle mechanism, closes the switch b. As soon as the circuit is completed the current ceases in a and the armature returns to its original position, but b remains closed. In order to switch off, the switch u is moved on to 2, a receives current again, pulls its armature up, and this, by means of the handle mechanism, opens the switch b again. At the same time the exciting current in a is stopped. All the above described switches are suitable for low-tension circuits.

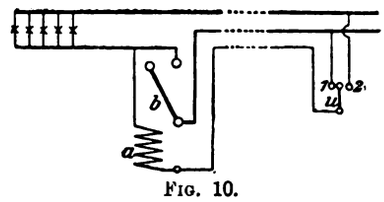

FIG. 10.

The introduction of high tensions has led to the introduction of arrangements by which the high-tension and low-tension circuits on central-station switchboards can be kept entirely separate. The operation of the high-tension switches is often carried out by means of more or less complicated auxiliary mechanism. On this account it has

* See "Traction and Transmission," "Electric Motors," May, 1904, pp. 39 and 40.

† Translation of an article in *Elektrotechnische Zeitschrift* for July 28, 1904, by F. Lindenstruth and O. Forster.

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become common in America to work the switches electrically, either directly or with the aid of compressed air. In this way the switchboard, besides the measuring instruments, only carries a number of small low-tension switches or bell pushes, through which the high-tension switches are actuated. Indicators or signals at the same time show the connections made. The current for operating the high-tension switches may either be taken from the exciting circuit or from any other available low-tension supply.

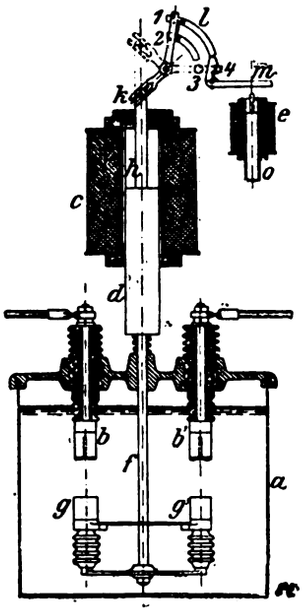

FIG. 11.

The above arrangements can, of course, also be employed for the switching in and out of distant transformers in order to reduce the light-load losses, and several devices for this purpose were described in the *Elektrotechnische Zeitschrift*, 1901, No. 17, and 1902, Nos. 24 and 25.

Modern high-tension switches are almost invariably of the oil-break type, and an automatic switch of this sort is shown in Fig. 11. The apparatus consists of the oil-holder, *a*, with the terminals, *b*, fixed to the cover by porcelain insulators. The switch on coil *c* is fixed above the oil-holder. The core *d* carries the insulated contact pieces, *g g'*, by means of the rod, *f*; *d* is continued upwards by means of a brass rod, *h*, a projection on which works in the fork of the arm, *k*. The latter carries a brush, *l*, which makes contact either with 1 and 2 or with 3 and 4, according to the position occupied by the handle. When coil *c*

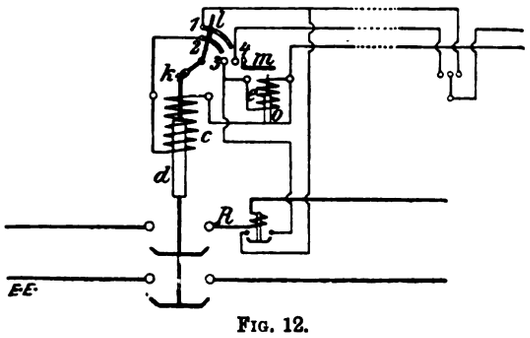

FIG. 12.

is excited *d* is drawn up, and makes contact between *g g'* and *b b'*. At the same time the handle, *k*, reaches the dotted position and is held there by the locking trigger, *m*. Before this extreme position is reached the brush, *l*, will have left contacts 1 and 2 and will connect 3 and 4. The current in the switching-on coil then ceases, whilst the switching-off coil, *e*, can have current sent through it when required. If such a current is sent the core *o* is pulled right up, releases the trigger, *m*, and the core *d* falls to its original position and open the circuit. Apparatus of this sort is as readily applicable to alternating as to direct currents. It is even unnecessary to employ laminated iron for the former, as the coils are only excited for very short intervals. Fig. 12 shows the connections of such a high-tension long-distance switch. In this case a relay, R, has been added, which sends current round the switching-out coil as soon as the main current exceeds a given value, and so makes the arrangement into a simple maximum cut-out.

Fig. 13 is the diagram of connections for two transformer stations feeding a single low-tension network at two different points. In order to reduce the no-load losses to a minimum at times of light load, one of the transformers (I.) is arranged to be cut out, station B being able to deal with the average load alone without objectionable voltage drop. At a certain load the relay *f* in station II. closes the circuit of relay *c*, which, after a certain (adjustable) lapse of time, closes the circuit of the switching-in coil, *a*,

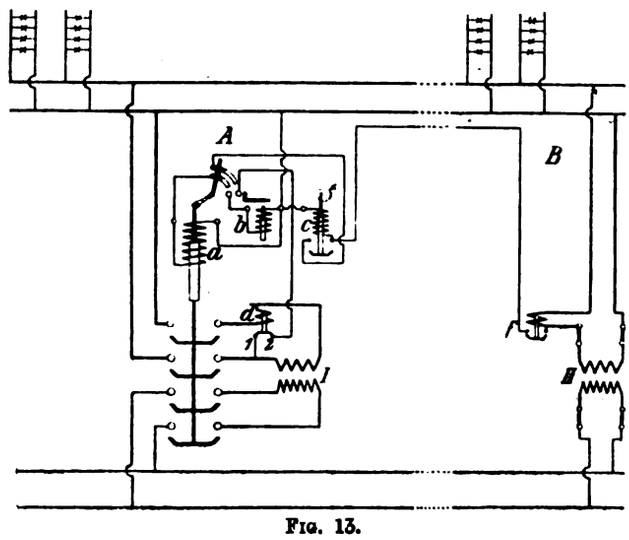

FIG. 13.

in station I. At the same time a relay, *d*, on the low-tension side of station I. opens contacts 1 and 2 when a certain current is reached. When the load on the network falls again, *d* connects contacts 1 and 2, thus making the circuit through *b*, which throws transformer I. out of circuit again. By the use of a maximum relay in station A transformer I. can be protected against overload in the way shown in Fig. 12. The time relay, C, is not absolutely necessary, though without it instantaneous short-circuits in the network would cause transformer I. to be immediately put into circuit.

WALLASEY TRAMWAYS.

The following is an abstract of the revenue account for the year ended March 31, 1904, taken from the annual report of Mr. R. R. Greene, general manager, to the chairman and members of the Tramways Committee.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Maintenance of cars	2,105	3	1
Maintenance of buildings	218	18	4
Maintenance of lines	262	16	8
Implements and tools	177	17	3
Depôt expenses	1,699	7	11
Repairs to overhead equipment	853	3	11
Traffic expenses	16,666	4	0
Rates and taxes	901	16	3
Printing and stationery	96	14	6
Advertising	16	2	11
Salaries	728	0	0
Law expenses	2	4	6
General charges	251	19	11
Insurance fund	1,000	0	0
Depreciation and renewal fund	4,500	0	0
	29,480	9	3
Balance carried to net revenue account	6,392	12	1
	£35,873	1	4

Cr. Receipts.	£	s.	d.
Traffic receipts	35,264	13	5
Advertising rents	522	2	2
Old material, etc.	58	6	11
Damage to cars and costs, etc.	11	16	4
Fines for breach of by-laws	2	0	0
Charges and stamp duty *re* loans	14	0	0
Mortgage transfer fees	0	2	6
	£35,873	1	4

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TO CORRESPONDENTS.

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THE CAMBRIDGE MEETING.

The British Association for the Advancement of Science have this year had a most successful meeting in the university town of Cambridge. The advantages of holding the annual gathering of the association in a town devoted as Cambridge is to the dissemination of knowledge are many. In the first place, it is the home of numerous scientific men who are the better able to put before the meetings their most recent researches. In the second place, the facilities in the way of lecture theatres are good, and every modern appliance has been placed at the command of the readers of papers. Thirdly (but first, as the wicked detractors of the British Association would say), the opportunities for sightseeing, garden parties, and social functions generally are exceptional. This year the association was honoured by having the Prime Minister as president. The Right Hon. A. J. Balfour, M.P., has every qualification for this position, and filled it admirably. The presidential address showed the depth of his scientific thought, and his regular attendance at the meetings of the sections was evidence of his keen desire for further information. We are afraid that this afforded little refreshment to the Prime Minister after his arduous work of the past session. It is true, in a sense, that a change of employment is a rest, but the atmosphere of the room in which Section A was held was even worse than that in the House of Commons after an all-night sitting. It was a good reply to those who hold that the British Association is merely a scientific picnic. The drawing office of the engineering laboratory was used by this section, and on Tuesday last was crowded throughout the whole of the morning to hear a number of communications on radioactivity and ionisation. These subjects have been the successful hunting ground of the Cambridge school of scientists under the able leadership of Prof. J. J. Thomson. When, therefore, this expert, Lord Kelvin, Prof. Schuster, and other workers on the subject were communicating their original results an exceptionally large audience was attracted, and but for the state of the air in the room one could truly say they were listened to with breathless interest. Prof. J. J. Thomson's opening speech in the discussion on the radioactivity of ordinary matter was a masterly exposition of the researches carried out at Cambridge under his direction. He showed the extreme difficulty of distinguishing between the primary radioactivity of a substance and the radioactivity induced in it by the influence of other radioactive substances, such as radium and thorium. There was also the difficulty of deciding whether a substance was radioactive because of its impurities containing small quantities of these radioactive materials. Prof. Thomson described how by enclosing a small charged plate in a metal box, and screening this box from outside rays, his students had secured definite and consistent figures as to the ionisation of the enclosed air. With different metals for the sides of the box, consistent varying results were obtained, even although the same metal used in two experiments came from widely different parts of the earth. Experiments in altering the size in the containing boxes enabled further analysis as to the source of the waves to be made, and the conclusion arrived at was that all ordinary matter was more or less radioactive. Definite figures were given, and although the conclusions were disputed by one or two other scientists, they were generally accepted. The compliment paid by Sir Oliver Lodge to the Cambridge experimenters is worthy of repetition. He said that there were such a large number of experimenters now at work on radioactivity, and such a legion of experiments published, that one

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could not begin to remember them all. It was only at Cambridge that theory and fact were advancing together, and the theory enabled the facts to be remembered. Other sections of the association were also well attended, and the papers brought before Section G were of a higher order than usual. The section, however, is still as badly organised as ever, and the engineering committee would do well to take a lesson from Section H, which is devoted to anthropology. In this section eight or nine communications were frequently got through in a morning, due to the fact that the time allowed for each was fixed beforehand. In the engineering section the first two or three papers took the whole of the time each day, and then the members adjourned to lunch, leaving the other authors to read their communications to the president and secretary.

FORTHCOMING EVENTS.

SATURDAY, SEPT. 3.

Association of Municipal and County Engineers.—District meeting at Birmingham.

APPOINTMENTS VACANT.

Mechanical Engineer. Messrs. Deacon's, Leadenhall-street, E.C. See advertisement.

Station Superintendent, Ilford electricity supply works. Salary £150 per annum. See advertisement.

Electrical Engineer. Mr. Frank Broadbent, consulting engineer, 4, Queen-street-place, E.C. See advertisement.

Draughtsman, Croydon. Salary £2. 5s. per week. Applications to Mr. Alex. C. Cramb, borough electrical engineer, Electricity Works, Croydon, by Sept. 5. See advertisement.

Switchboard Attendant, Kirkcaldy electricity works. Wages 25s. per week. Applications by 27th inst.

Resident Electrical Engineer, Willesden Urban District Council. Salary £250 per annum. Applications by Sept. 17.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY AT GLASGOW.

SIR,—I see that it is necessary to proceed patiently with this discussion, and to settle one point at a time. In his paragraph last week "W. O. T." calmly ignores the fact, clearly shown in my letter above, that the 1897 estimate described a totally different system from "the then existing system," and he assumes that it described a similar equipment. Mr. Bennett, in his communication, contributes several fresh errors and contradictions.

I must again state the point we are discussing. It is that the 1897 estimate was made "for the special purpose of showing what *the then existing telephone system* in Glasgow *ought to have cost* the National Telephone Company." "W. O. T." has said that he believes this to be entirely true, and that he has based all that he has written on it.

Now, sir, the first point of all, and one that I regretfully note "W. O. T." has extreme difficulty in grasping, is that an estimate to show what an existing system ought to have cost would describe a system similar to the existing system. The existing system of the National Telephone Company in Glasgow in 1897 was an overhead single-wire system. That is clearly shown in the report of the enquiry. If the estimate has been drawn up for the purpose of showing *what the existing system ought to have cost*, it would have described a similar system—that is, an overhead single-wire system.

I think I made it clear to any ordinary reader of my last letter that the estimate did *not* describe a similar system. It described a totally different system, and Mr. Bennett, in his evidence describing his estimate, drew as many distinctions as possible, in respect to the general design of the system, the quantity and quality of materials to be used, and the number of junction lines and switch-rooms to be provided, between his proposed system and the existing system. Therefore, the equipment described in the estimate and by the estimator was not a similar equipment to the existing equipment, but a totally dissimilar one.

"W. O. T." says he wants the truth. Why, then, should he persist in stating what is not the truth? In his paragraph appended to my last letter, notwithstanding that it is clearly shown in that letter that the 1897 estimate described a totally different system from the 1897 existing system, he persists in referring to the estimate as if it described a system similar to the 1897 existing system. He says, Mr. Bennett asked himself what would be the cost to replace the company's equipment by *a similar equipment*. He says, Mr. Bennett and the town clerk of Glasgow got tenders for *a similar equipment*. And again, below, he refers to the Glasgow committee being satisfied with the equipment *similar to that which existed*.

This is not argument, it is a weary reiteration of error. There is no similarity between a metallic circuit underground system and an overhead single-wire system. The estimate described a metallic circuit underground system, the existing system was a single-wire overhead system; therefore the estimate did not describe, the town clerk did not get tenders for, and the Glasgow committee did not consider a *similar equipment* to the company's equipment of 1897. Until "W. O. T." can realise this point clearly, we are arguing at cross purposes.

Regarding Mr. Bennett's communication, the value of it is somewhat diminished by the fact that it was written as an editorial, to be published anonymously, and it is still further diminished by the fact that whereas Mr. Bennett assumes that he is answering my criticisms, he is really trying to answer his own contradictory statements.

Mr. Bennett seems to have been not wholly frank in his evidence before the 1898 Select Committee. He was asked if there were anything to modify his evidence at Glasgow, and he said "No." Why did he not tell the committee that the Glasgow estimate "was for the special purpose of showing what the then existing telephone system ought to have cost the National Telephone Company"? That would have entirely changed the bearing of his evidence.

Apparently, Mr. Bennett now wishes to imply that his evidence regarding the Glasgow estimate before the 1898 Select Committee was subject to the mental reservation that it referred only to the possibility of building in Glasgow a certain kind of system, of a certain size, serving in a certain way a certain fixed group of subscribers situated in certain fixed localities, for a certain capital sum. The committee certainly did not take Mr. Bennett in that way; their report plainly shows that they understood him to be instructing them in the cost of telephoning the Glasgow area.

I am aware that Mr. Bennett "hedged" on his Glasgow estimate under cross-examination, but that is nothing unusual. Mr. Salvesen, after the estimate had been criticised in detail, hedged still further, but he was only backing up his client, as is a lawyer's duty.

Mr. Bennett now makes the remarkable statement that the National Telephone Company asserted that they had spent on their 1897 Glasgow system "four or five times the amount which Mr. Bennett estimated was the proper expenditure for an exchange of that kind." Am I correct in interpreting this to mean that the National Telephone Company asserted that they had spent £400,000 or £500,000 on an exchange of 5,000 lines, and will Mr. Bennett kindly give his authority for that statement.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, S.W., Aug 22, 1904.

SIR,—I have made up my mind to take no further notice of Mr. Webb's stupidities, but in view of "W. O. T.'s" remarks in your last issue, I think the annexed excerpt from the proceedings of the Local Government Board telephone enquiry in Hull last year, taken from the Hull *Daily News and Express*, will be of interest, as it shows that "W. O. T.'s" views coincide entirely with the Local Govern-

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ment Board inspector's. Mr. Webb, in his evidence, had stated exactly what he has done in his letters to you about the original five-thousand line system at Glasgow, and he and Mr. Robb did their best to make capital out of it in favour of the National Telephone Company. Colonel Slacke, however—who I may say was unknown to all the parties—consulted the Glasgow Blue-book for himself, and then committed himself to the strong language reported as to Webb's and Robb's conduct. You will see that "W. O. T." and Colonel Slacke arrive at exactly the same opinion. This incident, being unfavourable to the National Telephone Company and its advocates, is not included in the so-called Blue-book of the Hull telephone enquiry recently published by one of your contemporaries.

It will perhaps be within your recollection that Sheriff Jameson, the commissioner of Glasgow, in his report referred to my original estimate in terms which proved that he understood it thoroughly, and never thought of construing it in the same way as Webb would have you believe that he does.

Mr. Webb has consequently both the Hull and Glasgow judges against him.—Yours, etc, A. R. BENNETT.

The telephone enquiry was continued at the town hall this morning before Colonel Slacke, the Local Government Board inspector. The town clerk (Mr. E. Laverack) again appeared for the Corporation, whose application was supported by Mr. Dixon, on behalf of the Hull and District Chamber of Trades, and Dr. Woodhouse, on behalf of a ratepayers' committee. Mr. Robb and Dr. T. C. Jackson opposed.

At the outset Mr. James Watson remarked that there were two points upon which he would like to have a clear understanding. Supposing there were not sufficient subscribers to the municipal telephonic system to meet the working expenses, etc., could they increase the rates in the future to meet any deficiency?

The Town Clerk: Certainly.

With respect to moneys that you have borrowed for a specific purpose—those moneys are only used for that specific purpose?

The Town Clerk: That is so.

The Inspector: If there be any deviation from the scheme put forward, it would have to be submitted to the Local Government Board.

MR. ROBB AND HIS ASSERTIONS.

Mr. Bennett then asked Mr. Robb if he was prepared to withdraw what he said yesterday about the Glasgow enquiry. Mr. Robb had made certain allegations, and he (Mr. Bennett) earnestly wished that they should be withdrawn.

The Inspector: I remember the incident quite well.

Mr. Rabb (emphatically): I am not prepared to withdraw. My view on the matter is the same now as it always was, and is in harmony with the views of everyone who attended that enquiry. Mr. Webb, who gave evidence at that enquiry, tells me that Mr. Bennett's system for 5,000 subscribers was, in the first instance, evidently put in as a working scheme. Well, it is true that in the course of the enquiry Mr. Bennett referred to it as a mere comparison, and that he did say, after he actually proceed to telephone the city, that he would provide for a larger scheme.

GLASGOW AND HULL.

My point is this, that Mr. Bennett is suggesting a similar system here. In the Glasgow system Mr. Bennett said he would provide for 5,000 subscribers only, because it compared with the 5,000 subscribers of the National Telephone Company there. But in Hull Mr. Bennett is providing less—he is providing for 2,000 subscribers, where the National Telephone Company have 3,000 subscribers. Wherefore, if Mr. Bennett proceeds on the same scheme as Glasgow——

The Inspector: That is not the point. Mr. Bennett merely put forward the system for 5,000 subscribers as a scheme.

Mr. Robb then proceeded to quote from the report of the Glasgow enquiry, and concluded with the words, "There, sir, I think that clearly proves my point."

"PERFECTLY UNJUSTIFIABLE."

The Inspector: To my mind it clearly proves that you have taken the wrong view (laughter). I don't think you ought to have expressed your opinion in the way you did yesterday with regard to Mr. Bennett. It has been the only incident in this enquiry that I might describe as being of a personal matter. I was in the hopes that this enquiry would have been conducted free of personal references. Under such a serious allegation I think Mr. Bennett is perfectly right in calling attention to the incident. I think that such a remark was perfectly unjustifiable, and I regret that this personal element has been introduced. I further think that the movers in this scheme appear to have been actuated only by their views as to what is best for the city, and, in that way, for the ratepayers, and I cannot believe it is in accordance with the views of those for whom you are acting that you should express yourself in the manner you did.

Mr. Robb: I put it forward not as a personal matter, but as an illustration.

The Inspector: Well, I will hear no more of the matter.

SIR,—I am just a little surprised at Mr. Bennett's vindication of himself. It is all right, of course, as far as it goes, but, as an outsider, though desirous of getting at the real facts, I should have thought his triumphant vindication would have been found in Mr. Andrew Jameson's report dated Nov. 29, 1897, issued 1898 (C 8,768); price, 2½d. Mr. Jameson heard all the evidence for and against, he being the gentleman instructed to hold the public enquiry. After referring to another estimate Mr. Jameson goes on to say:

"But a new estimate has now been prepared by Mr. Bennett, which is based upon the footing of there being the same number of subscribers as there are at present to the National Telephone Company, and which shows a capital expenditure of £97,833. 3s. 8d., and professes to show a satisfactory working of the system at a uniform charge of £5. 5s. per instrument all over the Glasgow district area. As will be seen from Mr. Bennett's cross-examination, the correctness of this estimate is questioned by the National Telephone Company; but the estimate itself is of very little use for practical purposes, because from what the counsel for the Corporation said in answer to the commissioner, it appears that Mr. Bennett's view, if he were to advise the Corporation, is that they should lay down a system sufficient to accommodate from 20,000 to 25,000 subscribers, as, indeed, Mr. Bennett himself says. This would, of course, cost a great deal more money—perhaps about four times as much as the estimate of £97,833. 3s. 8d.; but this view seems not to have occurred to the gentlemen who considered this matter on behalf of the Corporation, because Bailie Alexander, the convener of the Telephone Committee, only contemplates spending £100,000 to £120,000, while it is quite certain that a very much larger sum than that would be required to establish a system for 25,000 subscribers. And Treasurer Colquhoun has apparently not gone into the question as to how much every new 1,000 subscribers would cost, although he says they look forward to getting ultimately 40,000 to 50,000 subscribers in Glasgow. All this shows that the Telephone Committee of the Corporation have not as yet really faced the question of finance."

If this conclusion of the "judge"—for judge he was in this case—means anything, it means that Mr. Bennett's estimate was just what Mr. Bennett says, an estimate for the purpose of showing what the system then in existence ought to have cost; and that Mr. Bennett's own estimate, when made, would be for an expenditure, not of £97,000 or £100,000, but about four times that, or £400,000.

Just one word as to Mr. Webb's play of words on the question of similarity or similar. It will be time enough to discuss whether I ought to have said "identical" rather than "similar" when the more important subject is decided, but I used "similar" because I did not mean "identical," only approximating to that which existed something almost or quite equivalent to what existed, as regards results to be obtained, though not absolutely identical as regards every detail of equipment. Neither Mr. Bennett, nor the "Town Clerk," nor even Mr. Webb would obtain tenders for identically the same things that existed, a close approximation being all that was required for the purpose in view. I suppose the difference between the "metallic circuit underground" and the "overhead single-wire system" was discounted for what it was worth by the judge. My point, however, is a very different one. The estimate—"identical, or "similar," or "approximate," whatever word be used—was not for work to be done, but for another purpose, to get, if you like, "approximately at the cost," "near enough for the purpose in view" (which phrases are glosses on Mr. Bennett's words, "ought to have cost"—of "the then existing telephone system." The idea so evidently conveyed to the judge was that Mr. Bennett's proposals, if ever formulated, would cost nearer

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£400,000 than £100,000, and that those proposals were not on the same lines as those on which the estimate was founded. If this is the correct view, and, as I say, it has the imprint of the "judge" who heard all the evidence, this well-discussed estimate has no more to do with the actual work carried out than had Zenophon.—Yours, etc., W. O. T.

[We are not altogether satisfied with the use of such words as "stupidities." Mr. Webb is entitled to say what is his interpretation of a certain estimate, and Mr. Bennett is entitled to deal with that interpretation in two ways: (1) With a direct negative; if that is rejected, and no further evidence be forthcoming, the world must judge of the relative credibility of the opponents. (2) To reinforce the negative with variant interpretations by others in a position to judge as well, or better, the facts of the case as his opponents. Mr. Bennett has given the direct negative. His assertion is supported by Mr. Jameson's report, also by the remarks of Colonel Slacke, which he says deals with the same question, though the excerpt he gives from the Hull paper leaves the exact question to which Colonel Slacke referred in doubt. It requires Mr. Robb's statement of the previous day.—ED. *E. E.*]

ARTIFICIAL LOADS.

SIR,—Referring to Mr. Davis's letter which appeared in your issue of 12th inst., I beg to say that I quite agree with him, that it is the publishing of one's experience, together with the general details and results obtained, that does much towards forwarding the general knowledge, but should like to remind him that exchanges of opinion, together with discussions from others who can claim to have had experience in the subject, are certainly healthy points, and must also go far toward assisting in the above object. Therefore, it was only with this object in view that I endeavoured to point out that although the method he used was certainly an improvement upon any arrangement of tubs or wire resistances—and I have not the slightest doubt but that the tank he mentioned proved itself both useful and satisfactory—there are still points which I thought might be improved upon, some of which have been mentioned, points which I have found by experience, and which have also been proved by other engineers, to be quite correct.

With regard to the question of earthing the tanks, I may say that there is nothing in this method that would specially recommend its practice. Personally, I have always considered it an unmerciful test upon the insulation of either dynamo or motor, especially in such places as a large engineer's testing department, where pony brakes, water brakes, surface-condensing plants, water-resistance tanks, pumps, and cylinder drains are all helping to saturate the atmosphere with moisture, which, settling on the insulation, does not tend to strengthen or increase its resistance. Besides, no practical engineer would think of running the machine under full load at the maximum voltage in order to test the insulation. Better by far test this with the proper instruments before starting up. Generally speaking, when a set is run for some hours on trial, it is for the purpose of testing the combined efficiency and general behaviour of same with regard to the rise in temperature, etc., and not so much for testing the insulation, because should there be any weak point in the insulation not detected before starting up it, is almost certain to burn up and probably ruin half the winding long before you can shut down.

Mr. Davis and "A.M.I.C.E." seems to be under the impression that the chief reason for using the earth system is to prevent serious results from shocks, which impression is entirely wrong, as it can be shown that the risk from shocks is far greater, when using the earth system, than when completely insulated from all earth circuits. With regard to the lives of the attendants being at stake, this is certainly an exaggeration. My advice is to see that all connections are both mechanically and electrically made before thinking of coming up under load, and not to allow any assistant to attempt to complete any unfinished work. Whilst the machine is on load there is no reason for having to handle any part of the circuit beyond adjusting the brushes or working the switches, which should, of course, be properly protected.

What I wished to point out regarding the use of chemicals was, that in order to get a very steady run it is necessary to keep the conductivity of the water perfectly constant, and this can only be done in two ways—viz.: (1) by keeping the temperature of the water constant by circulating a sufficient volume; and (2) by drawing the circulating water from some large source, such as a canal, of course taking great care that the suction pipe is right away from any works drains, and so prevent any possibility of contamination. Mr. Davis mentioned that occasion may arise when it would be an advantage to put a small quantity of chemicals into the tank, in order to get the last few amperes and so build up the full load, but this would be practically useless with a heavy circulation of water. What I would strongly advise him to do would be to increase the cross-section of the water by increasing the depth in order to build up the load, and this could easily be done with a suitable arrangement for adjusting the overflow. This, together with an arrangement for varying the distance between the electrodes by lowering the one tank into the other, would give his tanks a wide range of adaptability, and hence do away altogether with the need for chemicals. I should like to ask Mr. Davis to look up the back numbers of this paper for the month of March, in which he will read that a representative of a very large firm—makers of high-speed engines—read a paper on Feb. 17 before the Institution of Electrical Engineers, in which he clearly told the members that for some years past they had only used canal water for their tanks, and that on no account were chemicals allowed to be used. Then, surely, if a works of such magnitude, with a large testing department constantly making tests, find the canal water quite a success, I do not think that either Mr. Davis or "A.M.I.C.E." need have any fear in using it, providing proper care is exercised when deciding upon the position of the suction pipe.—Yours, etc, YRREB.

SIR,—Referring to the remarkable letter by "A.M.I.C.E." in the *Electrical Engineer* for Aug. 12, which is an outburst of nothing—at least, not of importance—and is also quite devoid of any real practical help upon the subject. In other words, it is a clear admission of carelessness and inexperience with these matters.

Every one of his remarks quite confirm this conclusion. Take, for instance, that part in which he states, "Mr. Davis points out the desirability of doing without acid or alkalies to reduce the resistance of the water, and emphasises the alternative method—a rapid changing of the water." Of course, meaning to say that, instead of using acids or alkalies to reduce the resistance of the water, he would effect a rapid changing of the water to produce this. Now, if he were running a dynamo set on part load, and wished to increase the load by lowering the total resistance of the tank, surely he does not mean to say that a rapid changing of the water would do this. If so, then I venture to say that he is entirely wrong with such an impression; what it certainly would do, if anything at all, would be to lower the temperature of the water in the tank, and by so doing, considerably increase the total resistance of the circuit, which in turn would take off greater part of the load, and therefore upset everything.

Then, again, it is quite absurd to attempt to show that a large body of water such as a canal is likely to instantly change in its physical properties or conductivity, and so bring about such a violent change in load such as he speaks of. But what it really does show in the remarks is that someone had evidently fixed the pump suction pipe very near the drains of some other works, and that any stream of impurities which may come down during the test he got the full benefit of. Which would, to say the least, be gross carelessness on the part of the one responsible for selecting the place to fix the suction pipe.

Then, again, the film of oil, and his impression upon the effect of such, is radically wrong, as anyone who has had occasion to use condensed water for the resistance or test tank, or who may have studied the physical change that

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would be produced by the addition of oil into water, would know that it is quite different in effect to that he mentioned, and cannot be responsible for the great fluctuation in load of which he has experienced. It rather suggests that "A.M.I.C.E.," or someone else, may have been oiling the overhead gear, and quite carelessly dropped the oilcan down between the electrodes in the tank, which would doubtlessly cause such a great change in the load he speaks of. If "A.M.I.C.E." is anxious to become a successful engineer, he must drop all slipshod methods, and carefully consider what he is going to do before he starts, provide proper tanks with ample supply of circulating water, suitable arrangements for varying the load, avoid all chemicals, and, above all, carefully avoid placing the pump suction pipe up the drain of some chemical works. If he will do this, he will meet with better results The indicator cards may not be quite so picturesque as before, but from an engineer's point of view they will be much better.—Yours, etc., YRREB.

THE HOPKINSON TEST AS APPLIED TO INDUCTION MOTORS.*

BY W. E SUMPNER, D SC, AND R W. WEEKES, M.I E.E.

The late Dr. Hopkinson was, as is well known, the first to suggest a method of testing direct-current dynamos by arranging similar machines in pairs so as to circulate the power, the portion of the power wasted being supplied from some external source. The method and its advantages are well known in regard to direct-current machinery. The principle of the method is, of course, applicable to any form of apparatus capable of transforming energy in a reversible manner. It was applied to the testing of alternating-current transformers by one of the writers some years ago, and it has since been utilised for the testing of alternators. The application to three-phase machinery involves some special points, and the writers, who have lately tested a number of induction motors by this method, have found it so satisfactory that it seems desirable to draw attention to the experimental details involved in the test.

The two similar machines have their stators connected with the mains, while their rotors are belted together. Switches must be used with the stator connections if the rotors are of the short-circuited type, but are unnecessary if the rotors are supplied with starting resistances. The connections must be such that the belt is driven in the same direction whichever motor is started. The pulleys on the rotors must be of different diameters, since one rotor must run above and the other below the synchronous speed The ratio of the diameters must be such as to cause the right amount of slip for the load required, assuming the rotors are to remain short-circuited during the test. If the slip of each motor is 3 per cent. at full load, and if 12 per cent. of the load is lost in each machine, the overload of one machine will be approximately 24 per cent, corresponding with a slip of $3\frac{3}{4}$ per cent.; while the other machine, working as generator, will give out full load and have a negative slip of 3 per cent. The pulley diameters must thus differ by $6\frac{3}{4}$ per cent., assuming no mechanical slip between the belt and the pulley, or if 1 per cent. be allowed for this, the pulleys must differ by about 8 per cent. in size. With such pulleys the machines, when switched on to the mains, will be subjected to a perfectly steady load admirably suitable for a long run on load. But with given pulleys the load cannot be adjusted or altered unless resistance is put in the rotor circuits. This can easily be arranged by using low-resistance connections between the rotor slip-rings and the short-circuited starter, or, better still, by using, when available, a rotor starter which can stand the passage of the load currents through the rotor circuits. By adjusting the position of the starting switch the load can be then adjusted to any desired amount, if the rotor pulleys have been chosen sufficiently different in size to fully provide for the slips required. The losses in the rotor resistances are very small, and can in most cases be neglected. They are, however, easily measured, and should be subtracted from the power taken from the mains in order to arrive at the total losses in the two machines and in the belt drive.

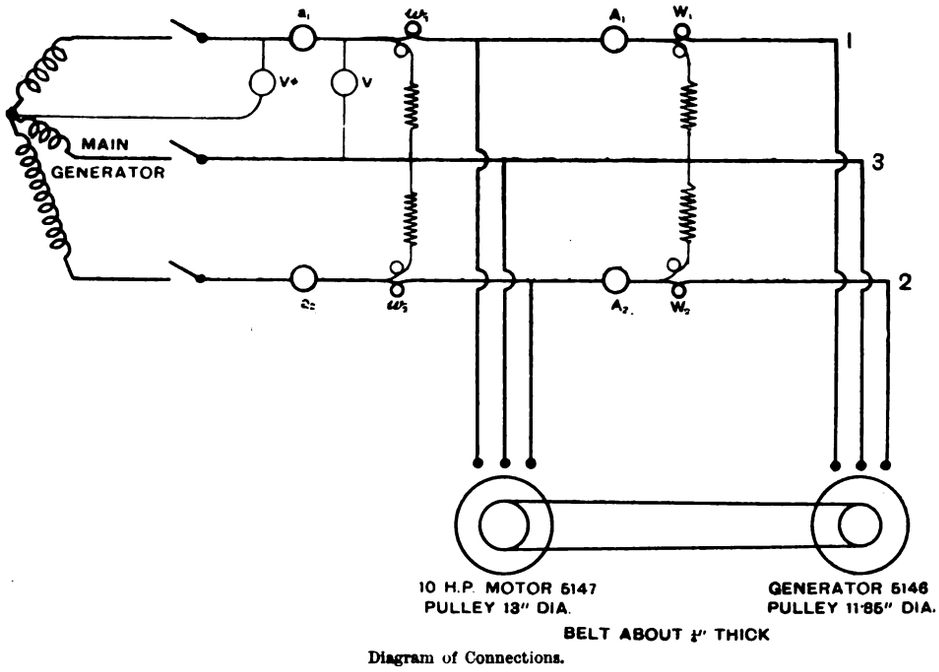

Diagram of Connections.

Another method of adjusting the load consists in altering the voltage of supply. For given values of the slip the torque of the machines, and therefore the load, is proportional to the square of the voltage.

The arrangement of instruments and circuits is shown in the diagram. The power, *w*, taken from the mains must be measured, and also the power, W, in the circuit between *one* of the machines and the mains. The machine used as motor, of course, takes the greater amount of power, and if W refers to the power given out by the generator, $W + w$ is the power supplied to the motor. Otherwise the difference between these quantities is the power given out by the generator. The load of each machine and the losses in the two are thus determined, and the efficiency can be obtained in the same way as for direct-current machines. In regard to the measurement of power, it will be found sufficiently accurate for all commercial measurements of efficiency to use the single-wattmeter method (which assumes that the load is balanced between the circuits) and treble the reading of a wattmeter with its current coil

* Paper read before the British Association at Cambridge.

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TABLE I.—TEST OF TWO 10-H.P. THREE-PHASE MOTORS, TAKEN APRIL 16, 1904.
No. 5,147 as a motor driving No. 5,146 as a generator.

No. of reading.	Time. p.m.	a_1.	a_2.	w_1. neg.	w_2.	A_1.	A_2.	W_1.	W_2.	V.	Vϕ.	⌒	Rotor period, seconds. G.	Rotor period, seconds. M.	Stator temperature, F°. G.	Stator temperature, F°. M.
1	4.23	28·0	25·6	1·24	3·58	24·0	26·4	4·88	2·64	210	131	41·6	·75	·50	—	—
2	4.39	27·2	25·2	1·20	3·77	25·0	26·0	4·88	2·73	205	129	41·2	·75	·50	—	—
3	5.0	26·0	25 0	1·12	3·51	24·1	25·0	4·45	2·51	203	126	41·0	·75	·50	—	—
4	5.15	26·3	25·0	1·12	3·41	24·0	24·2	4 31	2·51	205	127	40·0	·75	·50	90·5	98
5	5.40	28·7	28·0	1·48	4·48	26·0	26·5	5·51	2·90	225	140	41·5	·78	·49	93·5	103
6	6.15	27·5	28·5	1·32	4·35	25·0	25·5	5·30	2·86	220	136	41·5	·75	·50	98	110
7	6.50	27·0	27·5	1·20	4·23	25·0	25·0	5·30	2·84	220	136	41·0	·75	·50	100	113
8	7.25	28·0	27·8	1·32	4·36	24·0	25·0	5·30	2·82	220	137	41·0	·79	·49	100·2	114
9	7.55	27·0	27·5	1·40	4·03	24·0	25·0	5·10	2·75	218	134	40·6	—	—	100·5	114·5
10	8.10	21·3	22·0	1·16	2·93	0	0	0	0	218	—	40·6	3·8	·30	—	—
11	—	20·6	21·0	1·88	2·56	0	0	0	0	218	—	40·6	—	—	—	—
12	8.20	20·0	21·0	1·48	2·66	0	0	0	0	218	—	40·6	8·0	—	—	—

NOTES.—Reading No. 10 was taken with belt on, stators excited, rotor of motor open-circuited.
" No. 11 was taken with both rotors open-circuited, stators excited, machines standing.
" No. 12 was taken with belt off, both motors running light. Temperature of air, 64deg. F.

TABLE II.—RESULTS DEDUCED FROM OBSERVATIONS IN TABLE I. AS TO EFFICIENCY AND POWER FACTORS OF TWO 10-H.P. THREE-PHASE MOTORS.

Number of reading.	Loss from mains Kw. $w_1 + w_2$.	Separated losses – ·5 kw. for belts. Motor. Kw.	Separated losses – ·5 kw. for belts. Gen. Kw.	Gen. output $W_1 + W_2$	Motor efficiency. Input. Kw.	Motor efficiency. Output Kw.	Motor efficiency. η	B.H.P. 10 h.p.	Generator efficiency Input Kw.	Generator efficiency Output Kw.	Generator efficiency η	Slip %. M.	Slip %. G.	Power factor of motor. $W_1 + w_1$.	Power factor of motor. $W_2 + w_2$.	Power factor of motor. Ratio.	Power factor of motor. Cos φ.	Power factor generator. W_1/W_2.	Power factor generator. Cos ϕ.
1	2·34	1·10	·74	7·52	9·86	8·76	88·9	1·17	8·26	7·52	91·1	4·81	3·21	3·64	6·22	·583	·912	·540	·89
2	2·57	1·24	·83	7·61	10·18	8·94	88 0	1·20	8·44	7·61	90·3	4·86	3·25	3·68	6·50	·566	·903	·560	·90
3	2·39	1·13	·76	6·96	9·35	8·22	88·1	1·10	7·72	6·96	90·1	4·88	3·27	3·33	6·02	·550	·895	·565	·90
4	2·29	1·07	·72	6·82	9·11	8·04	88 3	1·08	7·54	6·82	90 5	5·00	3·33	3·19	5·92	·537	·887	·584	·91
5	3·00	1·54	·96	8·41	11·41	9·87	86·6	1·32	9·37	8·41	90·0	4·97	3·10	4·03	7·38	·545	·893	·527	·88
6	3·03	1 52	1·01	8·16	11·19	9·67	86·5	1·30	9·17	8·16	89	4·83	3·21	3·98	7 21	·550	·895	·540	·88
7	3·03	1·57	·97	8·14	11·17	9·60	86·1	1·29	9·10	8·14	89·5	4·88	3·27	4·10	7·07	·580	·910	·536	·88
8	3·03	1·57	·97	8·12	11·15	9·58	86	1·29	9·08	8·12	89·5	4·99	3·08	3·98	7·17	·557	897	·533	·88
9	2·63	—	—	7·85	—	—	—	—	—	—	—	—	—	3·7	6·78	·547	·894	·539	·89
10	1·77	—	—	0	—	—	—	—	—	—	—	8·2	·65	—	—	—	—	—	—
11	·68	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	1·18	—	—	0	—	—	—	—	—	—	—	·31	·31	—	—	—	—	—	—

placed in one circuit, and its volt coil connected between this and the neutral point. It is, of course, more accurate to use the two-wattmeter method as sketched in the diagram. The connections are then less simple, but from the ratio of the two-wattmeter readings the power factor of the circuit can be determined independently of the ordinary method of comparing the watts with the volt-amperes. Care must be taken in reading the wattmeters in the main circuit if the two-wattmeter method is used, since one of these readings will be negative owing to the low power factor of the current taken from the mains. A curious point about the test is that the machine used as generator produces current of about the same power factor as that of the current supplied to the motor, while the current supplied by the main circuit consists of the difference of the power components of the machine currents, together with the sum of the inductive components of these currents. The result is that the power factor of the current from the mains is very low, only about one-third of that of the machine currents. It thus happens that while the power taken from the mains may be less than one-third of that circulating round the machines, the current from the main generator is about equal to and may exceed that passing through the machines, a striking contrast with what happens in the corresponding test of direct-current dynamos.

The slip of each machine can be determined most conveniently and accurately by measuring the frequency of the rotor currents by suitably shunting any ordinary low-reading direct-current voltmeter to the slip-rings of the rotor. The period of the slow oscillations of the pointer can be measured with greater accuracy than the frequency of the main circuit currents. The ratio of the two frequencies is, of course, the slip of the machine.

A most interesting point in connection with the tests is the possibility of determining the belt losses, and the value of the mechanical slip between the belt and the pulleys. The losses due to the belt drive are caused by (1) extra bearing friction and in bending and driving the belt; (2) heating of the pulleys due to belt slip. The former loss (1) can be measured by reading the wattmeter in the main circuit, firstly, when only one machine is in circuit and driving the other by belt (with its stator excited, but with its rotor open circuited), and, secondly, when both machines are running light with the belt off. The difference of the two readings gives the belt driving losses. The latter loss (2) is determined by the ratio of the circumferential speeds of the two pulleys. This is a quantity difficult to determine with any accuracy in ordinary belt drives. The above test seems specially suitable for determining its amount. The ratio of the rotor speeds is

$$\frac{F + g}{F - m},$$

where F is the frequency of the current from the main generator, m that of the currents in the motor rotor, and g that of the currents in the generator rotor. Now, m and g are quantities which can be very accurately determined, and are each small compared with F, so that, although F cannot be determined with such great accuracy, the form of the above formula shows that the ratio is not appreciably affected by small errors in F. Thus the ratio of the rotor speeds can be very precisely measured. To obtain the ratio of the circumferential speeds of the pulleys, we have merely to multiply the above number by the ratio of the pulley circumferences, a quantity which can be accurately determined. A good experimental means thus exists for finding the actual values for the slip of belts under various conditions.

A number of experimental results obtained in testing various motors by this method have already been published by the authors in the *Electrical Engineer* for June 17 last, and some of them are reproduced in the appendix. Experience with the method shows that it possesses all the advantages associated with the Hopkinson test of direct-current machines. If anything, the experimental arrangements are easier to make with induction motors than with

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TABLE III.—HOPKINSON TEST OF TWO THREE-PHASE MOTORS.

30-h.p. machine as motor, 25-h.p. machine as a generator.

No. of reading.	Time.	a_1.	w_1. neg.	w_2.	A_1.	A_2.	W_1.	W_2.	V.	$V\phi$.	⌒	Rotor period second. G.	Rotor period second. M.	Stator temperature deg. F. G.	Stator temperature deg. F. M.
1	12.10	109·5	4 95	19·1	95	94	10·6	20·7	220	140	41 2	·65	·50	—	—
2	12.20	105	4·4	18 0	93·5	91	9 8	19 6	213	134	41·8	·65	·52	—	—
3	12.45	104 5	5·28	18·45	88	87	9·7	19·45	225	142	40·5	·76	·53	118	133
4	1.45	94·5	5·06	16·32	76	74·5	8·25	17·20	224	142	41·75	·87	·56	131	145
5	2.15	91	4 82	15 20	73	71	8·3	15·3	224	142	40·8	·85	·59	130	143
6	2.18	84	3·30	12·70	69	67·9	7 0	13 45	193	123	40·8	·78	·46	—	—
7	2.22	78	4·82	12·90	60	56	5·4	12·95	225	142	40·8	1·16	·36	—	142
8	2.52	95·5	5·50	16·4	74	72·5	7·9	16·4	224	142	41·5	·95	·60	128·5	147·5
9	3.10	88	4·75	15·2	71	69·5	7·4	15·8	229	144	41·8	·93	·56	129	146·6
10	3.20	67	4·84	10·6	39	37	1·5	8·4	225	143	41·8	2·06	·31	—	—
11	3.30	89	3·75	13 8	70	73	7·7	14·05	197	123	41 0	·75	·50	127	144
12	3.33	59	4·84	8·68	26	25	—	—	220	140	41·0	·30	4·0	—	—
13	3.35	56	5·29	7·61	24	25	—	—	220	138	41·0	—	—	—	—
14	3.40	56·5	4·72	7·82	24	23	—	—	220	136	41·0	30·0	5·4	—	—

NOTES.—Reading No. 5 was taken at a low voltage.
" No. 6 was taken with the first step of the motor rotor resistance in circuit.
" No. 10 was taken with the two steps of the motor rotor resistance in circuit.
" No. 11 was taken under varying conditions, and is not reliable.
" No. 12 was taken with belt on and the motor driving the generator with its rotor circuit open.
" No. 13 was taken with both rotors open-circuited and the machines standing.
" No. 14 was taken with the belt off, both motors running light.

TABLE IV.—RESULTS DEDUCED FROM TABLE III. AS TO THE EFFICIENCY, POWER FACTOR, AND SLIP OF 25-H.P. AND 30-H.P. MOTORS.

Number of reading.	Power supplied. w_1+w_2.	Separated losses = ·60 kw. for belts. Motor. Kw.	Separated losses = ·60 kw. for belts. Gen. Kw.	Gen. output W_1+W_2	Motor efficiency. Input Kw.	Motor efficiency. Output Kw.	Motor efficiency. η	B. H.P. 30 h.p.	Generator efficiency. Input. Kw.	Generator efficiency. Output Kw.	Generator efficiency. η	Slip %. M.	Slip %. G.	Power factor of motor. W_1+w_1	Power factor of motor. W_2+w_2	Power factor of motor. Ratio.	Power factor of motor. Cos ϕ.	Power factor of generator. W_1/W_2	Power factor of generator. Cos ϕ.
1	14·15	7·66	5·9	31·3	45·45	37·79	83·3	1·68	37·20	31 3	84·4	4·85	3·73	15·75	29·7	·53	·884	·513	·874
2	13·6	7·21	5·79	29·4	43 00	35·79	83·3	1·60	35·19	29·4	83·7	4·60	3·69	15·20	27 8	·527	·883	·504	·868
3	13·17	7·08	5·49	29·15	42·32	35·24	83·5	1·58	34·64	29·15	84·1	4·19	3·25	14·17	28·15	·506	·867	·498	·864
4	11·26	6·49	4·18	25·45	36·71	30·22	82 5	1·35	29·63	25·45	86·0	4·28	2·76	12·14	24·57	·505	·867	·480	·855
5	10·38	5·78	4·00	23·60	33·98	28·20	83·1	1·26	27 60	23·60	85·5	4·16	2·88	10·48	23·23	·472	·850	·543	·891
6	9·40	5·55	3·25	20·45	29·85	24·30	81·5	1·08	23·70	20·45	86·4	5·33	3·12	10·15	19·70	·514	·875	·520	·880
7	8 08	5·71	1·77	18·35				·92				6·80	2·11	8·13	18·30	·445	·835	·416	818
8	10·90	6·30	4·00	24·30	35·20	28·90	82·2	1·29	28·30	24·30	86·0	4·02	2·54	10·9	24·30	448	·837	·482	·856
9	10·45	6·14	3·73	23·20	33·65	27·51	81·8	1·23	26·93	23·20	86·8	4·26	2·57	11·05	22·60	·489	·860	·467	·847
10	5·76	4·50	·66	9·9				·50				7·75	1·16	3·56	12·10	·294	·726	·179	·638
11	10·05	5·67	3·78	21·75	31·80	26·13	68·5	1·17	25·53	21·75	85·0	4·87	3 25	10 3	21·50	·479	·855	·549	·895
12	3·84	—	—	—	3·84	—	—	—	—	—	—	·61	8·1	—	—	—	—	—	—
13	2·32	—	—	—	2·32	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	3·10	—	—	—	3·10	—	—	—	—	—	—	—	—	—	—	—	—	—	—

dynamos, while the accuracy of the method is a greater boon with three-phase plant than with direct-current machinery, owing to the greater complication of the testing, and to the fact that alternating-current instruments are not so satisfactory as those for direct-current.

APPENDIX.

The accompanying four tables give the results obtained by these methods of testing three-phase motors. The trials were made at the Witton Works of the General Electric Company during April and May last. It is also worthy of note that the power factors calculated from the ratio of the two-wattmeter readings agrees fairly well with the ratio between the apparent and true watts. The power factors given are those obtained from the ratio of these wattmeter readings.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

V.—ON THE INTELLIGENCE DEPARTMENT.

My Dear Young 'Un,—I assume that you are going into electrical engineering in order to earn your living. Most fellows do, and those wealthy bounders who are in it for the fun of the thing ought to be dropped on for the nasty way they have of cutting prices. Now, it is an unfortunate fact that modern business is conducted on the lines of the American duel. Two Yankee gentlemen desirous of conducting an affair of honour, select their favourite six-shooters and enter a wood from opposite sides. They then stalk each other until one of them loses all further interest in the game. The only thing the outside world knows about it is that two men went into the wood and only one came out. The late lamented was the one that didn't see quick enough.

At college you don't get much practice in keeping your eye open. You get facts and figures flung at you in such an insistent manner that you tend to lose whatever talent you had for nosing things out for yourself. When you get into actual practice you will find very few people who are inclined to give you information gratis. No one is pleased to see someone else getting on too fast. You will probably discover that most useful information is carefully tucked out of sight by those who know. You will be baulked in getting at it, and you will have to guard against being stuffed up with misleading statements.

You cannot, therefore, begin too soon the habit of putting two and two together and totting them up. In other words, you must start an intelligence department for your own benefit. When, therefore, you have attended the last college lecture of the day, don't think you can go off and play cricket. Neither should you limit yourself to going home to stew preparation. Go off on your own occasionally, and explore the neighbourhood for anything engineering. Stand on the kerbstone while the road is being pulled about for the electric trams. Wander into the railway station, and get a look at the underneath of an engine. Hang about the door of the blacksmith, the cooper, the timber yard—anywhere where there is work going on—and see all you can. You will get hold of many things not written in books.

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If you can manage it, get into conversation with any engineer you come across, whether he be of high or low estate, and cultivate the use of the leading question. There is an art in asking questions which can only be compared to the knack of milking a cow. An expert dairymaid can handle a cow so persuasively that the animal positively smiles with pleasure as it yields the milk. A novice will probably induce the beast to kick the pail into the back end of last week and push the operator after it. In the same way, one man can get information from you and make you proud to give it; another makes you yearn to give a gymnastic display on his person because of his impertinence. No one can explain the difference—it is just a question of trying till the gift comes. Only two general rules can be given: Don't be shy—delicate feelings are of no commercial value, and the actual risk to life through asking questions is very small. And don't be silly—don't ask before you think. You know that in boxing, one well-delivered upper-cut does more good than any amount of wild hitting. There is generally one question which will induce your *vis à vis* to tell you just what you want to know. Ask that question and no more—and don't ask it as if your soul's salvation depends on the answer, if you particularly want one. Slip it out easily, as if you are just humouring your acquaintance by keeping up a conversation. He will then be off his guard, and may give away something which on second thoughts he would rather have kept dark.

You will find that official information is often not much use. It may be strictly true in letter, but misleading by its paucity. An official's statement is limited by two things—the facts he doesn't know himself (for very often the complete knowledge of the ins and outs of a job is limited to subordinates in immediate charge of the job), and the facts he doesn't want you to know. If he were talking freely, as man to man, he might be able to tell you things which his position with respect to his employers prevents him as a man of honour from divulging. If you want to get a plain, unvarnished account of anything, go to people who know but aren't responsible. For example, if you want to know how a certain type of engine really runs, don't go to the chief engineer, but to the driver.

Make a study of keeping yourself *au courant* with all information available. Draw up a list of your sources—such technical papers as are suitable to your calibre, any engineering societies you have the opportunity of joining, any friends in engineering firms you can see or write to, any shops which you can visit. And take a look at your list occasionally to see whether anyone or anything is being neglected. You will thus surround yourself with a network of "feelers," by which a disturbance in any part of your field of activity will be at once detected by you. In my earlier days I belonged to a private information club kept up by six young fellows in different firms, who wrote month by month a record of any new ideas they had seen in their work, and passed round these notes and sketches as a sort of circulating library. I don't know how our employers would have liked it had they known, but it was very useful to us—it kept us in touch, it made us accurate observers, and it widened our field of observation.

Now, I want to shatter your faith in human kind by impressing on you that you can't go through life in our profession in a spirit of blind amiability. That attitude is one of the chief reasons why so many splendidly-educated men—fellows who have had good chances—are occupying badly-paid positions. On the assumption that the world is just, they have jumped at the conclusion that the way to get on is to get more internal knowledge. Nothing of the kind! The men who get on are those who keep their hand on the feeler network and respond smartly to its indications. When a country goes to war it not only wants to know its own resources, but what the enemy is going to do. The Japanese soldier not only carries a rifle and ammunition, but he has a field glass to see what the other fellow is doing. When two fencers engage, they watch each other's eyes to see the quick glance at the part which it is intended to attack. Your "intelligence department" must be directed not only to the collection of facts, but to the observation of the moves on the chessboard. The best jobs are seldom advertised. Even when they are you may be sure that they have been watched by more than one intelligence department for some time previously.—Yours,

THE OLD 'UN.

POWER—ECONOMICAL AND OTHERWISE.

BY CAPTAIN F. S. N. MACRORY, R.E.

"High Pressure"—that is the watchword of success in these modern times. It is applicable not alone to mental activity, but also, and with as much force, to the successful working of all mechanical and industrial problems of the present day. Our fathers walked—we must run. The future generation will probably fly. But let us to our case in point without further preamble—a sign in itself of low pressure.

The example is an Irish oatmeal mill, one of the few survivors of the good old times. For over 40 years the power necessary to drive this mill had been furnished by a low-speed, low-pressure, double-cylinder steam-engine, of a type well known and justly esteemed in the early sixties. The nominal horse-power (hideous and meaningless term) was 35, and the power actually developed might have been anything up to 60 h.p. A good old engine in its way. Built for everlasting wear, old fashioned, never in its easy-going life exceeding a boiler pressure of 60lb. to the square inch, and having even that reduced to 50lb. in its latter days, it can easily be imagined that it had a somewhat abnormal appetite for coal. This appetite increased with age. It made light (or more correctly speaking, power) of a daily meal of 25cwt. of good Scotch steam coal. Without going into details of the milling machinery, we may assume that the full amount of power required to drive it was 45 actual horse-power. So that the coal consumption was out of all proportion to the work done. Many expedients were tried with a view to reducing this extravagant consumption, but with little success. Finally, when the question of a new steam-boiler began to loom in view, it was determined to relegate the entire power plant to a well-earned rest, and to replace it with something of a more up-to-date type.

Electric transmission from a source of water power three miles distant: new steam engine and boiler: oil engine: gas-engine: the choice lay between these four. After due consideration of the *pros* and *cons.* of each system, the decision fell on the last one. To work a large gas-engine with town gas is, however, by no means the height of economy. Nor, in small country towns, is the supply usually all that can be desired. Therefore, a gas-producing plant was also decided on. Of these there are now many varieties on the market. But the latest type, known as the suction plant, seemed to offer so many advantages over the older form, that it was resolved to give it a trial. In this type of plant, the gas necessary to drive the engine is sucked in by the latter itself, the out-stroke of the piston producing the requisite vacuum to draw the gas into the cylinder. No gasholder is, therefore, required, and the pressure of gas in the apparatus is below that of the atmosphere when the engine is at work. The small steam-boiler required in the case of an ordinary gas-producer is also dispensed with in the suction type of plant, where the generator itself furnishes the steam requisite for the gas production.

The improved Dowson suction plant was accordingly installed as being the original, and probably as good as, if not better than, any of the later types. This plant is very simple, and consists essentially of (1) a generator or furnace burning anthracite or coke "nuts"—*i.e.*, cubes about 1in. square; (2) a water jacket for cooling the gases; (3) "scrubber" filled with coke moistened by a trickle of water, which serves to purify the gases; (4) a second "scrubber" filled with sawdust, which dries and further purifies the gases; (5) an expansion box near the engine, taking the place of the gas-bag provided with ordinary gas plants of this nature. The plant is started by blowing a jet of air through the fire in the generator till the gas is rich enough to burn, after which the engine is started, and itself keeps the air draught (now mingled with steam) going auto-

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matically. As for the gas-engine itself, all the leading makes are probably equally good, though differing in details. In the present case a 50-h.p. "National" engine was selected, as the makers of this engine have had great practical experience with the various forms of Dowson plants, and, in addition, turn out a most efficient and highly finished engine.

Next with regard to transmission of power. It must be borne in mind that a gas-engine, with its one power impulse in every two complete revolutions, is a very different affair to a steam-engine with its two or even more power impulses to every revolution. It was evident that the old system of driving by means of direct spur gearing would have to give way to a belt drive, in order to take up as much as possible the violent shocks of the impulses. And a 10in. belt, of suitable strength, driving from a 3ft. 6in. pulley on the gas engine to a pulley of similar size on a countershaft 23ft. distant from the engine, made a most efficient and smooth-running substitute. Fast and loose pulleys were fitted on the countershaft to permit of the engine being started light and the load being applied after the proper speed had been attained, for a gas-engine, unlike a steam-engine, cannot start under its full load. Another 10in. belt, in conjunction with a suitable arrangement of pulleys, transmitted the power to the main driving shaft, the arrangement of which remained unaltered. Yet another belt on the countershaft served to drive the remainder of the mill gear, and it may be mentioned now that this system of driving entirely by belts has proved eminently satisfactory. A little dressing on the belts occasionally obviates all tendency to slip—that bugbear of the belt user.

And now to revert once more to the gas-engine. It was resolved to have electric ignition, instead of the older type of firing the charges by means of a porcelain tube heated by an independent supply of gas. The electric type consists of a small Simms-Bosch magneto, having permanent magnets and an oscillatory armature. When the engine is working, a sharp rocking movement is imparted to this armature by a small stud on the cam shaft at the right moment for firing the charge, and an electric spark is thus produced inside the combustion chamber. With regard to cooling the cylinder of the engine. In most cases a supply of water-tanks are required for this purpose, but in the present case these were dispensed with, as a source of running water was available. The water was simply led by pipes in at the bottom of the water-jacket and out at the top. By regulating the supply the cylinder could be kept at any desired temperature. The "National" self-starting device consists of a small hand-pump fixed on one side of the cylinder, by means of which a starting charge of explosive mixture is forced into the cylinder, and the magneto lever being then oscillated by hand, the first explosion takes place, after which the engine takes up the running.

We have now reviewed the whole of the new driving plant. Let us pause a moment to consider the relative space required for both the old and the new systems. In the case of the steam-engine an engine-room 29ft. by 11ft was required, while the boiler occupied a space of 25ft. by 9ft.—in all, a total space of 558½ square feet. In the case of the gas-engine, an engine-room 18ft. by 13ft. was found ample, while the gas-producer plant required a space of 15in. by 10in.—in all, a total space of 384 square feet. Thus the space required for the new plant is only about two-thirds that for the old one. There is an additional saving of space, as no steam stack is now necessary.

We next turn to the relative fuel consumptions of the two systems. The average amount of this for the steam plant under full load, worked out at 25cwt. per day of Scotch steam coal, costing about 17s. per ton—that is, assuming the full load to be 45 actual horse-power, and the working day to be 10 hours in length, the power in this case cost ·566d. per horse-power hour. Under the same conditions, the fuel consumption of the gas-engine never exceeded 5cwt. per day, the fuel being Welsh anthracite "nuts" or "peas," costing about 24s. per ton delivered. From this, the power works out at ·16d. per horse-power hour. This shows a very remarkable saving, and it would therefore appear certain that, as far as actual cost of running goes, nothing but water power has yet been invented which can compete with such a system of power production as the one under consideration. Even the latest and best of steam-engines would probably cost twice as much in coal to generate the same power.

With regard to the actual starting up each morning and management during the day of the gas-producer and engine, the work required is simple enough when things are going right (that "when" is an important point, as will be shown later on). The daily routine is something as follows: The fire in the generator having been left slowly burning all night (which can be done every night except in the case of the periodic cleaning of the generator), the engineer on arrival proceeds to close up the grate doors and to fully open a waste cock on the gas-pipe. He then puts in a charge of about eight bucketfuls of coal, and starts blowing the hand fan. In about a quarter of an hour the gas produced will be rich enough to burn, and, when this is so, the waste cock is closed, and the gas produced is then forced through the cleaning apparatus of the plant to the engine. In a few minutes all the air will have been expelled from the pipes, etc., and the gas will burn at the engine test cock. About 60 strokes of the hand pump are given, and the engine is started in the usual way. Once started and the proper steam attained, the belt can be shifted from the loose to the fast pulley, and no more attention is required, except to see that all lubricators are working properly on the engine, and once in every three hours to add a few more bucketfuls of fuel to the generator. The whole operation of starting occupies less than half an hour, and is only increased by a few minutes on those occasions when the fire in the producer has to be lit and the apparatus started up from "the cold."

Lastly, let us review what is perhaps the most important point of all, simply for the reason that it is only discovered by experience, and is looked in vain for in the makers' catalogues. In other words, let us go into the drawbacks and disadvantages of the whole system. Its advantages are so very apparent that one naturally wonders why it is not universally adopted by all users of power. Well, there is undoubtedly one great drawback to gas-engines worked by producer gas, which at present precludes its adoption in a vast number of cases. As now made, at all events, it has not by any means attained to the same pitch of almost absolute reliability which steam, electric, or water power have. There is no doubt on the subject—it is tricky, deuced tricky. Inexplicable breakdowns may and do occur at the very moments when one least desires or expects them. Of course, skilful and thorough attention to details largely obviates this risk, but it is always there to some extent. And in the case of large factories, etc., which employ a great number of hands, even a temporary breakdown, which will throw all these hands out of work for the time being, is a most serious affair. Lack of absolute reliability—that is the drawback which in so many cases counterbalances the many great advantages of the gas-producing power system. We never get Perfection (with a big P) in this world. Our object is to get as near it as we can. Such little things will upset the equilibrium of a gas-engine—things that, once located, can be often put right in less than a minute. But the locating is the trouble.

There was a little girl of whom it is written that "when she was good, she was very, very good, but when she was bad she was horrid." Even so is it with oil and gas driven engines, not to mention their relatives—those most notorious offenders of all, automobiles. Yet all these things have come to stay (or, more correctly, to go), for in their better moods they are so fascinating that one is compelled to overlook their occasional lapses from virtue; in fact, one sometimes loves them all the more for these very lapses.

But now the worst is out, and be not discouraged too much by it. Let us see how we may, as much as possible, avoid these occasional breakdowns. With regard to the producer itself, attend rigidly to the makers' instructions. Clean the generator thoroughly, and rake out all clinker at least once a week. Clean all the pipes and water joints of the rest of the apparatus at least once a fortnight. Renew the coke in the coke scrubber not seldomer than once in three months, and perform the same operation for the sawdust scrubber every month. Do not go on the principle

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of letting well alone till a stoppage does occur. Prevention is better than cure.

With respect to the engine, it must be borne in mind that producer gas is, after all, a comparatively new thing, and its effect on the valves and interior economy of gas-engines is still, to a certain extent, unknown. The trouble with it is that, in spite of all cleaning operations, it still remains a much dirtier article than town gas, and tends to foul everything it comes in contact with to a proportionate extent. In the case I am dealing with, it was found necessary to clean the exhaust valve of the engine twice a week—just four times as often as recommended by the makers—otherwise, explosions in the silencer, weak and irregular running, and, perhaps, total stoppages occurred. The operation can, however, be satisfactorily performed in an hour. Once a fortnight seems sufficiently often to clean both the gas and air valves. The electric ignition system requires attention twice a week, in order to prevent the sparking device inside the combustion chamber from sticking. In addition, it is, of course, necessary to keep all insulated parts in good order and terminals clean. But, on the whole, this part of the plant is wonderfully free from trouble, if a little intelligence be exercised in its management. There are also many other little points which each user finds out for himself by actual experience—not too bitter, let us hope.

Depreciation of the plant due to wear and tear has not yet been touched on. A fair estimate would probably be 10 per cent. per annum on the initial outlay—about the same as on a steam plant of similar power. The upkeep of a gas-engine is slightly higher than that of a steam-engine, but the upkeep of a producer plant will certainly work out considerably lower than that of a steam-boiler.

So the sum total of the whole matter seems to be this: producer gas as a source of power is very highly to be recommended where an occasional stoppage in the course of a day's work is not of vital importance, but in all other cases it has hardly yet attained to a sufficient pitch of reliability to warrant its introduction. It has, at all events, a great future before it.

BRIDGEND ELECTRICITY ACCOUNTS.

The accounts of the Bridgend electricity department for the year ended March 31, 1904, show a total expenditure on capital account of £6,153. Appended are abstracts of the revenue account, general balance-sheet, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
S.W.P. Co. for current supplied	442	2	7
Distribution of current	19	17	8
Attending and repairs to public lamps	41	19	0
Management expenses	78	19	10
	582	19	1
Balance carried to net revenue account	562	4	10
	£1,145	3	11

Cr. Income.	£	s.	d.
Sale of current for private lighting	701	14	7
Public lighting	443	9	4
	£1,145	3	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	6,712	2	7
Due to treasurer on revenue account	423	15	11
Net revenue account—profit for year	150	3	11
	£7,286	2	5

Cr. Assets.	£	s.	d.
Amount expended for works, less repaid	6,712	2	7
Consumers for current supplied	423	15	11
Net profit paid to district fund	150	3	11
	£7,286	2	5

UNITS SOLD, ETC.

Units supplied by S.W.P. Co.	77,040
Units sold for private lighting	36,182
Units sold for public lighting	37,782
Quantity used on works	1,380
Quantity unaccounted for	1,696
Maximum load observed (kilowatts)	90

Number of lamps: 15 arcs, 184 incandescents.

ECCLES ELECTRICITY ACCOUNTS.

From the accounts of the Eccles electricity department for the year ended March 31, 1904, it appears that the total expenditure on capital account now amounts to £30,523. Abstracts of the revenue account and balance-sheet are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,310	2	5
Distribution of electricity	298	2	2
Public lamps—wages and renewals	80	10	4
Rents, rates, and taxes	93	9	7
Salaries	271	4	10
Establishment charges	75	6	4
Insurances	21	17	5
Interest and repayment of loans	1,415	5	1
Commission	5	7	1
	£3,571	5	3

Cr. Income.	£	s.	d.
Sale of electrical energy	2,984	7	6
Meter rents	88	4	4
Sale of cinders	0	16	0
Fittings and repairs on consumers' premises	240	10	4
	3,313	18	2
Balance being deficit on revenue account	257	7	1
	£3,571	5	3

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Loans on mortgage	£28,614	1	5
Sundry creditors	230	2	4
Balance due to treasurer	924	18	0
Sinking fund	83	1	8
Amount of loans repaid	2,272	18	7
	£32,125	2	0

Cr. Assets.	£	s.	d.
Capital account—expended on works	30,523	4	8
Sundry debtors	1,244	10	9
Stores in hand	11	17	10
Cash in hand	5	0	0
Sinking fund investments	83	1	8
Balance at credit of revenue account	257	7	1
	£32,125	2	0

TRADE NOTICES AND NOVELTIES.

The Utilisation of Waste Heat from Coke Ovens.

The Stirling Company, of 53, Deansgate-arcade, Manchester, have issued a pamphlet giving particulars of the performance of one of their standard boilers fired with waste heat from "beehive" coke ovens, and figures for comparison with Lancashire boilers working under similar conditions. These figures show that although the inlet temperature of the gases at the point where they enter the boiler setting was only 1,700deg. F., not only was the full normal duty obtained from the Stirling boiler, but an evaporation of 1·71b. of water from and at 212deg. F. per pound of coal coked in the ovens was obtained, as against a figure of 1·331b. of water evaporated by the Lancashires, or a difference in favour of the water-tube boiler, if expressed in terms of the amount of water evaporated by the Lancashire boilers per pound of coal coked, equal to 28 per cent. Our attention is further called to the prominence which is now being given to the question of utilising waste heat from coke-oven plant generally by some of the leading electrical power supply corporations. For example, the Newcastle-on-Tyne Electric Supply Company have put down a plant at Blaydon Burn, where they are utilising the waste heat from a battery of "retort" type coke ovens. This plant, it is stated, is being run, practically speaking, as a battery, and at a cost per unit generated which has never before been approached in this country.

Watertight Tumbler Switch.

To get over the difficulty which has always presented itself when using tumbler switches for outdoor work or in exposed positions where moisture is present, the General Contracts Company, Limited, of 1, Fenchurch-avenue, E.C., and 102A, Charing Cross-road, W.C., have recently put on the market the form of their patent "Strut" switch illustrated herewith. To facilitate manufacture, their standard type of switch is used complete, secured in the metal box either with or without the cover, as may be desired; while to retain the full advantage of the tumbler action, and at the same time produce a switch that is absolutely watertight, a second dolly is introduced, working

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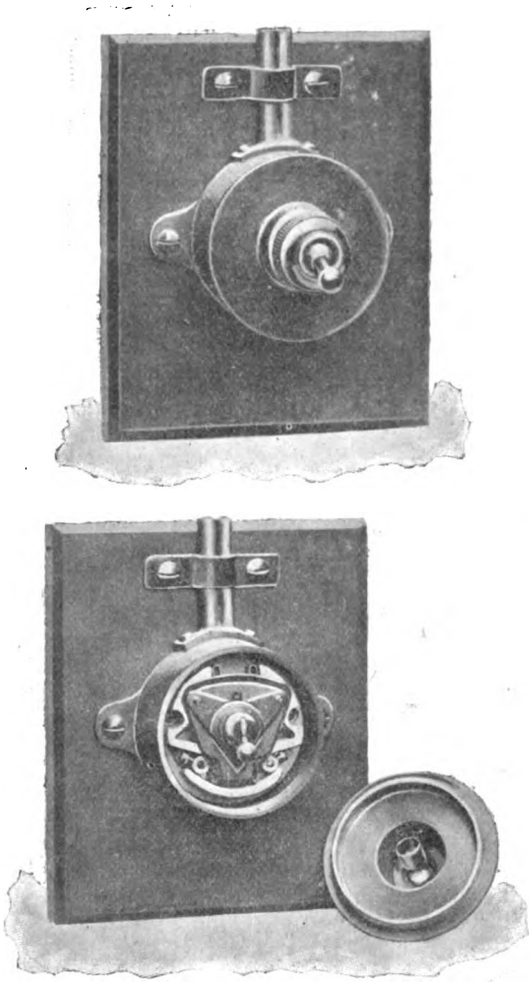
in a ball-and-socket joint in the cover of the watertight box. This second dolly carries a cupped end, which fits over the ball of the permanent switch dolly, thus forming a smooth working joint between the outer dolly and the switch lever. For convenience in coupling up, the wires are carried through glands in the side of the box, so arranged as to give sufficient length of wire to allow the switch being removed for making the connections, space being allowed in the bottom of the box for the slack wire to stow when the switch is fixed in position. The additional dolly and outer cover being concentric with one another, admits of the cover being unscrewed with the switch in any position, and as there are no small screws or loose parts in connection with this portion of the case which have to be removed when making the wire connections, and so interfere with the adjustment of the watertight joint, the switch becomes one of the simplest and most effectual watertight switches on the market. Moreover, it is claimed to be the only real watertight tumbler switch



Watertight Tumbler Switch.

which carries the working tumbler unprotected. We recently had an opportunity of examining this switch, and were perfectly satisfied with its action and construction. It may be added, in conclusion, that the switch is made up to take any form of gland or other tube connection, and is manufactured under the company's patents.

"SS" Intercommunication Telephones.

The General Electric Company, Limited, Queen Victoria-street, E.C., have recently introduced a new type of intercommunication telephone embodying many important advantages, chief of which is that it ensures an absolutely secret service while in use. In design the instrument is somewhat of a departure from the usual form, and it combines the very latest developments made in telephone work generally. Referring to the accompanying illustrations, it will be observed that there are a number of drop indicators corresponding with the number of lines, and immediately below these are the "jacks" or plug sockets. A connecting plug with a length of flexible cord is also provided, which is inserted into any "jack," according to the number of the line it is desired to communicate with. When a call is made the indicator corresponding with that particular line falls, denoting at once who is calling. Should the office be vacant when the call is made, this indicator serves a very useful purpose, for it clearly shows a person on returning that a call has been made and who it was that "rung up." Two stations cannot be accidentally rung up at one time by careless placing of the switch. It is, therefore, impossible for a third person to overhear the conversation, or to interrupt in any way whatsoever; moreover, inductive effects are eliminated with this particular type of instrument, and all chances of leakage disposed of by the adoption of a metallic circuit throughout. This telephone has been named the "SS." It can also be used as a central-station instrument for intercommunication between outlying stations. Should these stations

The "SS" Wall Pattern Telephone.

be a considerable distance away, instead of running a cable of the necessary size to each, a single pair of lines could be used between the instruments at the outlying stations and the central station, thus minimising the cost of wiring. If the "SS" telephone is used for this purpose it is provided with a pair of plugs which enables the calling station to be connected

The "SS" Table Pattern Telephone.

through to any other station on the system. The reputation of the makers for the class of apparatus in question is sufficient guarantee of its excellence, both as regards construction and careful design. Further particulars, together with a diagram of connections, will be found in the G.E.C. pamphlet (K)1,066.

LEGAL INTELLIGENCE.

DEBENTURE-HOLDERS' ACTION.

At a vacation sitting of the Lancashire Chancery Court at Liverpool last week a debenture-holders' application was made in the matter of Krauss and others v. the South Lancashire Electric Traction and Power Company and others.

Mr. Preston, for the applicants, said that this was a debenture-holders' action for the appointment of a receiver and for enquiries and accounts. The company did not oppose, but the trustees had put in a defence.

Mr. Stewart Deacon, for Sir William Forwood and Mr. W. S. Barrett, trustees for the debenture-holders, said the only point his clients made was as to the remuneration to which they were entitled. The arrangement was for £100 a year each, and as these proceedings might be prolonged they wished to have the question of their remuneration determined.

The **Deputy Vice-Chancellor** made an order in the terms of the proposed minutes, with the addition of an enquiry as to the trustees' remuneration.

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COMPANIES' MEETINGS AND REPORTS

DUBLIN AND LUCAN TRAM.

The half-yearly meeting of this Company was held at Dublin on the 18th inst. Mr. William Mooney, J.P. (chairman), presided. The report appeared in our issue of 15th inst.

The **Chairman**, in proposing the adoption of the report, referred to the great progress the Company had made since the construction and electrical equipment of the new line, and to the circumstances that had prevented, notwithstanding their success, the payment of a dividend on the ordinary shares. The expense of constructing the new line and of its electrical equipment had doubled their capital. The holders of debenture and preference shares had a priority to the ordinary shareholders. Their receipts for the last completed year (1899) under steam haulage were £4,058. 9s. 10d., as against £6,365. 15s. 3d. for the year ending June 30, 1904, whilst the working expenses had very considerably decreased, and they were declaring what was equivalent to a 10 per cent. dividend on preference shares. He was not, however, to be understood as suggesting that there was a prospect of the payment of a dividend on the ordinary shares in the immediate future. They had to get rid of the nine months' arrear on the preference shares, and there might be considerable sums required for increased rolling-stock, repairs, and renewals. Besides, he was very strongly in favour of at once commencing the formation of a substantial cash and invested reserve. The prospects of the Company were much brighter than they had been. The principal sum due to Messrs. Dick, Kerr, and Co., after the payment provided for them in the present half-yearly account should have been made, was £2,228. 15s. The Company was authorised to raise £5,000 additional debentures and preference shares, none of which had yet been issued. If the shareholders or the general public would subscribe sufficient of it to pay off Dick, Kerr, and Co., matters would be made much easier for the Company, and the prospect of a dividend on the ordinary shares increased.

The report was adopted.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The fifth ordinary general meeting was held on Tuesday at Winchester House, Mr. Roger W. Wallace, K.C. (chairman of the Company), presiding. Particulars of the report were given in our last week's issue.

In moving the adoption of the report, the **Chairman** stated that there was now a fresh-water supply at Kalgoorlie, but that the evaporating and condensing plant which had been sent out for converting the salt water would be available in case of emergency. Defining the policy of the Company, he remarked that the Company had had offers to take power, but they had thought it better to wait and get more remunerative prices, and also not to take every offer that was made, because they had to consider whether it was desirable to take loads which they might not be able to supply on a sudden demand, such as the supply to hoists which would only be at work certain times of the day. What they wanted was a regular supply, and not a supply which would leave the power standing idle at other times. They did not want to get exorbitant prices, but to do a good, steady business, and when the mine-owners came to recognise this he had no doubt that their power would be taken up, and that the business would increase. He recommended the shareholders, however, not to count upon a continuance of the abnormal rate of advance made during the 12 months under review, during which the sale of power showed an increase of 95 per cent. over the previous year.

The report was adopted unanimously.

BOLCKOW, VAUGHAN, AND CO., LIMITED.

The annual report states that expenditure upon new collieries, new blast-furnace plant, electric installations, machinery, and extensions during the year totalled £463 239. Of this sum £326,717 was for outlay on the new collieries at Ferryhill and Leasingthorne and new blast-furnace plant at the Cleveland Ironworks. It is also proposed to appropriate £100,000 from the reserve fund and £36,522 from the year's profits. The profit from all sources available for distribution, after providing for depreciation, is £199,641, which, with the added balance of £45,990 brought forward, it is proposed to distribute as follows: in payment of the dividend on the preference shares and on 1,629,760 fully-paid shares of 5 per cent., being 1s. per share, of which 6d. interim dividend has been paid, and a dividend on 1,860,900 shares (12s. paid) at 5 per cent., being 7·2d. per share, of which 3·6d. has been paid. Payment of extensions of new plant, etc., requires £36,522, leaving £48,190 to be carried forward.

LONDON UNITED TRAMWAYS.

In their interim report the directors state that the traffic receipts for the half-year were £139,452, against £132,932 last year, an increase of £6,520, with an increase in expenses of but £779. During the past seven weeks the receipts were £53 863, an increase of £5,172. An interim dividend on the ordinary shares at the rate of 6 per cent. per annum is announced. The large additional capital upon which the dividends have to be earned includes heavy expenditure upon important improvements and widenings of roads and streets incident to the doubling of the Hampton Court line and the construction of the cross-town connecting line between Hammersmith and Uxbridge-road, all of which might probably have been deferred; but the directors have considered it good policy in the permanent interests of the shareholders to at once provide for the future development of traffic rather than delay the outlays which, with the rapid advance in the value of property along the routes, would have had to be made at no distant date at an enormously increased cost.

YORKSHIRE ELECTRIC POWER.

The report for the half-year ended June 30 last intimates that the erection of the power station at Thornhill has made rapid progress. Current will be ready for supply to consumers this year, and contracts for this purpose are being negotiated. An agreement has been sealed with the Urban District Council of Mirfield for the supply of electrical energy in bulk. Under this agreement large power users in this district will receive a supply direct from the company, and economy in the cost of mains will thus be secured. Bills have been successfully opposed in this session of Parliament, promoted by various local authorities seeking powers to supply electricity outside their own areas. The directors trust that the definite lines laid down by the Parliamentary Committee on this matter will tend to hinder such attempts to encroach on the Company's area in the future. The accounts have now been closed, and a balance of £224 has been repaid to the Company.

LIENS REGISTERED.

Telephone Company of Egypt, Limited.—A trust deed, dated July 27, 1904, to secure £60,000 debenture stock, has been registered. Property charged: the company's undertaking and property, present and future, except uncalled capital (as a floating security). Trustees: Sir Auckland Colvin, Earl Soham Lodge, Framlingham; and G. F. Braithwaite, Kendal, Westmoreland.

Urban Electric Supply Company, Limited.—A trust deed, dated July 28, 1904, and a disposition of even date, to secure £200,000 first mortgage debenture stock, have been registered. Property charged (by trust deed): Electric lighting and tramway undertakings, certain freehold and leasehold hereditaments and the company's undertaking and property, present and future, including uncalled capital. (By disposition): Freehold property at Hawick. Trustees: Merchants' Trust, Limited, 63, Cornhill, E.C.

Electromobile Company, Limited.—A mortgage, dated Aug. 10, 1904, to secure £3,500 and further advances up to £10,000 has been registered. Property charged—15 per cent. of any moneys payable to the company under contracts for sale of automobiles or for garage, supply of electricity, or other services (not including moneys payable exclusively for tyre maintenance). Holders: North of England Trustee Debenture and Assets Corporation, Limited, 45, Spring-gardens, Manchester.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Swansea.—The Corporation invite tenders for two negative tramway boosters. Tenders by noon on Sept. 7. See advertisement.

Lemberg.—The Government Railways require tenders for accumulator battery at the central station at the railway station. Tenders by Sept. 4.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Bucharest.—The Roumanian Government Railways require tenders for supply and erection of electricity plant and for installation for lighting several workshops by 27th inst.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

The Hague (Holland).—The Council of the Hague require tenders for the supply of from 8,000 to 9,000 tons of steel rails, including appurtenances, for electric tramways. Tenders by Sept. 22.

Madrid.—Tenders are required by the Post and Telegraph Department for 70 tons of 4mm. galvanised iron wire, about £16 per ton, and 70 tons of 2mm. bronze wire, about £94 per ton, by Sept. 3.

Madrid.—Tenders are required by the Post and Telegraph Department for 9,000m. telegraph cable of 7 rubber-insulated wires, 2,000m. ditto of 28 paper-insulated wires, and 11,000m. cable of 7 steel wires by Sept. 6.

Hove (Sussex).—Tenders are invited for the supply, delivery, and laying, in the parish of Aldrington, of low-tension vulcanised-bitumen, dialite, or "leadless" paper cables, conduits, boxes, meters, etc. Tenders by Aug. 30. See advertisement.

Buenos Ayres.—The Municipality (Intendencia Municipal Section Obras Publicas) require tenders for the construction of an electric tramway from the Plaza de Mayo in the town to the suburbs of Ortuzar, Devoto, and General Urquiza. Tenders by Sept. 13.

London, S.E.—Tenders are invited for electric light installation at the Royal Arsenal Co-operative Society's, Limited, new branch stores, Plumstead Common-road, Plumstead, S.E. Tenders by 12 noon on Aug. 27 to Mr. Frank Bethel, 22, Queen Anne's-place, Bush Hill-park, Enfield, N.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity gene-

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rating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Manchester.—The Directors of the Manchester Dock and Warehouse Extension Company, Limited, invite tenders for the wiring (for power and light) and electric lighting of five transit sheds (now in course of erection) on the southerly side of dock No. 9, in the county borough of Salford. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Aug. 30.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

RESULTS OF TENDERS.

Madras.—The Secretary of State for India has ordered one 15-b.h.p. Diesel engine for the Public Works Department, Madras.

Dewsbury.—The Corporation have accepted the tender of Messrs. J. and J. Horsfield, Vulcan Ironworks, Vulcan-road, Dewsbury, for supply and delivery of one Lancashire boiler at their electricity works.

Newcastle-upon-Tyne.—The Guardians have accepted the tender of Messrs. Woods, Slacke, and Co., Corporation-street, Blackburn, at £353, for installation of the electric light in the hospital block at the workhouse.

Brighton.—The Town Council have accepted the offer of the British Westinghouse Electric and Manufacturing Company to supply and fix the circulating water pipes required for the west side of the engine-room at the Southwick power station for £550.

Acton.—The Howard Conduit Company, Limited, Trafford Park, Manchester, have secured the order for all the troughing required in connection with the Acton scheme, which our readers will remember was recently secured by the St. Helens Cable Company, Limited.

Johannesburg.—The Municipal Council have awarded Messrs. W. T. Glover and Co., Limited, Trafford Park, Manchester, the contract in connection with electric light and power cables for the Johannesburg Municipality, amounting to considerably over £100,000.

Beverley.—The Visiting Committee have received the following tenders for internal electric fire-alarm communications:

A. Dickinson, Leeds	£263	7	6
Siemens Bros. and Co., Limited, Hull	250	0	0
Private Wire and Telephone Installation Company, Limited, London	220	0	0
King and Co., Limited, Hull	220	0	0
R. Ernest and Co., London	209	16	0
Blaker Bros., Middlesbrough	205	0	0
E. M. Parsons, Hull	190	10	0
W. G. Padget, Hull	190	0	0
W. L. Harrison, Hull	167	18	0
G. Dixon and Sons, Leeds	166	18	6
Cox-Walkers, Darlington (accepted)	133	0	0

BUSINESS NOTES.

LIGHTING AND GENERAL.

Beeston.—The Council propose to introduce electric lighting.

Grimsby.—It is proposed to expend £3,000 for distributing mains.

Leek.—Sanction has been obtained to a loan of £1,800 for electric supply purposes.

Rand Central Electric Works, Limited.—The gross revenue for July was £8,850, against £6,200 last year.

Sale of Plant.—Particulars of sales of dynamos, condensers, motors, Cyclone electric fans, etc., appear in another column.

St. Pancras.—The profits from the electricity department last year amounted to £7,220 being allocated for the relief of the rates.

Buxton.—The Urban District Council will advertise for a pupil at the electricity works, as Mr. Perrin's term expires at the end of the year.

Leeds University.—The next session for civil, mechanical, electrical, and mining engineering will begin on Oct. 4. Particulars in another column.

Christchurch (N.Z.).—The cathedral will shortly be supplied with power for the organ and heating the building by electricity from the city destructor.

Wireless Telegraphy Act, 1904.—A notice by the Postmaster-General with regard to the establishment of wireless telegraph stations appears in another column.

Watford.—The number of consumers connected to date is 350. A report and correspondence on the subject of pumping by electricity is to be printed and circulated.

Linlithgow.—A provisional order is to be obtained by the County Council, prior to a loan of £3,500 for the electric lighting of the village of Broxburn and Uphall.

Caerphilly.—The Urban District Council have appointed a committee to carry out the electric lighting scheme and to appoint an engineer. The cost of the scheme is estimated at £5,500.

British Insulated and Helsby Cables.—The directors have declared an interim dividend at the rate of 8 per cent. per annum on the ordinary shares for the half-year ended June 30 last.

Brighton.—The railway company are being asked to allow the Corporation to carry overhead cables on the side of the line to enable outside districts to purchase electricity from the Corporation.

Pitlochry.—In connection with the proposed introduction of electric light, a public requisition has been promoted asking for consent to utilise the water of the River Tummel to generate the current.

Personal.—Mr. J. Clifton Robinson, managing director of the London United Tramways, Limited, has been placed by the Lord-Lieutenant of Middlesex on the Commission of the Peace for the county of Middlesex.

Oldham.—The Town Council have decided to apply for sanction to borrow £48,000, partly for extra expenditure on buildings and plant in connection with the Greenhill and Rhodes Bank electricity stations, and partly for new mains.

Dundee.—An application by the National Telephone Company, Limited, for permission to extend their underground telephone cables in the outlying districts of the city has been remitted to a sub-committee for consideration and report.

Sunderland.—The total estimated expenditure of the Corporation electricity department for the half-year ending March 31. 1905, is £13 370. 12s 11d. The total revenue is estimated at £27,694. 16s. 2d., leaving an estimated gross profit of £14,324.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in North Wales Power and Traction Company's 34,100 shares of £5 each, £4 paid, Nos. 1 to 34,000 and 37,401 to 37,500.

Victoria Technical School.—Messrs. Dick, Kerr, and Co., of Preston, have forwarded £500 for the purpose of completing the equipment of the electrical laboratory at the Victoria Technical School. The trustees of the late Mr. J. B. Booth had given £2,500 towards the same object.

Madrid.—The Ministry of Agriculture, Industry, Commerce, and Public Works has been authorised to acquire, without the formalities of calling for tenders, four lights of the fourth order in connection with the buoying and lighting of the estuary of Vigo at a cost of 38,500 pesetas (or about £1,100) placed *in situ*.

Rotterdam.—A new central station is about to be erected on the Schiehaven. An idea of the requirements may be obtained from the specifications for the foundations, etc., tenders for which are called for Aug. 30, and which may be obtained for one florin from Mme. veuve P. van Waesberge und fils, éditeurs, 73, Hout tuin, à Rotterdam.

Kingston.—The total expenditure on electric lighting, as shown by the electric light capital account, to March 31, 1904, is £86,468. A sum of £3,684 was expended during the year. The total receipts (amount raised by loans) remain the same as last year—viz., £76,226—and £10,242 represents the balance due to treasurer and to labour account.

Buckley.—At the last Urban District Council meeting it was suggested that as time went on the Council would be able to introduce electric lighting. They had got their own ground, near the Council chambers, upon which to put what plant would be required for supplying their own electric light. The present contract with the gas company will expire in about two years' time.

Alfreton Ironworks.—On Tuesday the new electrical works which have been erected for Messrs. Jas. Oakes and Co. at the Alfreton Ironworks, were formally opened in the presence of about 40 invited guests. It is proposed by the new works to substitute electric power for steam power. In the evening the firm entertained the members of their staff and a number of others to dinner at Greenhill Hotel, Riddings.

Dunedin (N.Z.).—The *New Zealand Mining and Engineering Journal* says it is anticipated that when the Lee Stream hydraulic works are completed there will be a considerable amount of surplus power to dispose of, but before the Dunedin City Council can supply either power or lighting for the city it will be necessary to obtain an order from the Governor-in-Council under the Electric Lines Act, 1884. The Tramways Committee of the City Council is now taking steps to obtain the necessary order.

Halifax.—The new set of engines that has been on order for some time for the electricity works is now being erected. It is a duplicate set of the one started at the beginning of the year. The engines are being erected by Messrs. Pollitt and Wigzell, of Sowerby Bridge, and the generator by the Electric Construction Company, of Wolverhampton. The cost of the scheme, with foundations, etc., will be not far short of £10,000. The set of engines started in January is now able to take

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the whole of the tramway load on ordinary days, and with the assistance of the new set the works will be equipped for some years to come.

Gosport.—When the Provincial Tramways Company undertook the supply of electric traction the lighting of the district by electricity was also placed in their power, and the company agreed to pay the expenses of obtaining the order, which amounted to something like £500. The compulsory area includes certain districts and localities where electric lighting would not be required, but it is very large, and it is doubtful whether the company will undertake the supply unless the area is restricted. However, the order has been obtained by the Council, and it expires in December next, and notices of intention to apply for an order have already been served on the District Council by the Empire Electric Light and Power Company, Limited, and by G. Vaughan Fowler.

Revised Board of Trade Rules.—The Board of Trade have issued drafts of revised regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy. We are informed that the experience which has been gained since 1896 has, in the opinion of the Board, rendered a revision of these regulations desirable, and drafts are classified as follows: (1) L.A.P.—local authority undertaking in the provinces; (2) C.P.—company undertaking in the provinces; (3) C.L.—company undertaking in London; (4) L.A.L.—local authority undertaking in London. The various codes differ according to circumstances in regard to the notices, etc., specified in the regulations as to supply, and in the codes relating to London the regulations as to overhead wires are omitted.

Derbyshire and Nottinghamshire Electric Power Co.—The company have taken central offices in Nottingham, and have appointed a preliminary staff. A preliminary station has been erected at Ilkeston, which has been at work since June of last year, and is satisfactorily supplying the whole of the power for the Corporation of Ilkeston tramways, and for the town lighting, and other customers are being arranged with and connected to the mains. An agreement with the Corporation of Newark has been entered into, and a station is to be established there to satisfy the demands of the Corporation and the customers in their area. An agreement is being concluded with the Nottinghamshire and Derbyshire Tramways Company for the power supply to some 40 miles of electric tramways in the company's area.

Newcastle.—In a report which has just been adopted the lamp inspector, Mr. George Lamb, points out that 180 electric arc lamps would be required to light certain thoroughfares in the city, and the total cost, at £12. 10s. per lamp, would amount to £2,250 per annum. This sum would include electric energy, ordinary maintenance charges, interest and redemption of capital expenditure. The total payment in respect to the existing 200 electric lamps was £3,100 per annum, and if the Tramways Committee reduced the price from £15 10s. to £12. 10s. per lamp per annum, there would be a reduction of £600 a year, making an annual charge of £2,500 for the 200 lamps. The cost of the additional 180 lamps at £2. 10s per lamp would be £2,250 per year, giving a combined total of £4,750 per annum for electric lighting.

Telegraph Clerks.—At Wednesday's meeting of the London members of the Postal Telegraph Clerks' Association in the Memorial Hall, Farringdon-street, the following resolution was passed: "That this representative meeting of the telegraph staffs of the whole Metropolis expresses its indignation that the Postmaster-General, having appointed a committee of his own choosing to enquire into Post Office wages; having invited the staff to prepare and tender evidence, which they did at great trouble and cost; having made statements in the House of Commons and elsewhere calculated to induce the belief in the minds of the staffs and the public that the findings of the committee would be adopted, now, for no good reason, has rejected their report. This meeting, therefore, calls upon the Postmaster-General to adopt immediately the whole of the recommendations of the committee on Post Office wages, in order to ameliorate the urgent and proved inadequacy of pay among the classes whose wages were investigated."

Tiverton.—An enquiry has been held into an application to borrow £13,000 for electric light purposes. The scheme was explained by the designers, Mr. J. Siddalls and Mr. J. S. Enright, the latter representing the contractors, F. Suter and Co. The annual receipts were estimated at £2,162, expenditure at £1,538, net profit £623. The Mercantile Association opposed on the following grounds: The rates were 6s. 8d., as compared with 4s. 11d. throughout England. The prosperity of Tiverton depended upon its being a cheap residential centre. The population had decreased 500 since 1891; there were many vacant houses, and rents had gone down considerably. Of 244 tradesmen canvassed, 160 said "no" to borrowing the money and 11 "yes," while 151 said "no" to taking in the light and 18 said "yes" The Mercantile Association regarded the light as unsuitable for a decreasing agricultural town like Tiverton. Mr. Siddalls, for the Corporation, said that 37 of the largest consumers had agreed to take in the light.

Carlisle.—The Postmaster-General, in his annual report, states that the proposals set forth in the report of last year with regard to the underground cable from London to the North have been carried into effect; the line of pipes is now completed as far as Carlisle; further north a section 19 miles in length has been laid across the Beattock incline; and a spur line of two pipes has been laid from Manchester to Leeds. A temporary cable has been provided over 25 miles of this latter section, the permanent cable has been carried northwards for a long distance on the main route, and provision has been made this year for carrying it as far as Carlisle. The laying of pipes as far as Glasgow is also contemplated. In order that the various sections of the underground system may be more readily available in case of damage to overhead lines, it has been decided to modify the scheme outlined in the Postmaster-General's report of July 29, 1902, and to carry the line direct to Glasgow, extending it thence to Edinburgh, instead of laying branches from Lanark to Glasgow and Edinburgh. This arrangement will also afford additional means of direct communication between Edinburgh and Glasgow, and the means of communication between Dundee and Aberdeen will be reinforced by the underground wires as far as Larbert.

Inquest.—The evidence at the inquest on the body of Christopher Walter Saunders, 21, a labourer in the employ of the Metropolitan Electric Supply Company, who was, while following his occupation, killed by an electric shock, showed that Saunders and other labourers were engaged last Friday in removing old electric cables and substituting new cables in Manchester-square, Marylebone. Saunders and Hennessy, another labourer, were together in a manhole, where a cast-iron pipe had to be cut to admit of the insertion of a new joint-box, and they were cautioned by the foreman to be careful as the pipe enclosed a "live main." For the purposes of this particular work, with which Saunders was said to be "familiar," he used a chisel, a hammer, and a "bursting wedge." The cable was insulated. Hennessy said that Saunders first made a small hole in the pipe with his chisel and then inserted the "bursting wedge" with his hammer. He struck the wedge twice with his hammer, and at the second stroke ejaculated "Oh!" and fell against the witness, rebounded, and dropped on the pipe. He was immediately removed, but found to be dead. Dr. W. F. Spurgin ascribed death to syncope consequent on an electric shock. Mr. James W. Drew, superintendent of mains to the company, stated that since this occurrence it has been decided to include hole-boring and wedge-inserting in the category of "dangerous operations," and instructions had been issued that the men engaged in this work must wear rubber gloves. The jury, in returning a verdict of "Accidental death," directed the company's attention to the circumstances of the case with a view to their adopting every practical means to prevent similar mishaps in the future.

Kent Electric Power Company.—The completion of the purchase of the undertaking of the Chatham, Rochester, and District Electric Lighting Company as a going concern by the Kent Electric Power Company is fixed for July 1 next. In the meantime the electric lighting company will carry on the undertaking; and pending the erection of a central station the electric lighting company are making arrangements for affording a temporary supply of current to customers who may require it. The company have also entered into an agreement with the Chatham and District Light Railways Company for the purchase of the whole of the plant in the existing power-house at Chatham. A part of the purchase consideration has already been paid, and the purchase is to be completed on July 1 next. From that date the company will operate the plant of the existing power-house and supply energy therefrom pending the completion of the central station. It has been found necessary to abandon the schedule site for a power station at Chatham; and in order to get the necessary coal conveyed direct from the steamers, instead of transhipping into barges, the company has, after considerable difficulty, acquired from the Ecclesiastical Commissioners on a 999 years' lease a site of eight acres for the erection of a central station at Frindsbury, with berthing facilities for steamers of large tonnage alongside. The preliminary installation at this station will consist of about 6,000 h.p., and the directors congratulate themselves on the fact that the whole of the work and plant will be of British construction. Negotiations are also pending for the erection of another power station at Northfleet. Many contracts have been entered into by the company for the construction of the central station and the supply of a very large amount of electrical energy to manufacturers and others in the locality, the supply to be afforded in rather more than a year's time on the completion of the central station.

London Gazette.—The partnership between James Lochhead and John Priestley Rhodes, carrying on business as electric merchants at Vance's-buildings, Cloth Hall-street, Huddersfield, Yorks, under the style of the Huddersfield Electric Company, has been dissolved by mutual consent. A receiving order has been made in the estate of James William Hunter, 8, Norwood-road, Leeds, and Albert Clapham, 289, Kirkstall-road, Leeds, electrical engineers and motorcar dealers, and trading together in co-partnership as the Yorkshire Motorcar and Electrical Engineering Company at 101, Kirkstall-road. The first meeting will be held at 11 a.m. on Aug. 31, 1904. A general meeting of the members of the Single-Wire Multiple Telephone Signal Company, Limited, will be held at 69, Electra House, Finsbury-pavement, London, E.C., on Sept. 26 at 2 p.m., to receive the liquidator's report showing how the winding-up of the company has been conducted and its property disposed of. The following notice appears in the matter of the Edison and Swan United Electric Light Company Limited, and Reduced: The capital of the Edison and Swan United Electric Light Company, Limited, and Reduced, henceforth is £941,090, divided into 150 000 "A" shares of £5 each, 26,436 "B" shares of £5 each, and 23,564 "B" shares of £2. 10s. each, instead of the original capital of £1 000,000 divided into 150,000 "A" shares of £5 each, and 50,000 "B" shares of £5 each. At the time of the registration of this minute, 116,400 of the said "A" shares and 23,564 of the said "B" shares have been issued, and the following amounts are to be deemed to have been paid up on the same respectively: upon each of the 99,261 "A" shares numbered in the register of the company from 1 to 99,261 inclusive the sum of £3, upon each of the 17,139 "A" shares numbered 01 to 017,139 in the said register the whole amount thereof. Upon each of the said 23,564 "B" shares numbered in the said register from B 1 to B 23,564 inclusive the sum of £2. 10s. The remainder of the capital is unissued.

Carnoustie.—At the last meeting the town clerk read correspondence with Mr. George Balfour, who proposed to promote an electrical power company in Dundee. It was stated that Mr. Balfour intended to apply for a provisional order to acquire the necessary

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powers for erecting buildings and constructing conduits. The draft agreement further bore out that the company should have the use of the streets so far as necessary for its purposes, while binding themselves not to supply electrical energy for lighting purposes within the city, except with the consent of the Corporation. The company also bound themselves not to supply any of the customers presently connected with the Corporation supply, and if the Corporation desired any further special exemptions they would consider it. The promoters sought the right to supply electric energy for motors for all classes of machinery in textile and other factories. They made a proviso that they would not lay cables in the streets of the central area of the city, and that their works would be subject to the approval of the Corporation, and it was stated that they would erect no overhead wires. In a subsequent communication Mr. Balfour pointed out that the Corporation, in the event of themselves going in for a power supply, would require to open the streets, so that no objection could be taken to his proposal on that score. He proposed to give Dundee the commercial advantages of cheap electrical power enjoyed by other centres of industry. Mr. Balfour expressed his willingness, in event of an agreement being come to, that the Council themselves should open and reinstate the streets for the company, charging a just and reasonable cost. This explanation, he considered, removed any objectionable features from the proposed agreement. The scheme would serve a limited number of consumers, chiefly millowners and manufacturers and it appeared to him that a speculative concern of this kind was one which the municipality would not be anxious to take up. He did not think the Council would be agreeable to erecting a power station involving an outlay of a quarter of a million pounds sterling for the benefit of, say, not more than 100 or 150 consumers. There were, in Mr. Balfour's opinion, a great many other reasons why the proposed scheme should be dealt with as a private undertaking. Mr. Balfour, in the course of his correspondence, sought an interview with the Town Council after his return from America in October.

TRACTION.

Pudsey.—A provisional order for an electric tramway scheme is to be applied for by the Town Council.

Southend.—The work of constructing an electric tramway by the coastline towards Shoeburyness is to be proceeded with at once.

Leicester.—During July the trams carried 2,032,849 passengers, being an increase of 1,085,031 over the same month of last year.

Swindon.—The *plébiscite* on the question of Sunday running has resulted in an overwhelming vote in favour of having cars on that day.

Rochdale.—The Board of Trade last week approved the new circular tramway route, which is about two miles in extent, and it was immediately opened for traffic.

Keighley.—It is reported that the completion of the scheme of Corporation tramways to Stockbridge has been postponed for a time, and that it may be necessary to apply for an extension of time.

Wellington (N.Z.).—The City Council propose to float a special loan of £77,000, at 4½ per cent. with a currency of 25 years, for the extension of the electric tramway to Island Bay, Ohiro, and Kilbirnie.

Bury, Rochdale, etc., Tramways.—A meeting of the joint authorities was held last week in reference to the allocation of the purchase money to be paid to the company, but Mr. More's report on this subject had not arrived.

Bury.—Mr. A. W. Bradley, the borough engineer, states in his annual report that the employment of direct labour in the construction of the tramways has resulted in a saving to the town. The remainder of the tramways are to be laid by the same method.

Aberdeen.—The Corporation have confirmed the Tramway Committee's recommendation that the fares should remain as at present, with the exception of the section from Market-street to the Woodside terminus, on which the fare is to be reduced from 2d. to 1½d.

Metropolitan Electric Tramways, Limited.—The number of passengers carried over the recently electrified route of the Metropolitan Electric Tramways, Limited, for the Bank Holiday week was 353,789 as compared with 198,061 for the corresponding period last year.

Light Railways.—The Board of Trade has confirmed the orders made by the Light Railway Commissioners authorising the construction of the Cheltenham and District Light Railway (Extension No. 3) and amending the Maidstone and Faversham Junction Light Railway Order, 1901.

Light Railways in Belgium.—There are now working in Belgium 1,300 miles of light railways, and about 430 more miles are in course of construction. The State capital sunk in them is a little over six millions sterling. The profit on the lines actually working amounted in 1903 to over £150,000.

Sarria-Barcelona.—The Sarria-Barcelona Railway Company have applied for a concession for an electric railway from Sarria to the district of Vallvidrera. There will be a statutory interval of one month before the application is decided upon, in order to give other concerns an opportunity of offering better terms.

Pontypridd.—At a special committee of the Pontypridd Electricity and Tramways Committee last Friday evening a long discussion ensued as to the advisability or otherwise of working the tramways as a municipal undertaking, or taking the advice of an expert with a view—if considered desirable—to lease the lines to a company. The question has been before the Council frequently. Finally, it was resolved to obtain expert information.

Birmingham.—Between 11 and 12 o'clock on Tuesday night a serious tramway accident occurred in Birmingham, resulting in 24 persons being more or less seriously injured. A portion of Coventry-road on the Small Heath route is at present up in preparation for the installation of the electric tramway system, and a steam car was proceeding over this section at a slow pace, when it over-ran the points and fell into an excavation from 2ft. to 3ft. deep, completely overturning. There were 47 passengers on board, 19 of whom were on the top, and a large number of these were pitched off, and many seriously injured. The car was completely smashed, and the top had to be sawn away.

Tramwaymen and "Live" Wires.—An interesting feature in connection with the Manchester tramwaymen's sports at Bellevue on Wednesday was a competition for dealing with "live" wires. Four emergency crews (each four strong) competed, and they were judged entirely upon time. Two poles were erected, with a wire connecting them, and for the purpose of the competition the wire was supposed to be "live," and was broken just before the signal being given to each crew. On the call being given the horses were fastened up and driven to the supposed breakdown. The tower of the wagon was raised, and the "live" wire picked up, joined, and made ready for the resumption of traffic. The competition proved very exciting, and on the timing Hyde-road No. 2 crew (with 3 minutes 29⅗ seconds) beat Queen's-road No. 2 crew (3 minutes 44⅗ seconds). Queen's-road No. 1 crew was third and Hyde-road No. 1 crew fourth.

Heywood.—At a meeting of the Town Council a long discussion took place on the tramway deadlock. The speakers vigorously denied that Heywood was responsible for the failure of the negotiations for the reconstruction of the tramways and the running of a through service between Bury and Rochdale through Heywood. It was pointed out that Bury and Rochdale had offered certain terms which were accepted by Heywood. Then Bury sought to amend these terms, and when Heywood would not accept the amended suggestion, Bury declared the negotiations at an end. The action of Bury in opposing Heywood's application to the Board of Trade for an extension of the time for the construction of the tramways in Heywood—an application necessitated by the failure of the negotiations—was declared to be an attempt to force Heywood to accept Bury's terms; and satisfaction was expressed that the Board of Trade had granted an extension of six months, with power to apply again if necessary. All the speakers agreed in expressing willingness to meet the neighbouring corporations and to discuss terms in a friendly manner.

Middlesex Light Railways.—The first section (Tottenham to Wood Green) of light railways constructed by the Middlesex County Council was opened on Saturday last by Sir Francis Cory-Wright, chairman of the Tramways and Light Railways Committee. The importance of the event attaches rather to the development of the scheme in progress than what has been actually carried out to date, since the section completed represents but a very small portion of the undertaking which the Council have embarked upon. When finished the present scheme will provide tramway facilities over about 50 miles of the main roads of the county. An interesting and, we think, a wise feature of the Council's policy in the matter is that the new lines have been leased to the Metropolitan Electric Tramways Company, Limited, by whom they will be worked until 1930. The cost of constructing the track is borne by the Council, and the electrical equipment and rolling-stock are provided by the company. A sum of 4½ per cent. on the Council's expenditure will be paid by the company as rent; out of the gross receipts the company will take 4½ per cent. on its capital expenditure and net revenue; and the net profits will be divided, the Council taking 45 per cent. and the company 55 per cent. The current is supplied from the Brimsdown power station. Now the company in question, it is well known, have an extensive tramways system of their own in course of development, and the advantage attained by the above arrangement of having the two systems under one management will tend to the best results in working, especially as physical connections are provided between the respective systems, which are therefore distinct only as regards ownership. We hope to give fuller details in a subsequent issue.

Stockport.—The annual tramway accounts to March 31 show that the traffic revenue for the year was £19,073. 2s., as against £14,679. 16s. 7d. in the previous year, while the total working expenses amounted to £12,209. 9s. 1d., as compared with £10,014 7s. 2d. Thus while the gross profit in the previous year was £4,666. 15s. 2d., last year it was £7,069. 9s. 4d. There were, however, over four miles more of lines to draw revenue from, the length of the system amounting now to some 10½ miles. The gross profit was applied as follows: extinction of last year's debit balance, £563. 3s. 7d.; interest on mortgage debt, etc., £3,834. 6s. 1d.; redemption of debt, £1,333. 18s. 4d.; rent of tramways, £1,174. 17s. 6d.; suspense account, preliminary expenses, £96. 0s. 7d.; net profit, carried forward, £67. 3s. 3d. The total cost per car per mile, including electrical energy, traffic expenses, general expenses, repairs, and renewals, was 4·830d., as against 5·322d. in the previous year. The car mileage was 606,476, and during the year 3,170 854 passengers were carried. The units of electrical energy totalled 790,892, giving the number per mile 1·30. The percentage of working expenses to receipts was 64; the average traffic revenue per car per mile, 7·54d.; the average traffic revenue per mile of single track, £971; the average total revenue per car mile, 7·62d.; average car miles per day per car, 109·45; average working expenses per car mile excluding power cost, 3·152d.; average working expenses per car mile including power cost, 4·831d.; average fare paid per passenger, 1·4d.; average number of passengers per car mile, 5; average journeys per head of the population per annum, 28; average number of cars in daily service, 15·18. There are altogether 30 cars. The gross capital expenditure on the system so far is £140,276. No provision has been made for depreciation, the Tramways Committee contending that this is unnecessary at such an early stage. In the report of the Corporation's auditor, however, there is a recommendation that some provision should be made in the future.

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Perth.—At a meeting of the Tramway Reconstruction Committee last week a large number of offers were received for the electrification of the tramway system. Tenders were invited for this work as a sort of safeguarding measure, in so far that should the petrol car prove a failure the Town Council, having these offers before them, would be in a position to immediately launch the scheme for the electrification of the system. A committee was appointed to consider the offers.

Huddersfield.—Considerable success is attending the arrangement for the conveyance of parcels on the Corporation electric tramways. The parcels are carried at charges varying from 1d. to 3d., the goods being handed over to applicants at various fixed stopping places, or "left until called for" with tradesmen on the various routes. A feature is made of dinner parcels, which are carried daily at a charge of 3d. a week. Last year over £700 was earned by the parcel department. The Board of Trade have certified the Longwood section as fit for traffic. The employés protest against the proposed annual medical inspection.

Belfast.—The Corporation have signed a request to the Board of Trade to appoint an arbitrator in connection with the acquisition of the company's undertaking. It is understood that the Tramways Committee have been in communication with Mr. Andrew Nance, manager of the Belfast Street Tramways Company, in reference to a proposal that he should be appointed manager of the Corporation tramways. Mr. Nance has intimated his willingness to accept the position on certain terms as to salary and other matters, and the Tramways Committee will communicate with other corporations owning tramways as to their practice in this respect.

Ashton.—At a meeting of the Tramways Committee a member, commenting upon the arbitration proceedings in connection with the Manchester Carriage Company, characterised the result as disastrous to Ashton. It will be remembered that the Corporation had to take over the horses of the company. The employés are aggrieved at the split-turn system introduced by the manager, and the committee, while approving the manager's action, have indicated that they will meet the men's wishes as far as possible. An arrangement has been entered into with the Manchester Corporation relative to the payment to be made by that authority for special cars running into the district.

Bewdley.—At a special meeting of the Town Council on Wednesday the application to the Board of Trade by the Kidderminster and District Electric Lighting and Traction Company for an extension for two years of the power conferred under a light railways order to make a tramway from Kidderminster to Bewdley was considered. The Mayor proposed a resolution, which was unanimously adopted, that the Board of Trade be informed that, as better travelling facilities between Kidderminster and Bewdley were most urgently needed, it would be unfair to the public that the time for making the tramway should be extended for two years, but if the tramway company were prepared to give an undertaking to the satisfaction of the Board of Trade that the tramway would be constructed within the proposed prolonged period of the extension, the Council would raise no objection to the application.

Swansea.—In reference to certain remarks made in the *Swansea Post* relative to the progress of the tramway extensions, Mr. W. Foley, engineer to the contractors, Messrs. Dick, Kerr, and Co., replies: "There is no real or serious delay. The contract is well ahead of schedule time, and what little stoppages have taken place have been due to matters relating to the gas company and water people. In Oxford-street, Port Tennant, and Wind-street our trenches have been cut right over the mains, and negotiations had to be entered into. At Eversley-road, Sketty, we were waiting for a loop; and at Sketty-road the Corporation's delay in road widening was responsible for a stoppage. Not a single minute was lost on account of the non-delivery of rails, etc., all of which are on the spot. I don't say if there had not been three holidays, the King's visit, etc., we should not have finished; but granted all goes well and the gas company and water department do their duty, we shall be completed by October certain."

London County Council.—Enquiries are being made by the residents of Nine Elms, Battersea, and Wandsworth as to when the tramways in those districts will be electrified. An official of the Council recently stated that the Battersea Park-road line would be converted "at no distance of time." Interviewed on the subject by a *Daily Chronicle* representative, Mr. John Burns, M.P., stated: "Work has already been commenced on the new authorised line from Tooting-broadway to Wandsworth. It will proceed by way of Defoe-road, Garratt-lane, and South-street, and, crossing Wandsworth High-street by the new road, will join the existing lines to Westminster and the Borough, which will, of course, be electrified as a continuation of the scheme. The widenings in York-road and Nine Elms-lane are practically complete, and when once the work starts from Wandsworth it should be completed in three or four months, for we are learning to do the thing much quicker now. On the Lavender-hill route the widenings are not yet completed, but you may have electric trams there much sooner than you think."

Rhodesia Railways.—The company's report shows that for the year ending March 31 last the revenue amounted to £573,286 against £526,560 for the previous year, the expenditure represented £434,542 against £322,774, and the profit £138,744 against £203,786, the percentage of expenditure to receipts being 75·8 per cent. against 61·3 per cent. During the 12 months ending March 31 last 212 miles of the Bulawayo-Victoria Falls line, the Gwelo-Selukwe branch (24 miles long), and 74 miles of the Gwanda branch were opened for traffic, the total length of line in operation at that date being 1,208 miles. Considerable reductions in fares have been made. The whole line from Bulawayo to the Victoria Falls was opened for traffic on June 20. The Zambesi is to be spanned by a railway bridge in the immediate neighbourhood of the falls. The Vryburg-Mafeking section has been relaid with 60lb. rails in place of the old 45lb. rails. New working arrangements have been entered into with the Mashonaland Company and the Cape Government, by which the former undertake the working of the whole of the company's system except the section from Vryburg to Bulawayo, which remains in the hands of the Cape Government.

Mashonaland Railway Co.—From the report of this company, covering the years ending Sept. 30, 1901, 1902, and 1903, it appears that for 1900-1 the revenue from the conveyance of general goods (the main source of income) was £139,689, construction goods £90,570, and from passengers £18,393; for 1901-2 the figures were £175,575, £80,454, and £79,997; and for 1902-3 the figures show £209 049, £79 997, and £18 049. The percentage of expenditure to gross receipts for the second of these periods showed some reduction over that for the first, and for the third period there was a substantial reduction over the second. For the nine months ending June 30 last the proportion is less favourable than for the year 1902-3, owing to the decrease in the volume of traffic consequent upon the depression in trade; but with a revival of trade in Rhodesia the directors look forward with some confidence to a change in this respect. Through bookings have now been arranged between the company and all the railway systems in South Africa, and an agreement has also been concluded with the German East Africa shipping line.

Ashton and Stalybridge.—The negotiations between the Ashton Corporation and the Stalybridge, etc., Joint Board for through running would appear to have been brought to an abrupt conclusion by the action of the Joint Board in refusing to entertain Ashton's latest offer, of which we gave particulars in our issue of the 12th inst. The Joint Board practically adhere to the terms previously indicated by them—that each authority shall retain the fares taken in their respective districts. They reject the proposal for arbitration. The Ashton Corporation decided to reply that they had nothing further to suggest. At a future meeting the Corporation will consider the advisability of constructing the Old-street and Scotland-street length of line, and running their own cars to the county bridge, Whitelands. An informal conference subsequently took place between the chairman of the Ashton Tramway Committee and the chairman of the Joint Board, but nothing definite was settled. "If," said the former to a local reporter, "Stalybridge would recognise the principle of halfpenny fares between Ashton Old-square and Cockbrook, and Cockbrook and Stalybridge Town Hall, and a penny through, the whole thing would be settled, and each authority would get the benefit of its own local receipts, and what it was entitled to."

Halifax.—In order to utilise their tramways to a greater extent for goods traffic, the suggestion has been made that in their next parliamentary Bill the Corporation should seek for powers to enter the navigation yards both at Halifax and Sowerby Bridge, and thus put the tramways in direct communication with the canal. It is claimed that a considerable saving, even in the transference of their own supplies, could be effected by the Corporation by such an arrangement, while, in addition, the direct communication with the canal thus secured would also help in the general development of goods traffic on the tramways. It is understood that the matter is receiving the attention of the sub-committee appointed to report on the tramway requirements to be provided for in the Corporation's next parliamentary Bill. The doubling of a number of the existing lines and the extension of the tram service to Elland by way of Salterhebble Hill and West Vale are also matters which will be reported on. The Tramways Committee have decided to recommend an extension from Sowerby Bridge to Style Bank at an estimated cost of £4,200. A sub-committee has been appointed to consider the staffing of the tramways department. Some members consider that it would be an advantage to split up the undertaking into departments, with a responsible head to each, under the general manager.

Newcastle.—At the invitation of the Tramways Committee a large number of members of the City Council last week made a survey of a part of the tramway system, especially some of the latest acquisitions and extensions. These included a new 3,000-h.p. engine at the power station, new car sheds at Wingrove, and an important addition of lines from Byker to Welbeck-road and Church-street, Walker. The party included, besides the chairman, the vice-chairman (Mr. J. D. Rodgers), the mayor (Alderman Andersen), Mr. Geo. Renwick, M.P., Councillor Renwick, of Cardiff (the junior member's brother), Sir Wm. H. Stephenson, Aldermen Sutton, Sanderson, Morton, Councillors Weidner, Harkus, Beattie, Flowers, Coates, Fitzgerald, Cail, Archibald, W. J. Sanderson, Farquharson, C. C. Elliott, Criddle, Mason, Robson, Murray, Hutchinson, H. Forster, Whitburn, and Meyne; Mr. J. Fewster, Mr. Gjemre, Mr. J. Ellis, Mr. W. Ellis, Mr. Le Rossignol (general manager of the tramways), Mr. J. C. Couper (traffic superintendent), Mr. Edge (city engineer), and other officials. After an extensive inspection there were refreshments and speeches, in the course of which Alderman Ellis (chairman of the Tramways Committee) stated that the committee were striving to the best of their ability to manage the trams so that they might reflect the greatest credit on the Council and the people. As yet the system was new, but before the end of the year it would be put upon such a basis that the people of Newcastle would be satisfied with the result.

Bradford.—When the annual accounts, of which we gave particulars in our issue of the 12th inst., were presented to the Tramways Committee, a request was made for supplementary information. In response, the city treasurer has prepared a series of returns showing the exact financial position of the Bradford tramways undertaking on March 31 last. The accounts are classed under different headings, and in substance they go to amplify the general statement made by Alderman Godwin a short time ago in introducing the annual municipal "budget." During the past year no less a sum of £40,000 was spent upon repairs and renewals, which, together with the sum of £2,917 set aside for depreciation, represents a percentage of 5·79 on the total working capital of the undertaking. The committee drew upon the depreciation and renewals account, which is practically a reserve for contingencies, to the extent of £5,000 for relaying a length of line in

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Thornton-road, and for covering certain expenditure on the Eccleshill and the Stanningley tramways. The sum now standing to the credit of that fund is £23,056. Great reductions were made in the fares on the lines taken over from the companies. The obligations attaching to the cost of reconstructing and equipping the lines were a first charge upon revenue, but the shareholders of the old companies had also to be recompensed, and the surrender value of the companies' leases has since been paid in instalments. In 1903 the sum of £9,000 was paid out of the net profit of close on £20 000 which was then made, and, similarly, this year the balance of £10,482 due to the old companies is to be paid out of the total net profit of £13,399. The amount set aside for interest and sinking fund amounted to £46,105, which was some £10,000 more than in the previous year. This was attributable to the rapid development of the system, the bulk of the capital expenditure on which was debited in the accounts for the year ended March last.

Derby.—The contractors for the Derby tramways (Messrs. J. G. White and Co.) entertained the members of the Tramways Committee and their ladies to luncheon at the Royal Hotel on Monday afternoon. The guests also included several of the principal Corporation officials. The chair was occupied by Mr. Connett, of Messrs. White and Co., with Mr. Balfour, of the same firm, in the vice-chair. After the usual loyal toasts, the Chairman proposed "The Derby Corporation Tramways Committee," and referred to the delay which had arisen in the completion of the work. On behalf of the contractors, he disclaimed responsibility, and said it was due to several unforeseen circumstances, not the least important of which was the determination of the Corporation to have English rails after having first agreed to the use of rails made in Belgium. Alderman F. Duesbury, J.P., chairman of the Tramways Committee, responded, and expressed the opinion that the contractors had made "a very good job." In this connection he paid a tribute to the watchfulness of the borough surveyor (Mr. John Ward), who, he said, had been very vigilant in looking after the interests of the ratepayers. "The Mayor and Corporation" was proposed by the vice-chairman, and Councillor J. W. Gandy, J.P., gave "The Health of the Contractors." During the proceedings the contractors presented handsome silver flower vases to the Mayoress and Mrs. Duesbury. These articles bore suitable inscriptions commemorative of the inauguration of the electric tram system in Derby. The Normanton-road section is nearly finished, while good progress has been made along the Burton-road. St. Peter's-street continues to be closed to vehicular traffic. Messrs. White and Co.'s employés have been working night and day during the present week, and confidently expect to complete their labours by the end of August. Arrangements are being made for the Board of Trade to make their official inspection in the first week in September, and, subject to the Government certificate being obtained, there will be an immediate extension of the present system.

Portsmouth.—The Mayor has negotiated for the purchase of certain premises, the removal of which will allow the awkward "S" curve to be abolished, and a practically straight line to be laid down The Tramway Committee have approved of the Mayor's action, and recommend that the purchase be effected. The annual report of Mr. W. R. Spaven, the general manager for the 12 months ended March 31 last, shows that the year's working has resulted in a total revenue of £94,174. 0s. 9d. Deducting from this amount the tolls paid to the Portsdown and Horndean Light Railway, there was a net revenue of £92,916. 18s. 6d., an increase over the previous year of £8,966. 16s. 6d. The working expenses for the year amounted to £43,426. 14s. 4d., which, together with instalments of principal and interest transferred, makes a total expenditure of £76,888. 7s., and gives a credit balance of £16,028 11s. 6d. By placing this balance to the amount already transferred, there is an accumulated reserve fund for the tramways of £22,993. 10s. 8d. The rents, rates and taxes have increased from £2,665. 11s. 5d. to £5,506. 9s. 9d., due to the assessment of the undertaking having been increased, and there is also an increase in the principal and interest charges. The average length of the penny section is now 1½ miles, as against 1⅛ miles previously. The changes thus made account for the falling-off in the average receipts per car mile from 12·37d. to 12·19d. Over 1,800,000 passengers have been carried in excess of the number conveyed during the previous year, and estimating the population of Portsmouth at 198,000, the tramways have carried the whole number of the population no less than 92 times this year. The mileage for the year shows an increase of over 199,000 miles compared with that of the preceding year. The length of the route is about 14½ miles, and there are 28 miles of double track, only half a mile being single track. The maximum gradient is 1 in 17; the sharpest curve is 35ft radius; carrying capacity per car is 56 passengers; car miles run per annum, 1,828,193; average per day, 5,008; passengers carried per annum, 18,204,426; per day, 49,875; passengers carried per car mile, 9·95; traffic receipts, £87,266. 8s. 3d.; average per day, £239. 1s. 9d.; average traffic receipts per car mile, 11·45d.; average per passenger, 1·14d.; gross receipts (less £1,257. 2s. 3d. tolls paid to light railway), £92,916. 18s. 6d.; average net receipts per day, £254. 11s. 1d.; average per car mile, 12·19d.; average per passenger, 1·22d.; percentage of working expenses to total receipts, ·46. Incorporated in Mr. Spaven's report is the report of the resident engineer, Mr. V. G. Leroni, on the power station, overhead line, cables, permanent way, and rolling-stock. A very satisfactory feature of the year's working is the reduction of the generating cost per unit by ·16d., bringing the cost now to the low figure of ·55d.

PROVISIONAL PATENTS, 1904.

AUGUST 15.

17674. Improvements in and relating to telephones. Samuel James Port, Cobden-buildings, Corporation-street, Birmingham.

17675. An automatic protection for third or live rail used on electric railways. Garnett Senior, 9, Olive-street, Sunderland.

17705. Improvements in vaporisers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17717. Improvements in electrical switches. Charles Julius Klein, 40, Chancery-lane, London.

AUGUST 16.

17733. Improved suspension fitting for electric motors. George Davis, 15, Victoria-street, London.

17738. Improvements in switchboards. Isaac Hardy Parsons, Faraday Works, Leicester.

17741. Alternating-current power-transmitting apparatus. Wallace Fairweather, 65, Chancery-lane, London. (Arnold Magnetic Clutch Company, United States.) (Complete specification.)

17752. Improved magneto-electric generator. Rooke Ainsworth and P. R. Jackson and Co., Limited, 70, Deansgate, Manchester.

17764. Improved means of regulating electric circuits. Harry Hill, Lynton, Dartnell-park, Byfleet, Surrey.

17784. Improvements in or relating to electrolytic cells. Edgar Arthur Ashcroft, 111, Hatton-garden, London.

17792. Improvements in and relating to the manufacture of incandescent electric lamps. Jean Michel Canello, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 12, 1903, being date of application in France. (Complete specification.)

17805. Improvements in or relating to telephone and other conducting cords. Thomas Henry Martin Harvey, 322, High Holborn, London.

17808. Improvements in electrical measuring instruments. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

17809. Improvements in electric controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17811. Improvements in automatic brakes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17812. Improvements in electric fuses. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17813. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17823. Improvements in or relating to telemeters. Giovanni Aragno, 111, Hatton-garden, London.

AUGUST 17.

17837. Improvements in terminals for secondary and primary batteries. Jasper Myers Richardson, 427A, Strand, London.

17841. Improvements in electric motors. Walter John Hawkins, 178, High-street, Tooting, London.

17862. Improvements in and relating to electrical conductors, specially applicable to overhead conductors for electrical tramways. Ernest Marsh Ginders, 34, Castle-street, Liverpool.

AUGUST 18.

17939. Improvements in electric trolleys. Jean Lauvernier, 23, Mittelstrasse, Berlin. (Complete specification.)

17975. Improvements in the control of electrically-propelled vehicles. John Smith Raworth, 46, Lincoln's-inn-fields, London.

17978. Improvements in or relating to suspending or supporting electric motors or differential gear or both on motor road vehicles or tramway vehicles. George Beloe Ellis, 70, Chancery-lane, London. (La Société A. Vedrine et Cie., France.)

17980. Improvements in the method of and apparatus for making pipes and conduits. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

AUGUST 19.

17997. Improvements in electrical switches. Frederick Francis MacDonald, Bank-buildings, George-street, Sheffield.

18020. Improvements in electrical driving mechanism for machinery in general. Joseph Richard Hill, 7, Staple-inn, London.

18021. Improvements in insulating electric conductors. Isidore Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

18034. Improvements in or relating to electric automobile vehicles. George Beloe Ellis, 70, Chancery-lane, London. (La Société A. Vedrine et Cie., France.)

18042. Improvements in processes of oxidation and reduction effected in an electrolytic bath. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Farbwerke vormals Meister, Lucius, und Brüning, Germany.)

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AUGUST 20.

18655. Improvements in or relating to trolley heads of electric tramcars. Holberry Mensforth, 2, Market-street, Bradford.

18669. Improvements in electro-mechanical apparatus for automatically operating the rail and electrical conductor points on electric tramways and railways from the tram or train. George Dudley Aspinall Parr, The University, Leeds.

18687. Improvements in the transmission and distribution of electric power. Jacob Krüyswijk, 77, Chancery-lane, London.

18695. Improvements relating to telephone switchboard cords and like flexible electric conductors. William John Burton and Charles Lincoln Burlingham, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18698. Improvements in and connected with wireless telegraphy and apparatus for carrying out the same. George Cecil Dymond, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

18101. A new or improved means of converting alternating current for use with continuous-current electrical measuring instruments and the like. Walter Charles Head, 62, Stoke Newington-road, London.

18105. Improvements relating to the transformation of repulsion motors when running at speed into rotating field asynchronous motors. Marius Latour, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 27, 1903, being date of application in France.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 8, 1904.

1903.

17601. Systems of electric lighting. Leitner and Lucas.

18010. Galvanic batteries. Fiedler and Gerard.

18076. Electric traction. Sayer.

18186. Telphers. Siemens Bros. and Co., Limited, and Clift.

18250. Thermal cut-outs. Carolan. (General Electric Company.)

18256. Time-limit controllers for circuit breakers. Carolan. (General Electric Company.)

20101. Construction of armatures for dynames and motors. Maclean.

20606. Multipolar dynamo-electric machines. Holmes.

21805. Alternating-current electric motors. British Thomson-Houston Company, Limited, and Meyer.

21654. Rheostats. Hobart and Punga.

21663. Electrical switches. Porter.

21140. Engine telegraphs or signals on board ships. Isdale.

21320. Apparatus for electric signalling. Brodin and Schepeler.

21972. Dynamo-electric machinery. Mawdsley.

22097. Trolley or like current collectors for electric traction. Upham.

22190. Alternating-current induction motors. Hunt and Sandycroft Foundry Company, Limited.

22507. Electrically-controlled hoists. Steven.

22906. Machines for covering electric conductors or the like with insulating material. Carolan. (General Electric Company.)

23910. Bearings for electric meters and other measuring instruments. Carolan. (General Electric Company.)

23546. Telephone mouthpieces or receivers. Cruickshank.

23767. Galvanic batteries. Halsey Electric Generator Company, Limited. (Halsey Electric Generator Company.)

24025. Printing telegraph receivers. White.

25657. Lightning arresters or devices for preventing overcharging in electric conductors. Zapf.

26165. Electrical elevators. Smith.

27133. Protective device applied to X-ray or radiant-matter tubes. Harnack.

28623. Joint-box for electrical conductors. Martin.

1904.

43049. Electric switches. General Contracts Company, Limited, Cook, and Chipperfield.

7823. Telephone transmitters. Fairweather. (American Electric Telephone Company.)

14350. Electrically-operated signalling and braking devices for railway trains. Krause.

14553. Burglar and other electric alarms. Getto.

15512. Lid for accumulator and other acid-containing boxes or tanks. Clark and Hart Accumulator Company, Limited.

15561. Indicators for electric oscillations. Thompson. (Gesellschaft für drahtlose Telegraphie m. b. H.)

15567. Electric or telephonic transmission. Carbonelle.

15657. Regulating mechanism for arc lamps. Upton, Elliott, and Pratt.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅜-½ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¾-6¼
—— 5 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	101-103
British Westinghouse Elec. and Manur., 6 per cent. Pref., 275,001-375,000	5	–	2¾-3¼
—— 4 per cent. Mortgage Debenture Stock	100	..	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,751 ..	2	–	¾-1
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock.....	100	..	98-99
—— 4½ per cent. 2nd Debenture Stock	100	..	70-75
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9¼-10¼
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	5	–	14-2
—— 5 per cent. Debentures.....	100	–	94-97
Edison and Swan United, "A" Shares, 1-98,261	5	–	¾-1
—— "A" Shares, 01-017,139	5	–	1-2
—— 5 per cent. Debentures.....	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	86-89
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	11-12
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-18¾
—— 4 per cent. Debentures.....	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance.....	12	–	35-38
—— 5 per cent. Bonds	100	–	101-104
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200 ..	1	–	¾-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv. ..	100	–	103-107
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¾-10¼ xd
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼ xd
—— 4½ per cent. Debenture Stock, Red.	100	–	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary.....	5	–	10¾-11¼ xd
—— 7 per cent. Preference	5	–	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 ..	5	–	7¼-7¾
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	105-109
Charing Cross and Strand, Nos. 1-70,000	5	–	7¼-8
—— 4½ per cent. Cum. Pref.	5	–	5¼-5¾ xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	106-109
City of London, Ordinary.....	10	–	10¼-10¾
—— 6 per cent. Cumulative Pref.....	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	102-105
County of London Electric Supply, Ordinary	10	–	7¼-8¼ xd
—— 6 per cent. Cum. Pref.	10	–	11¼-12 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	101-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6 6¼
—— 6 per cent. Cum. Pref.	5	–	6-6¼
—— 4½ per cent. First Mort. Deb.	100	–	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¾-6¼
—— 4½ per cent. First Deb Stock, Red.....	100	–	98-102
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7¼-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	101-103
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	⅜-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
—— per cent. Debenture Stock Red	100	–	102-105
Kensington and Knightsbridge and Notting Hill	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1¼-1¾
—— 6 per cent. Pref.....	5	–	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	96-99
Metropolitan Ordinary	10	–	15¼-16¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	–	109-113
—— 5 per cent. Mortgage Debenture, Red.	100	–	96-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb..	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14-15
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)..	100	–	100-103
Oxford Electric, Ordinary, 1-96 and 4,501-14,510.....	5	–	5¼-6¼
—— 4 per cent. Debenture Stock	100	–	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2¾-3¼
—— 4 per cent. Debenture Stock	100	–	83-88
South London, Ordinary			3¾-4¼
St. James's and Pall Mall, Ordinary, 101-30,080	5	–	14-15
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¾-5¼
Westminster, Ordinary	5	–	12¼-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251.....	5	–	6-6¼
Electric Railways.—			
Central London, Ordinary	100	–	87-89 xd
—— 4 per cent. Pref.	100	–	100-102 xd
—— ,, ,, deferred.....	100	–	80-82 xd
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100	–	106-109 xd
City and South London, Consolidated Ordinary	100	–	39-41 xd
—— 4 per cent. Debenture Stock	100	–	105-108
—— 5 per cent. Pref. Stock '91.....	100	–	121-124 xd
—— ,, ,, ,, '96.....	100	–	118-121 xd
—— ,, ,, ,, '01	100	–	117-120 xd
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10¼
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700..	—	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	..	96¼-97¼
Waterloo and City, Ordinary	100	–	87-90 xd

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Name.	Amount paid.		Last price.
Electric Tramways.—	£		£
Anglo-Argentine, 1-260,007	5	–	5⅜-5⅝
—— Permanent 6 per cent. Debenture Stock, 1888 ..	100	–	137-141
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	98-100
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	96 99
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..	1	..	11/16-13/16
—— 5 per cent. Cum. Pref. Shares. 1-59,394	1	..	¼-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10½-11½
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.	100	–	99-102
—— Ord Pref.	100	..	99-102
—— Non-Cum. 5 per cent. Pref.	10	–	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	–	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	8⅜ 9½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10½-11 xd
—— 5 per cent. Perpetual Debenture Stock	100	–	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	–	2⅝-3½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5½-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5-5½
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	101-104
Calcutta Tramways, Limited, 1-102,268	5	..	7¼-7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	104-107
Cape Electric Tramways, Nos. 1-480,000	1	–	1⅜-2
City of Birmingham Tramways, 5 per cent. Cum. Pref. ..	5	..	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)....	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	100-103
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	12½-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97

Name.	Amount paid.		Last price
	£		£
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100		108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	–	3¼-4
—— 4 per cent. Debenture Stock	100	–	88-91
Kidderminster and District Lighting and Traction, Pref.	5	–	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10½-10⅝
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb Stk., Red.	100	–	100-103
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¼-1 xd
—— 4½ per cent. Deb. Stock, Red.	100	..	98-100
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	5	–	⅛
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	–	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12-12½
—— 5 per cent. Cum. Pref.	10	–	9¼-9⅜
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	–	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8¾ xd
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	–	1
—— £101,132 6 per cent. Preference	1	–	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	–	100 p.c.
Telephones.—			
National Telephone, Preferred	100	–	104-106
—— Deferred Stock	100	–	89-92
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	104-106
Oriental Telephone and Electric Company	1	–	15/16-1 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 6	1,664	1,378	+ 285	+14,755h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Aug. 20	37	—	—	—	1½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 21	1,033	1,101	- 68	+ 172	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 20	5,130	5,139	- 9	+11,570	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 19	861	759	+ 103	+ 1,860	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 18	2,499	2,097	+ 402	+ 2,740	17½	17½	,, 31	211,169	6,169,121	784,443	1·62	10·8	—	—
Blackpool-Fleetwood Trams.	,, 20	1,606	1,955	- 349	—	16½	16½	Dec. 31	30,923	2,043,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 21	1,938	2,285	- 295	—	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	5,430	5·67
Bournemouth Corporation	,, 3	1,713	1,664	+ 49	+ 1,302	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 20	4,951	4,112	+ 839	+17,026	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 21	1,385	1,131	+ 255	+ 2,023h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 19	5,029	4,851	+ 178	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 20	1,128	902	+ 226	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 21	375	385	- 10	—	8½	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 6	2,813	2,596	+ 216	+ 1,162	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 20	201	227	- 26	+ 275	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 20	5,420	5,445	- 25	— h	6	6	,, 31	357,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City & South London Railway	,, 21	2,235	2,252	- 17	— h	6⅔	6⅔	,, 31	165,033a	19,069,318a	—	—	—	—	—
Cork E. T. and L. Company	,, 18	541	662	- 121	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 19	213	223	+ 10	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 20	310	304	+ 6	- 229	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 19	134	143	- 9	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 19	4,206	4,106	+ 100	—	46	45	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 19	1,170	1,128	+ 42											
Dundee City Tramways	,, 17	841	843	- 2	—	23	23	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 20	749	760	- 11	—	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 20	14,110	13,642	+ 478	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 17	340	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 10	4,046	3,630	+ 416	+ 2 287	30½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 21	1,470	1,320	+ 150	—	34	34	March 31	55,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·32
Hull Corporation, E. S.	,, 20	2,186	1 833	+ 353	+ 5,857	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	July 9	528	552	- 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Aug. 18	145	187	- 42	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 17	297	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 20	6,033	5,632	+ 401	—	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 20	1,351	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 13	10,907	10,183	+ 724	+11,806	103	101	Dec 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 21	1,611	1,716	- 75	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	July 2	13,329	11,473	+1,856	+25,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Aug. 20	441	370	+ 71	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 20	12 407	11,836	+ 571	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 19	1,884	1,425	+ 460	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 20	135	112	+ 23	+ 940	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corpn.	,, 20	3,573	3,509	+ 64	—	38½	38½	March 25g	150,334	33,474,122	3,378,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 20	538	505	+ 33	+ 2,050	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,026	+ 466	+ 3,951	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Aug. 18	473	505	- 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 20	425	—	—	—	7½	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 23	4,579	4,616	- 37	—	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	July 28	1,031	1,109	- 77	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Aug. 17	611	559	+ 52	+ 591	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 19	695	343	+ 353	+ 5,403	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 14	1,424	1,405	+ 19	+ 654	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	,, 20	854	834	+ 20	+ 937	10·5	10·5	,, 31g	31,474	5,685,182	664,742	1·30	11·63	3,593	7·03
West Ham Corporation	,, 18	1,152	—	—	—	12	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 17	801	449	+ 354	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Personal.—We understand that Messrs. Browett, Lindley, and Co., Limited, have again secured the services of Mr. F. C. Gibbons, who has now been appointed sole managing director of the firm. It will be remembered that Mr. Gibbons was for many years associated with Messrs. Browett, Lindley, and Co., Limited, and that he left them to join Messrs. Howden and Co. His return to Messrs. Browett, Lindley, and Co., Limited, should have beneficial results as a sign that in business old friends are best, and we wish the firm every success under his management.

Rheinfelden.—Negotiations are proceeding between the German and Swiss Governments with reference to the utilisation of the Rhine at Laufenburg for generating power in connection with the extension of the Rheinfelden works, to which we referred in our issue of April 29. It will be remembered that in the course of this enlargement use is being made of an island in the Rhine, and as at this point the river forms the boundary between the two countries, the works will be situated partly in each. This will be the first international convention for the regulation of electric power.

Iron and Steel Institute.—We have received a copy of the revised programme in connection with the American itinerary. On arrival in the capital one party will enter upon a tour to Cleveland, extending from Oct. 27 to Nov. 9, in the course of which they will visit several points of interest, including the Schenectady works of the General Electric Power Company. A second party will proceed to the St. Louis Exhibition. An earlier function has been fixed for the 13th inst., when the institute will give a dinner to a party of the Liège Association of Engineers at the Hotel Cecil, the time fixed being 7.30. Tickets (price £1. 1s., including wine) may now be had from the secretary, 28, Victoria-street, S.W.

New Publications.—"The Diseases of Electrical Machinery," by E. Schulz (London: E. and F. N. Spon). This little volume provides a concise handbook on a subject that has received limited attention in electrical publications. In a brief preface, humorous and felicitous, it has the recommendation of Dr. S. P. Thompson.—"Relations between the Effects of Stresses Slowly Applied and of Stresses Suddenly Applied in the Cases of Iron and Steel Comparative Tests with Notched and Plain Bars," by M. Pierre Breuil (London: E. and F. N. Spon). The secretary of the Iron and Steel Institute has forwarded us a copy of this publication, which is issued as a supplement to vol. lxv. of the institute's *Journal*, and describes the author's researches into this subject, which gained him the gold medal for 1904. The work, we may add, is admirably illustrated.

The Ether-Pressure Theory.—A paper was contributed by Mr. J. Macfarlane Gray to Section A at the Cambridge meeting of the British Association, in which he examined the important experiments of Dr. Grindley in the light of the ether-pressure theory, the basis of which is indicated by the following: Newton regarded the pressure of the ether as very great and sufficient, by its slope, to account for terrestrial and stellar gravitation. Ether-pressure cannot be selective; if it acts upon stars it must also press upon every atom of matter and be the most important of all natural forces, and the fundamental factor in every physical phenomenon. Neothermodynamics therefore begin with ether-pressure as in equilibrium with every other pressure, whether of solids, liquids, or gases. The play space of every contributory molecule of gas, as its amplitude of vibration was acquired, from absolute zero temperature—even if in an envelope of constant volume—must have been obtained by driving back the ether, and, just as external work is $p\,v$, so this internal work is also $p\,v$. The translation energy of gas is $1\frac{1}{2}$ times its $p\,v$; or, the constitutional energy of a gas exclusive of external work is $2\frac{1}{2}\,pv$. Including the external $p\,v$, the total energy from absolute zero is $3\frac{1}{2}\,p\,v$, and the ratio is 1·4. By this reasoning the same ratio must hold good for all gases.

An "Electric Thinking Machine."—A correspondent writing from Baden, Switzerland, sends us a facsimile of a letter received by him, the text of which we reproduce, and asks if any of our numerous readers can solve the enigma. We think we can do so, and that the writer is a gentleman who has called at this office making much the same statements as those contained in the letter. He is an electrical engineer who has been responsible for outdoor work on mains, and is now afflicted with an idea that his thoughts and actions are influenced by some malicious person from a distance. When he called to see us he stated that he had been informed by this means (?) that he had been appointed chief electrician on board the King's yacht. So implicit is his faith in such delusions that he actually went to join the yacht, which was then at Southampton. The letter, which is sent from South Wales, England, and dated Aug. 23, 1904, reads as follows: "Sirs,—Please is there at your Estab. Electric Thinking Machine if so. which Gentleman has ordered a Machine to speak me. & give thoughts to me. Wrong explanations speaking & thoughts given to me. *Very Bad*, 2 persons Welsh. follow my thoughts Day & Night, *Scandal. Search your Machine & Stop persons at once* I dont know where to Apply. *Machine open not Locked.* Some person did pass by me or somehow for Electric Machine when I did not know."

Chamber of Commerce.—The London Chamber of Commerce has for some time past been in communication with the representatives of the Commonwealth of Australia, the Government of India, and the Canadian Government relative to the levying of duty upon price-lists and catalogues sent to Australasia, India, and Canada. As a result of the representations made, the practices of the several customs authorities have been defined, previous to which considerable ambiguity existed as to the levying of duty or otherwise. The Government of India, in a recent communication, have stated that "as they consider it desirable to afford all possible facilities for the development of trade, they have issued instructions that all trade catalogues and circulars imported into India by packet, book, or parcel post shall in future be admitted free of duty.' In reference to Canada, the High Commissioner has informed the chamber that *bonâ fide* trade catalogues and price-lists of goods for wholesale not exceeding three to one person, are admitted into Canada without payment of customs duties. As regards Australasia, the manufacturers and Australasian sections of the chamber have also communicated with the Colonial Chambers of Commerce, who have unanimously supported the representations of the London Chamber in favour of the free admission of trade catalogues into Australasia. It is to be regretted, however, that up to the present the representations have not been favourably considered by the Commonwealth Government, it being officially stated that the primary object of the duty was not for the purpose of revenue, but for the encouragement of local printing, and that, therefore, the Commonwealth Government has no present intention of altering the law in this connection. Further efforts are being made with the object of

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obtaining a reconsideration of the matter by the Commonwealth Government, and it is suggested that the free importation of trade circulars and price-lists will largely assist in promoting the trade of the Empire.

International Meteorological Committee.—At the meeting of the International Committee on Sept. 11, 1903, a proposal to constitute a sub-committee to combine and discuss meteorological observations from the point of view of their relations with solar physics was adopted, and the following gentlemen were elected thereto: M. A. Angot, Bureau Central Metéorologique, Paris; Prof. S. P. Langley, Smithsonion Institute, Washington; Sir Norman Lockyer, Solar Physics Observatory, South Kensington; Prof. J. M. Pernter, Hohe Warte, Vienna; and Mr. W. N. Shaw, Meteorological Office, London. It was left to the sub-committee to supplement the number of its members and to constitute its bureau, and the sub-committee nominated seventeen scientists belonging to various parts of the globe for membership. A meeting during the Cambridge session of the British Association was decided upon, the subjects enumerated in the programme comprising the selection of the meteorological and magnetic elements which should be collated for the purpose of comparison with solar observations, and the form in which the observations might be presented with the greatest advantage for the purposes of the comparison; the specification of solar observations which should be collected for the purpose of the comparison, and the preparation of a list of observatories which should be asked to furnish such observations; the means that should be adopted to facilitate the collection of observations arranged upon a uniform plan; and the consideration of additional methods of observation bearing upon the subjects which are not yet in general use in solor or meteorological observatories, such as the observations of solar radiation.

Fireproof Insulated Wire.—A description is given in the *Street Railway Journal* (New York) of a fireproof insulated wire devised by the Teter-Heany Developing Company, of York, Pa. Our contemporary remarks that in the general trend of modern engineering toward fireproofing, electrical insulators, especially for wires, have been to a great extent neglected, not so much because of lack of effort in this direction as on account of the difficulties that surround the subject. Asbestos is an excellent though not the only material for this purpose, but its thickness, frailness, unevenness, and cost has precluded its general use. It is to supply this gap that the Teter-Heany Developing Company, of York, Pa., has devised its fireproof insulated wire. By an ingenious device, asbestos, in its fibrous form, is applied directly to the wire, and then is treated with a special cement that on pressure and heat yields a firm, hard, even, thin insulation, that is said to be efficient in every respect. It is stated that the insulation will not crack, peel off, or break under bending or twisting, and that it will withstand temperatures above red heat without being destroyed. The advantages claimed over ordinary asbestos covering are that the total thickness of insulation is but ·011in., and ·009in. may be obtained if desired. This is the same as double cotton-covered insulation, and in its use old forms can be employed without alteration. While asbestos insulation is ordinarily very uneven, this insulation varies on the average about ·003in. Asbestos, while it will not burn, will crumble under heat, and so become useless for insulating purposes. This insulation protects the asbestos, so that it will stand much higher temperatures without crumbling. A coil in possession of Mr. Heany has been heated red-hot several hundred times, for hours on some occasions, yet the coil retains its insulation unimpaired. Temperatures of this degree are rarely met with in practice, and no effect whatever is observed at temperatures that usually cause coils to burn out. This means that coils wound with this wire, armatures, fields, arc lamp and transformer coils, etc., are practically indestructible. As our contemporary remarks, there is a wide field for this wire for use in motor and generator coils, especially for electric apparatus subjected to heavy overloads, and, in fact, wherever a high degree of heat is met with and must be resisted. The insulation has been thoroughly tested, both in the laboratory and in practice, with very satisfactory results.

Presentation to Huddersfield's Tramway Manager.—Mr. H. W. Thomas, who for the past five years has held the position of general manager of the Huddersfield Corporation tramways, was the central figure in a gratifying ceremony at Monday's meeting of the Tramways Committee. The Chairman (Councillor T. H. Moore), in moving a resolution recording the committee's appreciation of the zeal, ability, and success with which Mr. Thomas had discharged his duties, and congratulating him upon his appointment to an important office at Durban, testified from personal experience to the diligence and courtesy he had invariably shown. These sentiments were endorsed by the Vice-Chairman (Councillor Cartwright), who expressed the hope that Mr. Thomas would enjoy health and happiness in his new sphere, and the resolution was carried unanimously. The Mayor (Alderman R. H. Inman), in conveying the vote of thanks to Mr. Thomas, presented him with a piece of plate, bearing an appropriate inscription, and subscribed for by all the members of the committee. His Worship remarked that it afforded him great pleasure to convey these tokens of the high esteem in which Mr. Thomas was held by the committee. They were conscious that as the head of a large and important department like the tramways he had exercised his best efforts and energies, not only in making it a financial success, but also to give a maximum of comfort and convenience to those who used the trams. In conclusion, his Worship associated himself with the views of the chairman, and echoed the hope to which the vice-chairman had given expression. Mr. Thomas, in response, thanked the committee for their manifestations of appreciation, and wished prosperity to the tramway undertaking.

A 500,000-Volt Transformer.—One of the features of the Palace of Electricity at the St. Louis Exhibition is the 500,000-volt transformer exhibited by Mr. C. H. Thordarson, of Chicago, who has made a special study of high-tension apparatus. It is of the closed magnetic circuit type, with a capacity of 20 kw., and is operated from 110-volt 60-cycle mains. The primary and secondary coils are wound on a laminated core, the whole being immersed in oil. The weight of the iron in the magnetic circuit is 700lb., and the weight of copper is 45lb. in the primary and 60lb. in the secondary coils. The tank containing the oil is of wood, lined with metal. The two terminals of the secondary coil rise out of the oil to a height of 2ft. above the top of the tank. These terminals placed 32in. apart are surrounded by standards heavily insulated with paper boiled in paraffin. The wires emerge from glass insulators which cap the paper insulation. After leaving the insulated standards, the current passes through heavy choke coils and then to the terminals proper. As usually operated, a heavy glass plate is placed between the two points, and the discharges, leaping a maximum distance of 32in, around this plate, have a particular fascination for the spectators. The discharges between the two points are attended with a sharp crack when the arc is established. Frequent reports of lesser volume, due to the opening of shorter paths across the atmosphere, when the main arc in its fantastic writhings assumes such a shape that the resistance of a short cut

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across the air is less than that of the long arc between the two points, continue as long as the arc is sustained. No detriment to the transformer results from these discharges, thus proving that the maximum voltage for transmission is governed by the insulation of the line and not by that of the transformer. For varying the voltage of the transformer a regulator is provided. This consists of a transformer with a ratio of 1 to 1, whose primary is connected to the Exposition mains. The secondary coil is movable, and by operating a regulating wheel can be moved out of the main path of the magnetic flux of the transformer and the voltage so reduced. We summarise the foregoing from the *Electrical World* of New York.

Energy of Water and Steam at High Temperatures.—This subject was dealt with by Prof. C. Dieterici in the paper which he contributed to Section B of the British Association at the Cambridge meeting. The author has devised a method for determining the specific heat of water at temperatures up to 300deg. C. The water is enclosed in quartz tubes, which are sufficiently strong to withstand the pressure of steam—namely, about 100 atmospheres at 300deg. C.—and the determinations are made with the aid of the ice calorimeter. The results obtained may be expressed by the formula $c_t = 1{\cdot}0160 - 0{\cdot}0_3 6057\ t + 0{\cdot}0_5 4302\ t^2$, in which the specific heat, c_t, is given as a function of the temperature. The formula holds between 50deg. and 300deg. C., but does not hold below 50deg. C., because at such low temperatures the point of maximum specific heat first observed by Rowland occurs. The observations made with water completely enclosed in a tube give the difference between the energy of the liquid water at t degrees C. and that of the water at 0deg. C. Since the heat of evaporation is known or calculable, this quantity, diminished by the external work, gives the energy difference between saturated steam and liquid water at t degrees C. Very careful observations have been published by Sir W. Ramsay and S. Young (*Phil. Trans.*, 1891) on the pressure of unsaturated steam between 140deg. and 270deg.; and since the relation between energy change and volume at constant temperature is given by the equation $\left(\frac{\delta\ U}{\delta\ v}\right)_\tau = \tau\ \left(\frac{\delta\ p}{\delta\ \tau}\right)_v - p$ of the mechanical theory of heat, the change of energy of superheated steam depends only on the pressure, and can be calculated from the author's present observations. It is, therefore, possible to calculate the energy isothermals, and to draw the isothermal lines for water. After applying the most accurate methods of calculation possible to the new observations, the author draws the following conclusions: At about 200deg. C. the specific heat of superheated steam at constant volume is 0 5, and is practically independent of the volume if the latter is much greater than the saturation volume. As, however, the volume diminishes to the volume of saturation, the specific heat increases to about 0·7. The specific heat at constant pressure, C_p, similarly varies from 0·6 to 0·8. Further, in the well-known equation of state of Van der Waals, $p + \pi = \frac{R\ T}{v - b}$, the cohesion pressure, π, cannot be taken as $\frac{a}{v^2}$, but is such a function of v and T that it has a considerable value for large volumes at low temperatures, and for small volumes at higher temperatures.

Universal Testing Machine.—The paper presented by Mr. J. H. Wicksteed, the president of the Institution of Mechanical Engineers, to Section G at the Cambridge meeting of the British Association had for its subject "A Universal Testing Machine of 300 Tons for Full-sized Structural Members." The machine will admit a column or strut 88ft. long, 3ft. 3in. square in cross-section. It will admit a beam 3ft. 3in. broad, 6ft. 6in. deep, and 20ft. between supports. It will shear a bar of mild steel 8in. by 2½in. It will break a steel wire rope 9in. in circumference. It makes autographic stress-strain diagrams in all these tests. The sensibility of the machine with a pull of 100 tons is 1 in 10,000. The purpose of the machine is not simply that of testing the strength of material itself, but it is for testing the strength of a full-sized member of any structure—that is, the strength which results from the disposition of the material in the sections and in the proportions of, for example, a strut, an eye-link, or a beam. The reason for employing a machine for the purpose of making tests instead of loading on full loads directly upon the specimen is, that for no reasonable cost could you possibly make experiments with heavy loads applied in bulk. Three hundred tons of accurate dead weights would themselves cost about £2,400; their application to the specimen would be so tedious that each experiment would cost as much in time and in labour as 100 experiments conducted in the machine to be described, where the full load is applied through hydraulic pressure and balanced by small accurate weights acting through levers and knife-edges. To minimise time and labour in making tests on various forms of structural members, this machine has been so designed as to be applied, without any change of apparatus, either to thrusting strains or pulling strains, and this is accomplished by making the straining frame in the form of a large trough, which is pushed forward by a hydraulic plunger, and which carries with it a straining head capable of being locked at any part of its length. This trough, hydraulic ram, and cylinder are completely surrounded by a balancing framework of tension rods and cross-heads, and this enables the straining cross-head to apply its force to one part of the balancing frame which surrounds it for compression tests, and to another part of the balancing frame for tension tests. Wherever the force may be applied to the balancing frame, it is delivered to the levers and poiseweights where it is measured. Besides the facility for bringing forces to bear either in compression or tension, it is requisite that no labour should be involved in arranging the machine to take in long or short pieces, and this is accomplished by mounting the straining head upon wheels, so that it can be quickly run to any part of the moving trough and locked there by bolts, which can be shot with the same facility as those in the door of a strong-room.

Harcourt Pentane Lamp.—"Some Investigations on the 10-c.p. Harcourt Pentane Lamp made at the National Physical Laboratory" was the title of the paper contributed by Mr. Clifford C. Paterson to Section G at the recent meeting of the British Association. This paper gave briefly the results of investigations carried out at the National Physical Laboratory in order to determine changes in the illuminating power of the 10-c.p. Harcourt lamp due to variation in (1) barometric pressure, (2) in the quantity of water vapour present in the air. When photometric comparisons are made between the pentane standard and a source of light unaffected by atmospheric conditions, as, for instance, an electric incandescent lamp, errors of the order of 5 per cent. may be introduced into candle-power measurements if corrections are not made for the hygrometric and barometric conditions existing at the time. In order to ascertain the amount of variation, photometric comparisons were made against two large-bulb Fleming-Ediswan electric standard incandescent lamps. The double comparison method only was employed, and the two electric lamps used to standardise a comparison incandescent lamp anew for each experiment, so that it was only necessary to burn the standards for five or ten minutes at a

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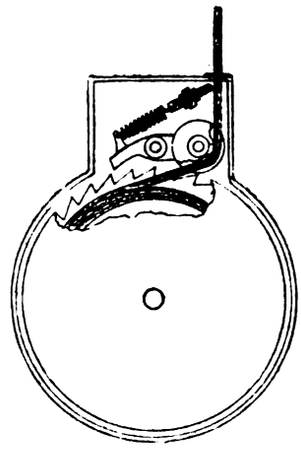
time. It is found convenient to state humidity volumetrically, as the number of litres of water vapour to a cubic metre of pure dry air, at the barometric pressure existing at the time; so that if b = reading of barometer in millimetres, e = aqueous pressure, and e_1 = vapour tension of carbon dioxide present in the atmosphere, the litres of water vapour per cubic metre of pure air equal $\frac{e}{b-e-e_1} \times 1{,}000$. Upwards of 60 observations have been made on different days over a range of humidity varying from five to twenty litres per cubic metre, which are about the limits obtained under ordinary conditions in a well-ventilated photometer room; 80 per cent. of these, when corrected by means of the formula, fall within + or − ½ per cent. of 10 c.p. The barometric pressure in these observations has varied from 739mm. to 780mm. of mercury, so that, applying the method of least squares for these two variables, the following formula has been obtained for correcting the candle-power of the lamp to the standard atmospheric conditions of 760mm. of mercury and 10 litres of water vapour per cubic metre of pure dry air. Candle-power = $10 + 0\,066\,(10 - \epsilon) - 0{\cdot}0008\,(760 - b)$, where ϵ is the humidity as explained above and b the height of the barometer in millimetres. From this it will be seen that a variation of one litre per cubic metre in the moisture causes a variation in candle-power of about 0·7 per cent., and that 10mm. change in barometric pressure brings about an alteration of 0 8 per cent. in the illuminating power of the lamp. The standard humidity of 10 litres per 1,000 has been fixed upon as being the mean value for three years found at Kew Observatory. The figure is also borne out by observations made at the Meteorological Office.

The Penetrating Power of "N_1-Rays."—Prof Blondlot recently drew attention to a novel kind of N rays, diminishing, instead of augmenting, the phosphorescence of calcium sulphide. These rays, called by him "N_1-rays," are given off from a Nernst lamp simultaneously with the N-rays, and are also produced by stretching out a copper, silver, or platinum wire. In a paper recently presented to the French Academy of Sciences, Mr. Julian Meyer describes some experiments with these N_1-rays, produced by an extended glass or copper wire or by a closed glass tube, in the interior of which the pressure is diminished, an account of which is given in the *Scientific American*. The glass of the tube, on account of the strain resulting from the difference in pressure, was, in fact, found to be a powerful source of N_1-rays. The brilliancy of a screen covered with sulphide spots and introduced into a glass bulb resting on the plate of an air-pump would diminish when the machine was started, but would recover its initial value as the air was allowed to re-enter. If the sulphide screen be placed outside of the bulb, the phosphorescence would likewise diminish from the very first stroke of the piston. An incandescent lamp bulb, not traversed by any current, a hydrogen Geissler tube, a Crookes tube, were all found to be sources of N_1-rays without being actuated by a Ruhmkorff coil. While the N_1-rays from a Nernst lamp are arrested by an oxidised lead plate or by a sheet of moistened paper, those issuing from the sources named are gifted with a high penetrating power; in fact, the action of incandescent lamp bulbs on the screen is not appreciably diminished if between the bulb and the screen there be inserted a board 10cm. in thickness or a sheet of oxidised lead 1mm. in thickness and folded round itself so as to be traversed eight times, or else a glass vessel filled with pure water. Pasteboard, paraffin, aluminium, zinc, iron, copper, silver, gold, mercury, and the hand are also transparent to these radiations. The only opaque bodies found were platinum of a thickness of 1mm. and opalescent glass 3mm. in thickness. While examining the refraction of the rays by means of an aluminium lens, the author stated that this metal would store the rays in great amounts, giving them off again for more than 24 hours after it had been withdrawn from the source. A similar power, though of smaller intensity, was found in the case of ordinary glass; while lead, copper, and pure water did not show it. Salt water and a solution of sodium hyposulphite in water, on being submitted to the action of a source of N_1-rays, would become active themselves, acting as sources for a very long time. When the hand is held for some time at a small distance from a source of N_1-rays or touching the latter, the hand would diminish itself the phosphorescence of the screen, this property being kept for some minutes. N_1-rays as given off from the above sources are refracted by glass, copper, and aluminium prisms and diffracted by a grating. We notice, by the way, that the French Academy of Sciences has awarded the Le Compte prize of 10,000fr. to Mr. Blondlot for his researches into the N-rays.

New Trolley Catchers.—The accompanying illustration, taken from our contemporary, the *Street Railway Review*, shows a new trolley catcher for preventing the trolley pole from springing up when the trolley leaves the wire, quickly enough to avoid damage to the overhead apparatus, in connection with which application has been made for a patent in the United States by Mr. E. H. Amet.



The appliance comprises an ordinary drum for taking up the slack of the cord, which drum acts like a self-rolling window-shade pole, keeping a slight tension on the cord at all times. The locking device is the main feature of this invention. The cord, it will be observed, passes over a small grooved idler, which revolves on a bearing mounted on one end of the pawl or dog, and the other end of the pawl is free to engage with the teeth of the ratchet on the winding drum. As long as the trolley wheel remains on the wire the cord passes smoothly back and forth from the winding drum, and the spring attached to the pawl prevents it from engaging the racket. When the trolley wheel leaves the wire, the sudden upward pull on the idler end of the pawl throws the free end of the pawl into the ratchet, and this locks the drum. It will be seen that it is not necessary that the drum should move at all to lock the catcher. The same journal gives a short account of the Shanahan trolley catcher and retriever, recently invented by Mr. T. B. Shanahan, of the Shanahan Trolley Speciality Company, which, it is stated, has emerged successfully from numerous tests, and invariably performs its work regardless of speed, rain, snow, or ice. It works entirely automatically, and the instant the trolley leaves the wire, from any cause whatever, it will pull it down from 2ft. to 6ft. as may be desired, and hold it there until released. Replacing the trolley and resetting the retriever are accomplished easily and quickly. The motive power of the retriever is a

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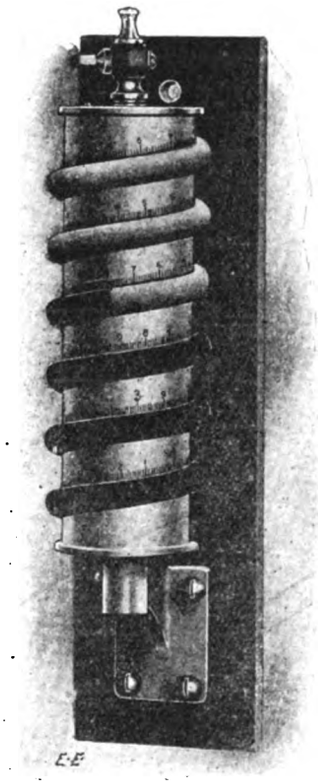
large spring, and this can be adjusted to any tension desired, so as to correspond with the tension of the trolley pole. Two bases are furnished with each retriever, and these are attached to the ends of the car, and by the use of a small locking lever the device can be changed from one end of the car to the other very readily without the use of tools.

Wireless Telegraphy.—The developments of the last few months show that the ethergram has entered upon a new phase. How far the promises that have been held out for its extensive development will be realised it would be premature to say; but the system may fairly claim now to have obtained a distinct footing commercially and in other important spheres, while there are indications that considerable expansion is in prospect. Following on its partial adoption by the Eastern Telegraph Company, news comes from America that the De Forest wireless telegraph is working commercially between the St. Louis Exhibition and Springfield, Illinois, a distance of 105 miles. Other installations are in progress, notably between New York and Philadelphia, which are to be used for ordinary telegrams by day and Press work at night. The De Forest Company has also entered into a contract for the erection of 20 stations in Morocco, where the system will, at any rate, have the advantage of being immune from the wire-mutilating operations of the brigand; and the same company has been engaged to instal a service connecting the various islands of the Azores, which are not suited to cables, owing to the rocky condition of the ocean bed. In France the control of the system has lately been transferred to the Ministry of Commerce. The agreement recently entered into by the Canadian Government with the Marconi Company calls for the installation by July 1 next of seven stations, two of which have already been in communication with Allan Line steamers. In Italy, where the Government have taken up an encouraging attitude, the largest station in the world is to be installed at Pisa, and will be designed to establish communication with Great Britain, Holland, the Northern Continent of America, the Indian Ocean, and the Baltic. The belligerents in the Far East have employed the system with much success, and in last Saturday's *Times* there appeared a complete and highly interesting account, dated June 20, from the special correspondent of that journal, describing the achievements of the De Forest wireless telegraph in the interests of journalism, and the now historic action of the Russian authorities in closuring the enterprise. The *Times* correspondent expresses the opinion that this will prove to be the first and last instance of the system being used by a journal to report naval warfare, and predicts that in future it will be controlled during military and naval operations by international law as constituting a menace in the hands of unscrupulous users. The new Wireless Telegraphy Bill and the report of the Board appointed by the United States Government afford some confirmation of this view, and it is probable that political considerations will cause this field to be materially circumscribed, if not extinguished. Apart from this, the invention has played a unique part in journalism by the establishment of the "ocean daily." Another use is exemplified by the wireless telegrams for meteorological purposes inaugurated by the *Daily Telegraph*, pending Government action, and in this repect the promptitude of the United States in adopting a similar recommendation by the above-mentioned Board to that previously advanced by the English committee, is in marked contrast to the dilatoriness of the authorities in this country. These are some instances of the system *in esse*, and the advent of the thermo-galvanometer and other apparatus may appreciably facilitate progress. It has just been reported from Rome that a young student of the Lycée of Arpino has invented a device for neutralising attempts to intercept messages. A series of tests were conducted at the laboratory of the college, as a result of which an application has been made to the Government for a grant to pursue the experiments on a large scale.

A Draft Gauge.—The necessity of accurate determinations and the desirability of a strong, portable, direct-reading, ornamented, unbreakable draft gauge or monometer which can be mounted on a gauge board and read to $\frac{1}{100}$in., with a capacity of 6in. pressure or vacuum, led Mr. C. E. Sargent, of Chicago, to design the instrument shown in the accompanying diagram, some particulars of which are given in the *Electrical World* of New York. It consists of a nickel-plated brass cylinder, closed at both ends, encircled with a spiral groove in which is wound a transparent flexible celluloid tube, the bottom end of which is cemented in and communicates with the interior of the brass chamber. An extension of its lower head passes through the bracket, which supports the gauge,



yet allows it to be revolved at will, around its vertical axis. The whole device can be attached to a gauge board if desired. A small hose cock to which a rubber tube can be attached admits pressure through the top head of the cylinder. Distilled water, usually coloured, is put in the cylinder through this cock until the zero mark is reached on the scale. Pressure will cause the level of the liquid to ascend in the tube, and for every inch of vertical rise it will travel around the cylinder a distance of about 9in., which is divided into 100 equal parts. The angle of the tube is such that the plane of the meniscus is radial, making close reading possible. The cylinder can be rotated so that the level of the liquid comes on the front side. Rarefaction causes the liquid to descend, and by adjusting the cock any degree of steadiness of the level in the tube may be obtained. The upper end of the tube is closed with a screwed brass plug, and the inlet cock is shut when the gauge is carried about, maintaining the liquid in place without danger of spilling. As the tube is tough and elastic it is not liable to be broken. The whole device is 3in. in diameter by about 12in. long, and weighs about 3lb.

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FLAME TEMPERATURES IN INTERNAL-COMBUSTION MOTORS.*

BY DUGALD CLERK, M.I.C.E.

Had we lived in an atmosphere of much greater density, it is probable that the internal-combustion motor would have developed on very different lines from those actually followed. Assuming an atmosphere of double the present density, say 30lb. pressure absolute per square inch instead of 15, for given flame temperatures the explosion pressures would have been double, and the non-compression engine of Lenoir would have been much more successful; perhaps, also, the schemes of the earlier English inventors, such as Brown (1826), to produce a gas-engine using vacuum and condenser like the steam-engine, would have been crowned with success. Had we lived in a very dense atmosphere, say of the order of 70 existing atmospheres, there can be little doubt the compression combustion motor would not have appeared at all, because it would not have been really needed. The explosion pressures to be dealt with would have been so great that the necessity would have arisen for reducing pressure instead of increasing it. This is very well shown by some most interesting explosion experiments recently made by Mr. J. Petavel, of Victoria University, with gas and air mixtures previously compressed over 70 atmospheres and then ignited. These mixtures produced pressures of the order of four to five tons per square inch.

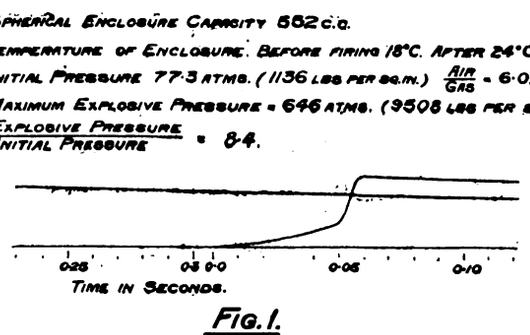

FIG. 1.

RISE OF PRESSURE.

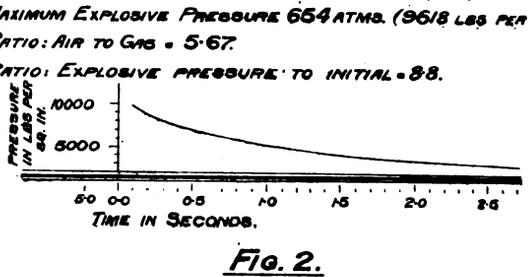

FIG. 2.

FALL OF PRESSURE.

Mr. Petavel's Experiments with High-Pressure Gaseous Explosions Coal Gas and Air.

Figs. 1 and 2 are prepared from photographic diagrams which Mr. Petavel has been good enough to send me. They show Mr. Petavel's rising and falling curves with explosive mixtures with about one volume of gas to six volumes of air. It is quite apparent that a gas-engine constructor existing in a world having an atmosphere 70 times as dense as our own would be dealing with explosion pressures of up to five tons per square inch at ordinary atmospheric pressure instead of the modest 100lb. per square inch, which is the limit of pressure obtained from ordinary gaseous explosions without compression at present. It is interesting to follow to some extent the effect of such changed conditions as these. It has long been assumed by gas-engine designers that the heat loss to the enclosing walls of an explosion chamber does not increase in proportion to the increase of pressure or density of the gaseous mixture before explosion. No accurate measurements, however, appear to have been made under rigidly determined conditions until some experiments, also by Mr. Petavel, upon the loss of heat to atmospheres of different densities from incandescent metallic wires kept at constant temperatures. Mr. Petavel finds (what gas-engine people long believed) that the loss of heat increases relatively slowly with increase of density. Roughly, his figures appear to prove that, with an atmosphere of 100 density, the loss to the walls increases only six times that of the loss at unit density. This, of course, means that, if a gas-engine could be operated in an atmosphere of double density using exactly the same temperatures, the heat loss would not by any means be doubled. With the same temperatures, therefore, gas-engines under such conditions would be more economical at the high-pressure atmosphere than at the low. Something of this kind has been experienced by gas-engine constructors where engines have been operated at high mountain levels; such engines usually experience not only loss of total power, but also some loss of heat efficiency.

In view of certain difficulties which are experienced, especially in large gas-engines of considerable cylinder dimensions, due to impossibility of securing equality of expansion of the metal parts in contact with the hot flame, it is interesting to consider what could be done by reducing cylinder dimensions and increasing mean pressures within a given cylinder. It becomes interesting, in fact, to consider whether there is no way of working at artificially enhanced atmospheric pressures, because it is obvious that such enhanced atmospheric pressures permit of great flame temperature reductions without requiring reduced maximum or mean pressures. With an atmosphere of double the existing density it is obvious that in a given engine mean pressures may be doubled, or, if desirable, mean pressures may be kept of the same value and flame temperatures reduced—that is, engines may be made much more powerful for a given cylinder diameter, and cylinder losses may be greatly reduced, not only by increased density, but by reduced temperatures capable of giving the desired pressures.

In small engines high temperatures may be used with comparative impunity, and, accordingly, we find with both coal-gas and petrol engines flame temperatures in the cylinder as high as 1,800deg. C. to 1,900deg. C. With larger coal-gas engines operating without water-cooled pistons and exhaust valves lower temperatures become imperative, and, accordingly, we find in such engines the maximum temperature reduced to 1,500deg. C., or a little under. Nearly all makers have been forced to recognise the necessity of reducing flame temperature with unwatered pistons and exhaust valves where the cylinders are of dimensions of the order of even 18in. diameter. In coal-gas engines, accordingly, the gas and air passages are so set as to produce a sufficiently dilute mixture to prevent the temperature rising unduly. In engines using producer gases of various kinds, the temperature is naturally somewhat lower than with coal-gas, so that special dilution is not so much required. This is also true of the very large engines using blast-furnace gas. In such engines, where the main constituent of the gas used is carbonic oxide, the flame temperature possible is not high, mainly because of the slow-burning nature of the carbonic oxide and the small heat value per cubic foot of the mixture of blast-furnace gas and air. To study the question I have calculated out from a number of recent diagrams the flame temperatures attained in standard engines of various types under the conditions found by the respective makers to give the best economy.

Fig. 3 shows diagrams taken from engines operating with coal-gas by well-known makers—Messrs. Crossley, the National Gas-Engine Company, and an engine built by Messrs. Fielding and Platt and experimented with by Prof. Burstall. From these diagrams it appears that the maximum temperatures range from 1,500deg. C. to over 1,900deg. C. Fig. 4 shows similar diagrams taken from engines using producer gas obtained from Dowson, Wilson, and Mond producers. Fig. 5 shows a series of diagrams taken from a very interesting tandem double-cylinder double-acting engine erected by Messrs. Richardsons, Westgarth, and Co., Limited, at Middlesbrough at the

* Paper read before Section G of the British Association Cambridge meeting, Aug. 19, 1904.

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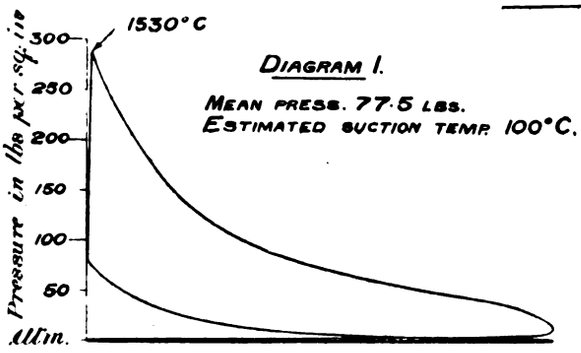
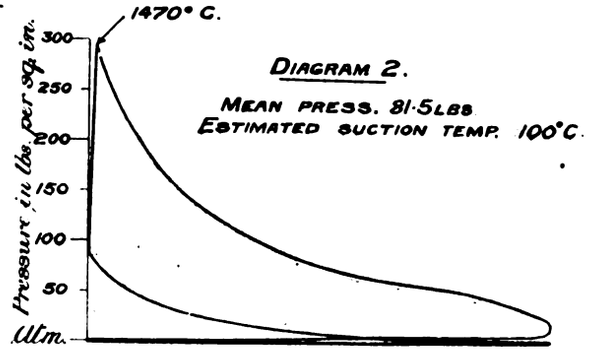
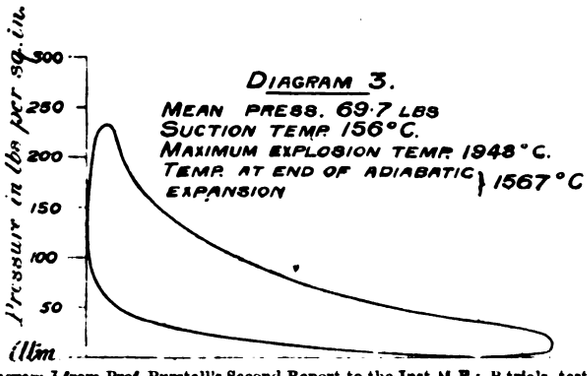
works of Messrs. Cochrane and Co., Middlesbrough. The temperatures on one of these diagrams have been taken out. furnace gas diagram shows as a maximum temperature 1,400deg. C. In all the low temperature diagrams it will be

FIGS. 3.





Diagrams 1 and 2 from Crossley Two-Cylinder Engine; cylinders, 18¼in. dia. by 30in. stroke. Average speed, 172 revs. per min. Indicated h.p., 278. Brake h.p., 253. Indicated thermal efficiency, 30·3 per cent. Test made with Manchester Corporation coal gas, 607·5 B.T.U. per cubic foot, lower heat value. Particulars handed to author by W. J. Crossley, Esq.



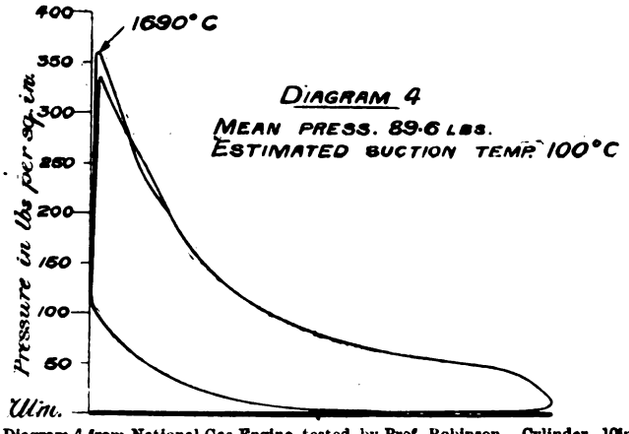
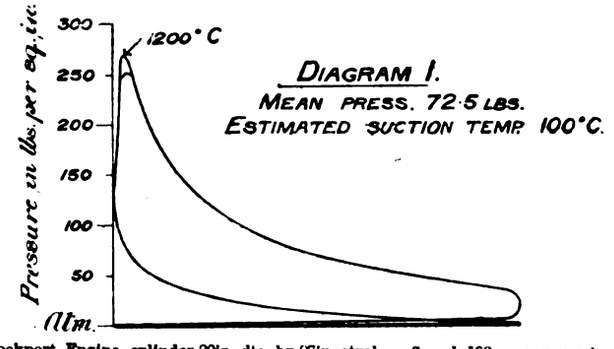
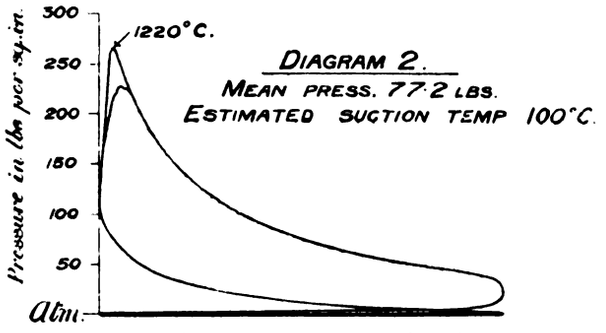


Diagram 3 from Prof. Burstall's Second Report to the Inst. M.E.; B trials, test 1. Engine cylinder, 6in. dia. by 12in. stroke. Speed, about 200 revs. per min. Indicated thermal efficiency, 19 per cent.

Diagram 4 from National Gas-Engine tested by Prof. Robinson. Cylinder, 10in. dia. by 18in. stroke. Average speed, 170·3 revs. per min. Indicated h.p., 26·4 Brake h.p., 23. Indicated thermal efficiency, 28·7 per cent.

FIGS. 4.

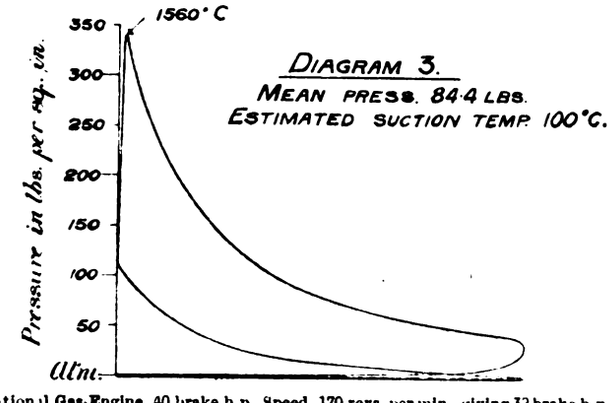


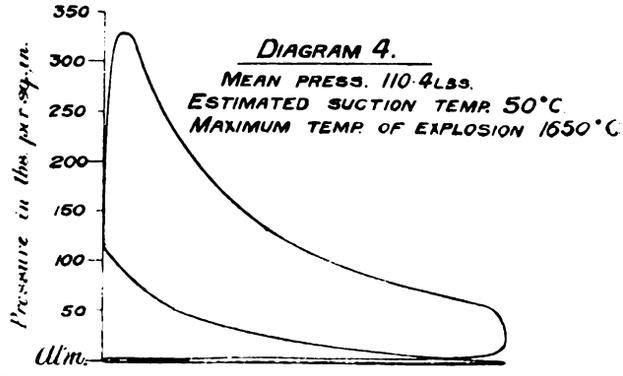


Stockport Engine, cylinder 20in. dia. by 27in. stroke. Speed, 182 revs. per min. Indicated h.p., 141. At Musker and Co.'s, Limited, Liverpool, using Wilson producer gas.

Stockport Engine, cylinder 18in. dia. by 27in. stroke. Average speed, 180. Indicated h.p., 113. At Musker and Co.'s, Limited, Liverpool, using Wilson producer gas.

Diagrams 1 and 2 and particulars of test have been supplied to the author by Messrs. J. E. H. Andrews and Co., Limited.





National Gas-Engine, 40 brake h.p. Speed, 170 revs. per min., giving 32 brake h.p. at time of test; 4 explosions and 1 cut-out. Engine at work at Dowson's Works, Basingstoke, with Dowson suction gas plant using anthracite. Diagram taken by the author.

Premier Gas-Engine at Winnington, two cylinders. Cylinders, 28¾in. dia. by 30in. stroke. Air-scavenging cylinder, 43½in. dia. Average speed, 128 revs. per min. Working with Mond gas. Pistons and exhaust valves watered. Diagram taken from engine by Mr. Humphrey in author's presence.

In the producer-gas diagrams the temperatures, it will be observed, vary from 1,300deg. to 1,650deg. The blast- observed that the mean pressure obtained is somewhat low—70lb. per square inch, or under.

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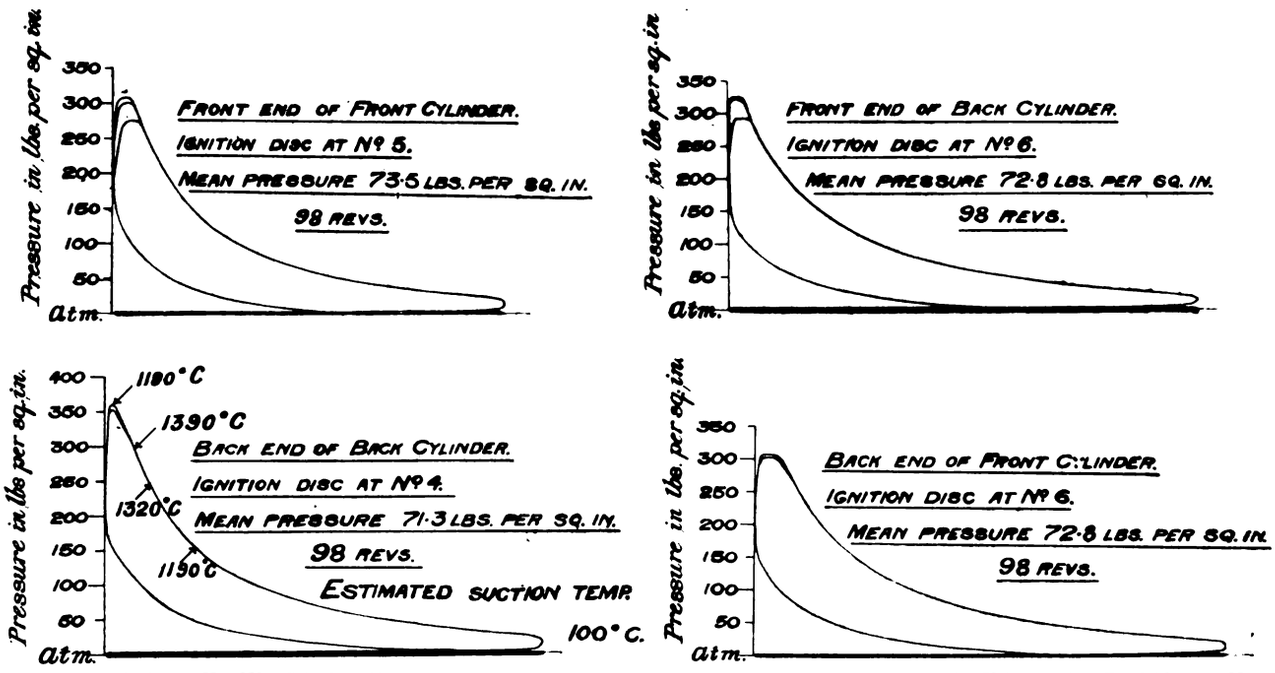
Two years ago it appeared to me possible to reduce the maximum temperatures to 1,200deg. C., or something near that figure, while maintaining a mean pressure only heretofore possible with high temperatures. My idea was to increase the atmospheric pressure artificially, in order to work under conditions which would permit of any desired mean pressure without requiring a corresponding flame temperature. For this purpose I experimented with two engines—one of 7in. diameter cylinder by 15in. stroke, and the other 10in. cylinder by 18in. stroke.

its return stroke. The suction valve of the engine had to be closed a little earlier than usual to prevent the added charge of air from blowing back into the supply pipe. The exhaust valve, too, in this experiment had to be opened a little earlier to prevent the exhaust gases passing up the overrun ports. With this engine I am able to study the effect of adding an air charge to a charge drawn into the cylinder without altering the amount of gas drawn in.

Two diagrams are shown at Fig. 6. One diagram shows the ordinary diagram such as the engine gives without

FIGS. 5.



Gas-Engine, Cochrane No. 250. Cylinders, 29½in. dia by 35½in. stroke. Piston rods, 7¼in. dia. Mean m.p. of 4 cards = 72·6lb. sq. in. Total i.h.p. at 98 revs. = 810. Indicator diagrams taken on July 15, 1904, with temporary load on dynamo. Diagrams handed to author by Mr. Westgarth.

The 10in. by 18in. engine arranged for these experiments is one of the ordinary four-cycle type operated with coal-gas. At the outer end of the stroke the piston over-runs a number of ports placed all round the cylinder, leading into an annular space which is carefully water-jacketed. Two sets of experiments were made with this engine. In one set an additional charge of air was used to increase the pressure within the cylinder after the ordinary charging stroke was complete. The air was compressed by means of a pump driven by belt from the flywheel of the engine. This air

added air. It is not quite as good, however, as the usual diagram obtained from this type and size of engine, as the alterations have slightly impaired the efficiency. The thermal efficiency, however, calculated from the indicator is 27·7 per cent. The usual results obtained from this engine show a thermal efficiency of 28 7 per cent. The other diagram with added air shows clearly the increase of efficiency due to dropping the temperature. The addition of air here increases the thermal efficiency of 27·7 to 34 4, while the temperature falls from about 1,700deg. to

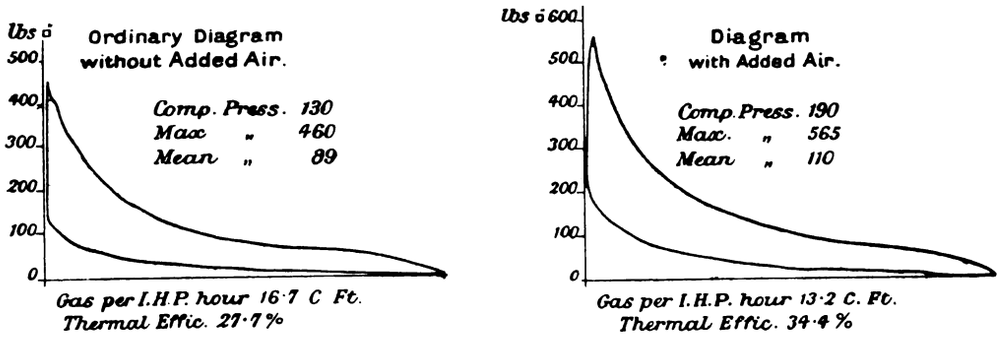


FIG. 6.—Average Diagrams from 10in. by 18in. National Engine.

was passed into a reservoir, and the reservoir was connected to the annulus in front of the engine cylinder by a pipe. A piston valve was provided operated from the engine-valve shaft, which valve opened at a proper time to fill up the annulus. This annulus was thus filled with air when desired at a determined pressure. The valve actions were so arranged that when the piston over-ran the ports, just completing its charging or suction stroke, air was discharged into the cylinder by way of the ring of ports so as to fill up the cylinder to nearly the pressure in the reservoir, during the time the piston was crossing the ports in completing its out stroke and closing the ports in beginning

1,200deg. The real improvement effected by the addition of air is better taken as compared with 28·7, the ordinary efficiency, rather than 27 7. A substantial improvement, however, is here shown—about 20 per cent. on the diagram. In this particular experiment, the brake power with added air is, of course, considerably increased; but as the compressing pump was attached in an entirely experimental way, the results of the brake tests made during the experiments are not of much interest.

Another set of experiments were made on this engine, in which the additional atmosphere was supplied without a separate pump by means of the exhaust gases passing from

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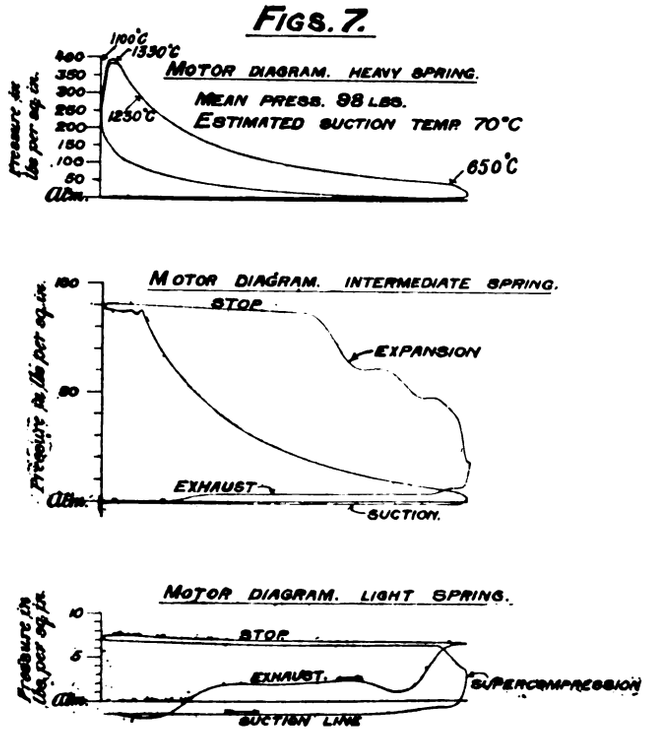
the engine itself. In this experiment the same engine was used with the annulus and ring of ports at the front end of the cylinder, but here the piston valve was so operated in conjunction with the exhaust valve that the exhaust gases under pressure from the cylinder were allowed to pass through the front ports by way of a cooled pipe to a reservoir, and the opening of the ordinary exhaust valve was adjusted to discharge into the reservoir exactly the amount of exhaust required to give the desired exhaust pressure. At the end of the suction stroke, before the out end ports are over-run, the piston valve opens to the cold end of the reservoir, and shuts off communication to the hot pipe. Cooled exhaust products thus fill the ring, and, discharging into the cylinder, bring the pressure up to the artificial atmosphere desired.

Fig. 7 shows three diagrams with particulars marked under them taken from this engine under these circumstances. The upper diagram is the power diagram; the lower two diagrams show on a scale of one-fortieth and one of one-tenth the effect of adding the exhaust charge under pressure. In this case, comparing the best results obtained with the engine by Prof. Robinson in his test found at p. 254 of his book, we find an increase of 5 b.h.p., an improvement in indicated efficiency, increasing the indicated thermal efficiency from 28·7 to 32·5 per cent., and an

FIGS. 7.



National Gas-Engine altered for Exhaust Super-compression Experiments. Cylinder, 10in. dia. by 18in. stroke. Speed, 180 revs. per min. Brake h.p., 28. Indicated thermal efficiency, 32·5 per cent. Brake thermal efficiency, 27·5 per cent. Test made by author with Ashton gas; 566 B.T.U. at 32deg. F. gas temperature, lower value. A later test with slightly diminished combustion space gives 27·2 brake h.p. Indicated thermal efficiency, 34 per cent. Brake thermal efficiency, 29 per cent.

improvement in the brake efficiency from 25 to 27·5 per cent. This improvement is obtained entirely by adding exhaust products under pressure to increase the weight of charge present, to increase the pressure before compression, and to diminish the flame temperature. This method of exhaust super-compression has the great advantage over air super-compression that no additional pumping is required. There are certain advantages, however, to be obtained from the use of air super-compression, notwithstanding the addition of a pump, and these advantages have induced the National Gas-Engine Company to build an engine (shown at Fig. 8) to carry out the fundamental idea of reducing flame temperatures while increasing mean pressures. This engine is intended to indicate 300 h.p. when working with producer gas of about 150 British thermal units per cubic foot. The idea is to keep up mean pressures while keeping down flame temperatures in order to avoid the well-known liability of heavily loaded gas-engines to overheating and pre-ignition. The engine is now at work with a weaker gas, and diagrams are shown at Fig. 9. In this engine the back end of the cylinder is arranged as a four-cycle motor of normal type; the front end is arranged as an air-pump, and is closed with cylinder cover, through which a piston rod passes from a cross-head guide of usual construction. One air-valve is operated at the pump end from the cam shaft. On one back stroke a charge of air is taken into the cylinder, the valve is closed, and on the out stroke this air charge is compressed into a reservoir forming the clearance space between the piston and the cylinder head. Ports over-run by the piston communicate with this clearance space, which is well water-jacketed, and the pressure causes the air to flow into the cylinder when the charging stroke is nearly complete. In this way the pressure of the charge is raised to about 7lb. per square inch.

The pressure in the front reservoir is raised to about 16lb. per square inch, as is shown upon the diagram, but the fall is only sufficient to raise the pressure within the cylinder to about 7lb. above atmosphere. The reservoir still contains some air at a little above 7lb. pressure, and this air is used on the next exhausting stroke to act as a scavenging air charge to displace the exhaust products from the cylinder and secure that no exhaust remains to form part of the further charge. The engine is thus not only a super-compression engine, but it is a scavenging engine. The pump side is arranged to draw air in on one stroke only—that is, the valve only opens once in two revolutions. One air charge is sufficient both for the purpose of super-compression and scavenging. Calculation from the diagrams proves clearly that a high mean pressure of over 100lb. per square inch is obtained with the very low maximum temperature of 1,200deg. C. The effect of this reduction of temperature in the smooth working of the engine is most remarkable. The tendency to pre-ignition or overheating is found to be entirely absent. Notwithstanding the fact that no watered piston is employed, the engine runs with perfect certainty at full load, with consecutive ignitions, at 160 revolutions per minute. So far as my experience goes, no engine of these dimensions without a watered piston could run at an average pressure of over 100lb. per square inch without difficulty due to pre-ignitions. So far, my attempt to use higher atmospheric pressures has succeeded. It has allowed increased load for a given cylinder and permitted consecutive ignitions at full load and speed without requiring any water cooling of the piston. It appears probable that temperatures may be still further reduced with advantage, especially in operating large gas-engines.

I need not inform the body of engineers before me that the difficulties with which the large gas-engine is at present struggling, are in main due to the high temperatures of the flame in the interior of the cylinder. So long as high-temperature flames are used within cylinders of relatively small dimensions, the difficulties due to unequal expansion of parts does not appear. The steam engineer is well aware of the care which has to be exercised in using large steam-cylinders in such a way as to avoid cracking, and he can quite well imagine that the difficulties of allowing for free expansion in a gas-engine cylinder are much more serious than his own when he considers the relatively low temperature of his steam. Even with superheated steam, 300deg. C. is a fairly high temperature, while in existing gas engines of either large or small types it may be taken that the lower limit of maximum temperature at present is nearly 1,400deg. C. The water-jacketing of a moving piston is an admirable expedient most carefully and ably carried out by many Continental and English engineers; but it is an expedient which has never satisfied me, and is, I believe, regarded with distrust by a considerable number of English engineers. In my view many of the troubles which have been experienced with large gas-engines—cracking pistons, back covers, and the like—are due to the difficulties introduced of getting rid of very large heat flow through cylinder and piston walls, and it appears to me desirable, if possible, to reduce this flow to the lowest point consistent with maintaining the economy of the engines. In doing this, of course, it will not do to reduce the mean pressures of the engines. Large gas-engines are at present undesirably heavy for the power as compared with steam-engines, and it will not do to increase the weight in any way by reducing the temperatures. This

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plan of artificially raising atmospheric pressure, either by the addition of air under pressure or by the addition of cooled exhaust gases under pressure, appears to me to furnish a very promising solution of the problem. In gas-engines operated with producer gas or blast-furnace gas the question of maximum possible economy is not at present a pressing one. The thermo-dynamic efficiency of all gas-engines is now so much greater than any heat efficiency attained in steam-engines that we can well afford to reduce economy, if need be, in order to make more certain of good practical results—that is, to make more certain of low cost for upkeep and repairs. In my view it would pay in large gas-engines even to reduce fuel economy if by so doing entire immunity from breakdown was secured. So far the best means of limiting temperature in a simple way appears to be found in the addition of cooled exhaust gases to the charge before compression; and this method, although reducing flame temperature, has actually increased the efficiency instead of diminishing it. This is quite evident from the figures shown with reference to air and exhaust super-compression diagrams found at Figs. 6 and 7. The results obtained with the 10in. by 18in. engine are, so far as I am aware, the best heat efficiencies ever obtained from a gas-engine of the dimensions. It will be noted that the exhaust super-compression indicated efficiency is 32½ per cent., while the air super-compression indicated efficiency is 34·4 per cent. The exhaust super-compression thus appears to give slightly lower results than the air super-compression in the same engine. Theoretically, under equal conditions, the efficiencies should be the same for either air or exhaust gas additions. No doubt the cause of difference is due to a somewhat smaller clearance space which was used in the engine while the air experiments were in progress. It would have been interesting to compare the heat efficiency of the large air super-compression engine with the smaller one, but unfortunately I have not been able yet to instal apparatus for making accurate measurements of the producer gas supplied to this large engine. The results obtained I will have pleasure in publishing later.

In bringing forward this question of flame temperature in gas-engines, both large and small, I must not be understood to depreciate in any way the efforts of those able Continental and English engineers who have made so brilliant an advance in the application of the large gas-engines to producers and blast-furnace gas within the last few years. The present position of the large gas-engine in Britain is due to the work of Thwaites, Hamilton, Crossley, Atkinson, and Humphreys in England, and that of Delamere Debautteville, Krafts, Koerting, Oechelhauser, and the Deutz Company on the Continent, while Westinghouse has contributed his share of work in America. The progress made in solving the large gas-engine problem is a notable one, and most creditable to all these able engineers and firms. Nothing is to be gained, however, by over-estimating our present position either with regard to large or small gas-engines. With small and moderate engines, no doubt, it may be considered with truth that all the problems have been solved, and that in these engines, not only on the point of heat efficiency, but also in all points of reliability and low cost of repairs, the gas-engine more than holds its own with the steam-engine. This cannot yet be said, however, of the really large gas-engine. At present these engines are in a state of somewhat rapid change, and the types upon the market are so numerous and varied that they are engaged in a struggle of which the fittest will survive. This question of flame temperature, however, affects them all, and much will be gained if engineers will frankly recognise flame temperature as a matter to be dealt with in itself instead of merely providing palliatives to neutralise the effects of high flame temperatures when generated. The advance in the knowledge of the theory of internal-combustion motors has made it quite clear that so long as flame temperatures are higher than temperature of adiabatic compression, so long will the full thermo-dynamic efficiency be attained for a given compression. This fact, however, barely requires restatement; it is so largely recognised by all gas engineers.

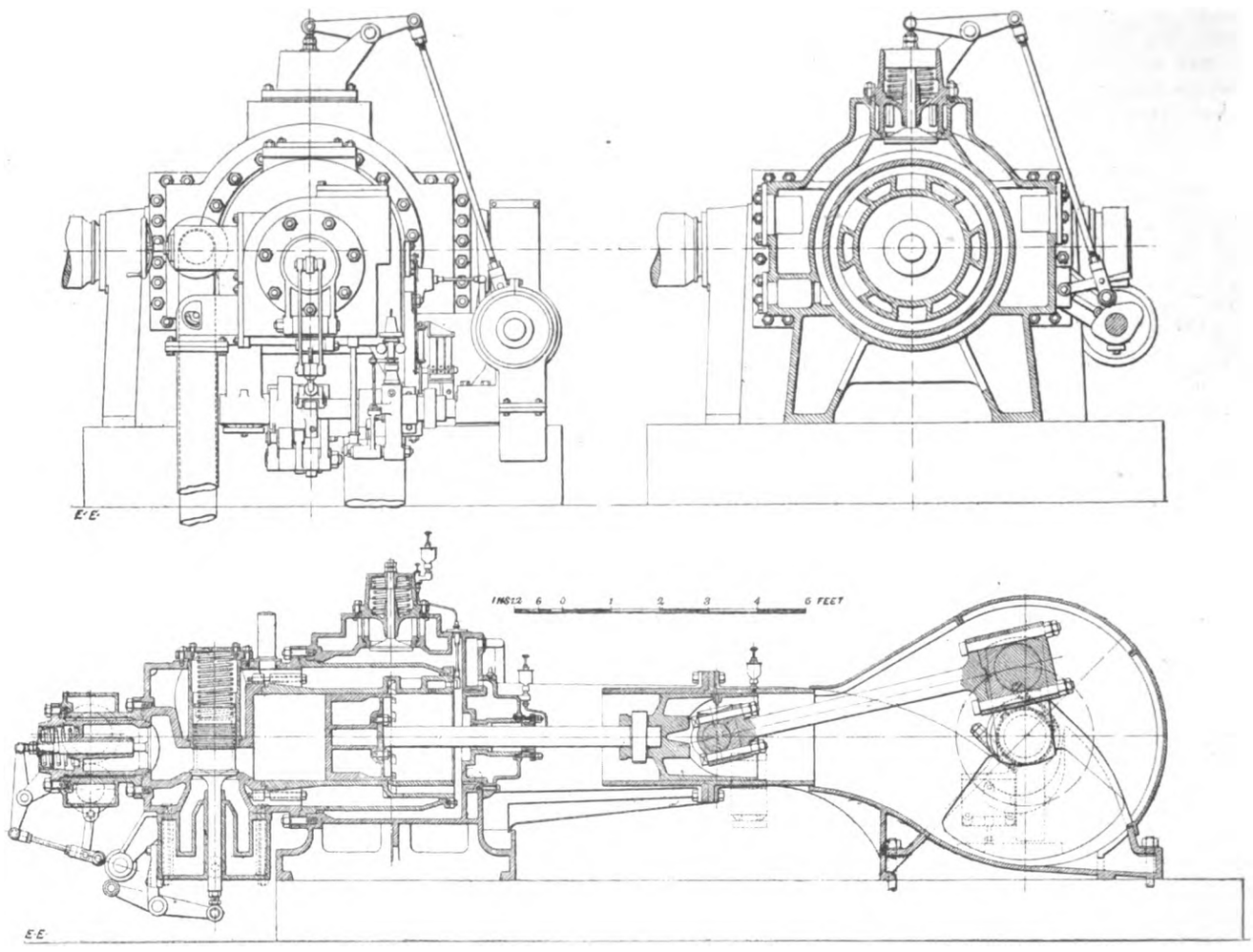

FIG. 8.

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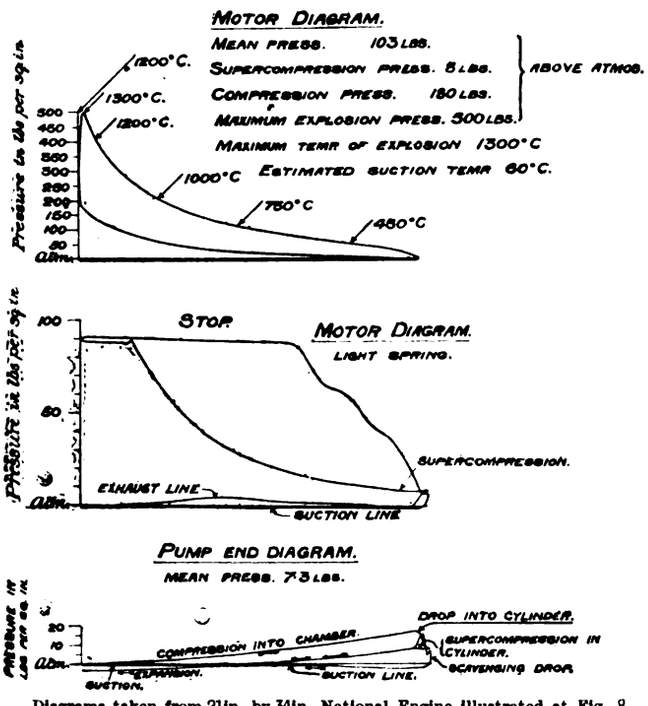
In Britain at present we are fortunate in having before us examples of all the leading internal-combustion motors of the world, large or small. British makers are now occupied in building, among large gas-engines, those of the Cockerill, Ochoelhauser, Koerting, and Westinghouse types, while other English firms, such as Crossley Bros., the National Company, and the Premier Company, are producing large gas-engines of British invention on British lines. Indeed, some of the Continental engines may also be said to be operated on British lines, because both the Koerting and the Oechelhauser engines are really modifications of the Clerk cycle invented and operated in this country over 20 years ago. From this it will be seen that British makers are no longer neglecting—if they can be said to have ever neglected—the large gas-engine problem. So far as small and moderate gas-engines are concerned, British engineers have a very long lead. From information supplied me by many English firms, I estimate that there have been manufactured and sold from Britain alone some 100,000 stationary gas-engines, the average power being something like 20 h.p. The present output of gas-engines in Britain is very large. It at present amounts to at least 200 engines per week. This includes

FIGS. 9.



Diagrams taken from 21in. by 34in. National Engine illustrated at Fig. 8. Revs. at test, 160 per min.

stationary gas and oil motors, but takes no account of petrol motors for cars. So far as these engines are concerned, the British position could not be improved upon. In the large gas-engines, too, the problem is being seriously attacked. I had the pleasure of visiting the works of Messrs. Richardsons, Westgarth, and Co., Limited, a couple of weeks ago, and inspecting at Middlesbrough and Leeds a number of large engines built by them. They show a very interesting installation of seven Cockerill engines coupled to blowing cylinders in one engine-house. These engines are rated at 600 h.p. each, so that this one engine-house contains 4,200 h.p. of gas power for using blast-furnace gas. The engine installation is practically complete, and will be in operation when the scrubbing plant for the gas is finished fitting up. Messrs. Richardsons, Westgarth, and Co. also showed me a tandem-cylinder double-acting gas-engine of very interesting construction, from which the diagrams shown at Fig. 5 have been taken. This engine was shown to me in operation at the works of Messrs. Cochrane, of Middlesbrough, driving a dynamo. It worked with all the steadiness of a steam-engine, and the governing was effected by varying the gas admission, keeping compression constant, so that two impulses were given to the crank at every revolution under all circumstances, light and loaded. This is a most interesting engine, which promises very well. I also inspected two single-cylinder single-acting Cockerill engines of 250 h.p. at the pits of the Yorkshire Coal and Iron Company, near Leeds, where they were driven by coke oven gas, also an interesting installation.

This question of flame temperature appears to me, perhaps, the most important and fundamental at present before engineers engaged in the design of these internal-combustion motors. It is fitting that this branch of the subject should be considered before the British Association, and assistance is particularly desirable from physicists who have interested themselves in temperature measurements, especially high-temperature measurements. The determination of these flame temperatures is one of great difficulty, and the data available are very incomplete. Certain assumptions have to be made, for example, as to the temperature of the total charge at the moment of filling the cylinder before compression begins. The only serious attempt to determine this charge temperature has been made by Prof. Burstall in the very able experiments conducted by him for the Gas-Engine Research Committee of the Institution of Mechanical Engineers. In arriving at the flame temperature numbers given in this paper, I have made free use of Prof. Burstall's results to enable me to assume some reasonable temperature for the "suction temperature," as Prof. Burstall calls it. The whole of this subject requires investigation, and new methods require to be discovered to enable the determination of the suction temperatures to be easily made for every experiment. I am glad to say that a committee of the Institution of Civil Engineers has been formed to attack the whole question of the thermo-dynamic standard for these engines; and, among other points, I hope that this point of flame temperature and its determination will be duly considered. There can be no doubt that in these times, when internal-combustion motors are being applied to every purpose of motive power both on land and sea, the scientific problems, which, after all, are fundamental and necessary to rapid progress, require much more serious consideration than has been yet given them.

In addition to the figures referred to, the paper is illustrated by a large number of photographs and sections of large and small gas and oil engines.

THE SPECIFIC HEAT OF GASES AT HIGH TEMPERATURE.*

BY PROF. H. B. DIXON.

Prof. Dixon gives in his paper a description of some original work carried out at Manchester on the above subject. The paper was not in manuscript, and the following is a brief abstract of the author's description of this work. Dealing with the combustion of gases, Prof. Dixon showed that carbon monoxide would not burn at a very high temperature. This fact tended to keep down the temperature after explosion. He had experimented on the specific heat of gases on the bomb method. The bomb was first heated when empty and dropped into a calorimeter. It was then filled with CO and again dropped in. By means of differences the specific heat of the gas could be calculated. It was difficult, however, to use this method for temperatures over 400deg. C., owing to the steam given off when the bomb was dropped in. Instead, he had developed a method of determining this specific heat from the velocity of sound through the heated gas. He used a tube for this purpose which could be uniformly heated, and obtained the following results:

Temperature.	Ratio of specific heats. Air.	CO.
15deg. C.	1·398	1·314
100deg. C.	1·395	1·29
200deg C.	1·390	1·25
300deg. C.	—	1·19

It will be seen from this that the specific heat of carbon monoxide decreases considerably with the temperature. Prof. Dixon is carrying his experiments up to higher temperatures. He also dealt in his remarks with the explosive pressure in a confined space. Bunsen has shown

* Abstract of paper read before the British Association at Cambridge.

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that this pressure was only one-third of what would be expected. The reason for this had been attributed to a rapid rise of specific heat, and also to incomplete combustion. Photographs taken in a glass cylinder by Prof. Dixon showed that the combustion was by no means instantaneous. The flame actually travelled the full length of the cylinder and half way back before the pressure began to rise.

Discussion.

The discussion on Mr. Dugald Clerk's paper and on the one by Prof. Dixon was commenced by Prof. B. Hopkinson, who said that there must be a considerable amount of stratification in the gases in Mr. Clerk's engine. The normal proportion of air to gas is 9 to 1. Mr. Clerk added extra air, making the mixture 14 to 1, which was very near the non-explosive point. The rapid explosion shown by the diagram, therefore, indicated stratificaticn. Prof. Hopkinson attributed the loss of heat referred to by Prof. Dixon to a turbulent motion in the gases caused by the explosion. He thought that the energy was converted into kinetic energy in the moving gas, which was then again converted into heat at the cylinder walls.

Sir Andrew Noble referred to the behaviour of explosive mixtures under pressures of from 500 to 5,000 atmospheres. This resulted in very high temperatures, with the result that carbon monoxide would not burn to carbon dioxide. He concluded from the results of experiments that this specific heat of gases was very much less at high temperatures.

Prof. Schuster, of Munich, congratulated Mr. Clerk on the success of his experiments. He knew of an instance in Germany where the temperature in an oil-engine cylinder had been successfully reduced by the injection of small quantities of water. It was a happy idea of Mr. Dugald Clerk's to use the products of combustion as the inert material to reduce the temperature. He had experimented some two years ago on Prof. Hopkinson's calorimetry method of testing gas-engines, and had secured accurate results within 2 or 3 per cent.

THE CALORIMETRY OF EXHAUST GASES.*

BY B. HOPKINSON.

So far as I am aware, in all gas-engine tests hitherto made, the indicated work, the heat in the cooling water, and the calorific value of the gas used are the only quantities which have been directly measured. The balance of heat unaccounted for has been put down to exhaust gases, radiation, and conduction. In some cases an attempt has been made to separate the last-mentioned items by estimation, but these attempts have been very rough in character, and have led to very divergent results. The special point of the tests to be described is that the exhaust gases were passed through a calorimeter, and so cooled to near atmospheric temperature, the heat rejected by them being measured. In this way a complete heat account has been obtained, in which the only item not directly determined is the loss by conduction and radiation.

The first set of tests were made on a Crossley engine in the engineering laboratory, Cambridge, of somewhat old pattern, giving about 5 h.p. on the brake. The following are the particulars of the engine: speed, 250 revolutions per minute; cylinder diameter, 7½in.; stroke, 9in.; compression space, 143 cubic inches; ignition, hot-tube with timing valve. Cylinder only is water-jacketed, piston and exhaust valve being uncooled. Cambridge coal gas was used, having an average calorific value of 680 British thermal units at 0deg. C. and 760mm., of which about 70 British thermal units are the heat evolved in condensing and cooling the steam produced in the explosion.

The calorimeter for the exhaust gases is shown in Fig. 1, from which its construction will sufficiently appear. It consists of a section of flanged cast-iron pipe fitted with baffle plates, by which the gases are caused to pass several times backwards and forwards through its length, and finally to bubble through the water collected at the bottom. The water, after passing through the jacket surrounding the calorimeter, meets the exhaust gases in a fine jet, and is partly caught by them and carried round with them, and partly trickles down the baffle plates. It was found that in this way the gases could be cooled, with the engine fully loaded, down to 120deg. F. or less, the cooling water rising in temperature from about 60deg to 90deg. This instrument was designed of ample proportions, so that it should be certain to work satisfactorily; there can be no doubt that it is big enough to serve for a much larger engine. In a test on an engine of double the power—to be described later—the calorimeter was very much smaller and the results quite satisfactory.

There is no need to particularise the methods of indicating the engine or of measuring the amount and temperature rise of the jacket water, about which there was nothing peculiar. Some pains, however, were taken to secure accurate measurement of heat put into the engine. The gas was measured with a wet and dry meter in series, and both meters were calibrated with a standard holder at the rate of flow of gas actually used. The calorific value of the gas was determined with a Junker calorimeter at the time of the test on the engine. The amounts of heat stated as having been supplied to the engine are probably correct to within 2 per cent. The results obtained are given in Table I. The fifth column is an estimate of the energy still left in the exhaust gases after passing the calorimeter in those cases in which it is not negligible. It is based on the assumption that the volume of gas discharged per cycle is that of the engine stroke, corrected for the suction pressure (observed) and the suction temperature (assumed), and that these gases are saturated with water vapour. Their temperature is observed, and thence can be calculated the heat which they would evolve (by cooling and condensation of steam) on cooling to 80deg. F., which is about the temperature at which the gases leave the Junker calorimeter.

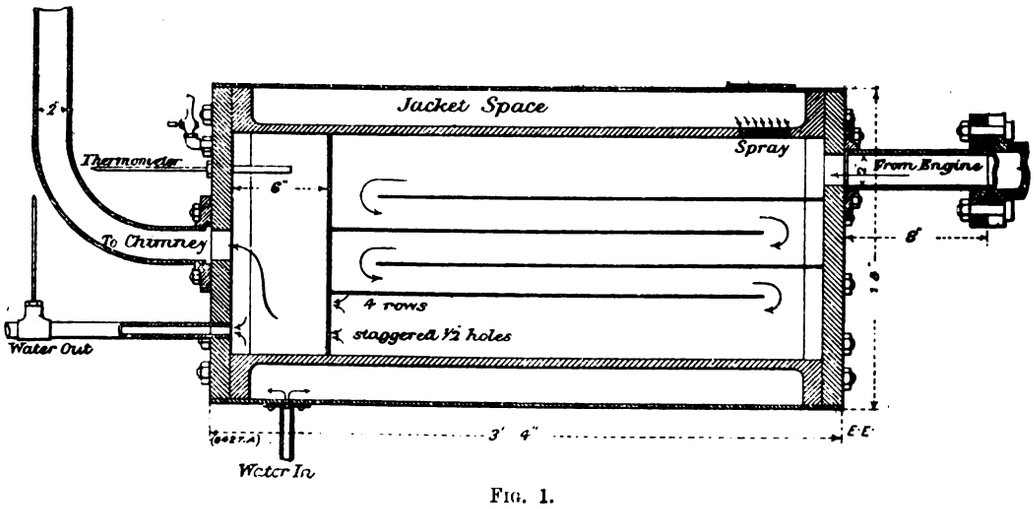

Fig. 1.

* "The Calorimetry of the Gases exhausted from an Internal-Combustion Engine." Abstract of paper read before Section G of the British Association at Cambridge, August, 1904.

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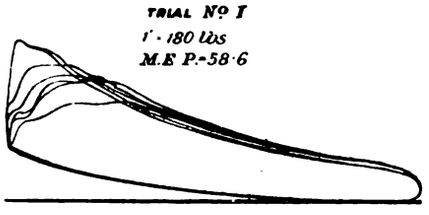
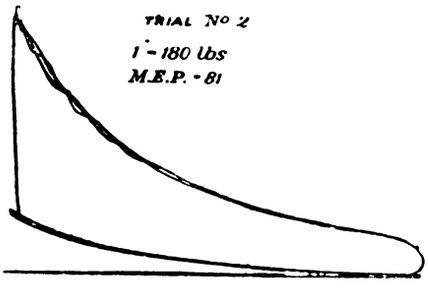
TABLE I.

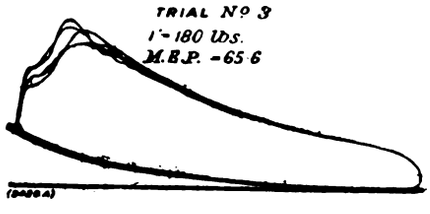
No. of trial.	Heat value of gas, B.Th.U. per explosion.	Indicated work, B.Th.U. per explosion.	Heat to jacket water.	Heat to exhaust calorimeter.	Heat up chimney.	Balance unaccounted for.	Explosions per minute.	Release pressure, pounds per square inch in absolute.	Energy of gases at release, B.Th.U. per explosion.	Release temperature, Cent.	Liner temperature, Fahr.	Temperature of jacket water (exit), Fahr.	Temperature of exhaust gases after passing calorimeter, Fahr.	—
		p.c.				p.c.								
1	13·3	2·5 = 19	5·5	4·0	—	1·3 = 10	32	49	6·4	780	102	72	80	
2	18·5	3·4 = 18½	8·3	5·2	—	1·6 = 8½	23	53	7·5	870	106	72	80	
3	16·0	2·9 = 18	6·4	5·2	0·4	1·1 = 7	32	56	7·7	930	86	70	100	Late ignition.
4	13·0	2·7 = 21	5·1	4·1	0·1	1·0 = 8	110	46	6·0	900	122	80	105	
5	12·6	2·5 = 20	4·2	4·6	0·1	1·2 = 9½	117	43½	5·5	800	156	200	105	
6	15·1	2·9 = 19	5·9	4·2	0·2	1·9 = 12½	116	45	6·0	880	126	92	118	
7	15·0	2·8 = 18½	6·4	4·0	0·1	1·7 = 11½	120	45	6·0	880	126	81	112	
8	16·1	2·7 = 17	6·4	4·3	0·1	2·6 = 16	91	53	7·2	1,250	103	75	107	Late ignition.
9	15·2	2·65 = 17½	5·7	4·2	0·4	2·2 = 14½	111	52	7·0	1,200	100	82	144	Late ignition.

All the figures are stated in British thermal units per explosion and the first four columns need no further explanation.

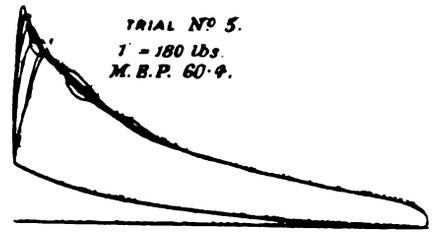
This estimate is a very rough one, as the volume may be in error by 10 per cent. in certain cases, and the gases may not be fully saturated; but the item is a very small one. The sixth column shows the balance unaccounted for, and consists of the radiation and conduction losses, and the sum of the errors in the first five columns. In the first three trials, as appears from the seventh column, there was no load on the engine, and practically all the explosions were preceded by one or more scavenging strokes. In the other trials the engine was nearly fully loaded, so that very few of the explosions were preceded by a scavenging stroke. The release pressure

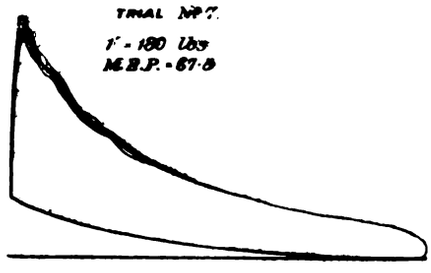


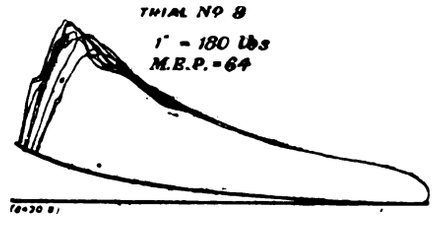




in the eighth column is the pressure at a point one-tenth of the stroke short of the out-centre at or about which point the exhaust valve begins to open. The energy of the gases at release is calculated from the release pressure on the assumption that we have then perfect gas mixed with the steam produced by the explosion, the amount of which is known from the gas analysis. The heat of condensation and cooling of this steam is added to the heat in the gas considered as perfect gas. The actual energy is probably more than this, since the steam and CO_2 are almost certainly somewhat dissociated at the temperature of release. In the tenth column are the temperatures of release. These are calculated from the suction temperature (assumed) and release pressures. In the case of the light-load trials the suction temperature cannot be far different from the temperature of the gas before admission, and I have taken a round figure of 27deg. C. or 300deg. absolute. In the full-load trials the suction temperatures are very uncertain. I have drawn on Prof. Burstall's measurements for these, and have assumed a round figure of 77deg. C. (350deg. absolute) for Nos. 4, 5, 6, and 7, and 127deg. C. (400deg. absolute) for the others in which the release temperatures are higher. It will be seen that the temperature measurements are extremely rough, but I have only based conclusions on their relative order of magnitude in the several trials, and that is, no doubt, correctly shown. The "liner temperature" is that of the







outer end of the cylinder liner where it projects in front of the cylinder. Since this portion is not water-jacketed, is not exposed to the flame, and is in all trials except No. 5 hotter than the jacket water, it must receive its heat entirely from the piston, which comes into contact with it on the out centre. Its temperature is, in the case of the full-load trials, a rough indication of the heat being given to the piston. In trials Nos. 3, 8, and 9 the ignition was retarded, so that it commenced about one-thirtieth of the backward stroke after the in-centre. In the other trials the ignition was normal, and commenced slightly before the in-centre. The following points are worthy of note:

1. The gases lose much heat between release and entering the calorimeter. Table II. shows the difference between the estimated energy at release and the energy given to the calorimeter, and sent up the exhaust pipe. The actual difference is greater, since, as already

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explained, the energy at release is certainly underestimated.

TABLE II.

Number of trial	1	2	3	4	5	6	7	8	9
Release temperature	780	870	930	900	800	880	880	1250	1200
Temperature of passages	cold	cold	cold	hot	hot	hot	hot	hot	hot
Loss in passages	2·4	2·3	2·1	1·8	0·8	1·6	1·9	2·8	2·4

The gases lose heat after release, partly in the exhaust valve and passages, and partly to the cylinder walls in the exhaust stroke of the piston. The latter part of the loss goes to swell the jacket losses; the former is largely radiated away from the hot exhaust valve. We should expect the amount of loss to depend mainly on the difference of temperature between the gases and the passages or cylinder walls. Thus, high-release temperatures should mean much loss of heat, and in the light-load trials, where the passages are fairly cool, the loss should be greater than in the full-load trials, where they are kept hot. The conclusions are confirmed by the last table. The smallest losses are in trials 4, 5, 6, and 7, where the release temperature is low, and the passages hot. Then come Nos. 1, 2, and 3, where, though the release temperature averages about the same as in 4, 5, 6, and 7, the passages are cold and the losses undoubtedly higher. Finally, we get the largest losses of all in Nos. 8 and 9.

2. The balance unaccounted for (column 6 of first table) seems to consist mainly of radiation from the exhaust valve. The biggest balances are those in trials Nos. 8 and 9, where, by reason of the late ignition, the release temperature is high. The exhaust valve in these trials was observed to be very hot. It will be noticed that in these cases the temperature of the liner, and therefore of the piston, was lower than in the other full-load trials, and the temperature of the jacket water was by no means excessive. In No. 5, although the jacket water was nearly boiling, the balance is low, because here the exhaust valve was fairly cool.

3. There is no marked improvement in efficiency caused by scavenging.

4. The piston is cooler with the late ignition. Compare the liner temperature of Nos. 8 and 9 with the other full-load trials of Nos. 4, 6, and 7.

One object of these trials was to ascertain whether a practical method of testing gas-engines for efficiency could be based on the calorimetry of the exhaust gases. At the present time manufacturers are mainly concerned with making their engines reliable; the thermal efficiency, being with any design far and away better than in the steam-engine, is a secondary consideration. But it cannot be doubted that in the future gas-engines will have to be as closely tested for efficiency as steam-engines now are. Now to measure the heat put into a large engine worked with producer gas is a very difficult and costly undertaking. The volume of gas is very great, and its quality may vary largely in the course of a day's trial. It seems to me that it may be easier and more accurate to measure the indicated work and the heat rejected, as is usually done in testing a steam-engine. One large part of the rejected heat—that is, the heat in the jacket water—presents no difficulty; we have therefore only to measure the heat carried away in the exhaust gases. The only question is whether the balance of heat unaccounted for, which cannot be measured, is too large a percentage of the total heat. From this point of view the tests made on the small Crossley engine are not very satisfactory, the heat unaccounted for in the full-load tests ranging from 8 to 16 per cent. of the total. Moreover, in those tests the calorimeter was very much more bulky than was necessary for the purpose. It appeared to me from consideration of the results that the lost balance of heat must have gone mainly in radiation from the exhaust valve and other uncooled parts of the engine. I therefore made a similar trial on a second and larger engine in the laboratory, in which, as it had a water-cooled exhaust valve, it appeared probable that the radiation loss would be substantially less. This engine is by the Forward Engineering Company, and gives about 10 h.p. on the brake. The following are the principal particulars of it: speed, 250 revolutions per minute; cylinder diameter, 7in.; stroke, 15in.; compression space, 140 cubic inches; ignition, hot-tube with timing valve. Cylinder and exhaust valve are water-jacketed, piston being uncooled. This engine compresses to 115lb. absolutely against 70lb. in the Crossley. In the case of this trial the exhaust-gas calorimeter was made very much smaller. Fig. 2 sufficiently shows its construction. The water is sprayed through two flat-flame gas burners into the exhaust pipe, so that the exhaust gases immediately on leaving the engine encounter a sheet of cold water, and they are further cooled by churning up the water at the bottom of the calorimeter. The gases, after leaving the calorimeter, were taken into the ordinary exhaust box of the engine, which was provided with a drain and acted as a water separator. It was found, however, that very little water was carried over from the calorimeter by the gases. With this apparatus the gases were cooled down to a temperature of 120deg. F. or less, the engine being fully loaded, and the apparatus itself occupied but very little more space than the bit of exhaust pipe which it replaced.

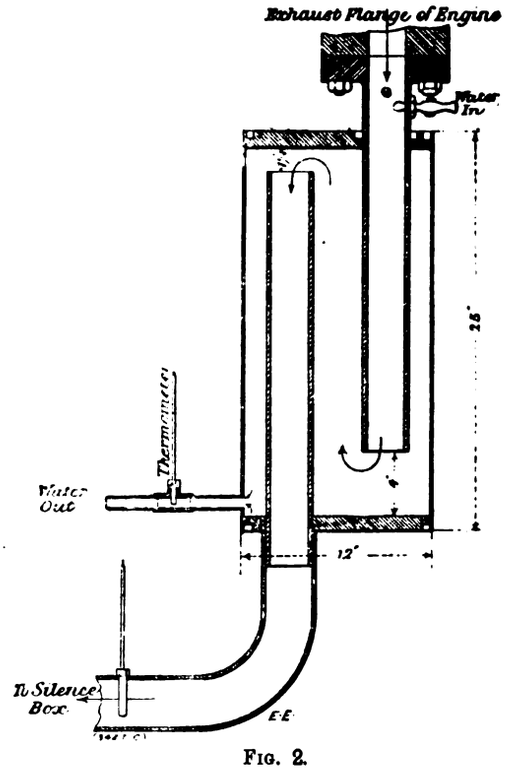

FIG. 2.

The following are the results of a trial made on this engine:

TABLE III.

	B.Th.U. per explosion.	Per cent.
Jacket water	7·0	32
Exhaust calorimeter	7·5	34·5
Heat up chimney (estimated)	0·3	1·5
Indicated work	5·7	26
Balance unaccounted for	1·3	6
Heating value of gas used	21·8	100·0

Temperature of exhaust gases after passing calorimeter, 107deg. F. temperature of jacket water at exit = 105deg. F.; explosions per minute, 106; indicated horse-power = 14·2. The gas measurement in this trial is correct to within 2 per cent., the indicated power is correct to within 5 per cent., and the other measurements to within 2 per cent.

It will be seen that the heat lost by radiation and conduction certainly does not exceed 10 per cent. of the heat put into the engine, and is probably a good deal less. I have made a large number of trials of the same kind on this engine, in all of which the balance unaccounted for is less than 6 per cent., even when the jacket water was very hot. This seems to me a sufficiently good result to justify trying this method of testing engines on a larger scale, especially having regard to the very compact character of the exhaust-gas calorimeter. In ordinary steam-engine trials it requires extraordinary precautions to get a closer agreement than this between the heat put in and the heat rejected, plus indicated work. Moreover, I think it is reasonable to suppose that in a large engine with a water-

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cooled piston, the loss unaccounted for would be smaller still. Of course, the precise design of the calorimeter for the exhaust gases would have to depend on the arrangement of engine and piping in each case; but there is no doubt, I think, that the secret of success is to spray a sheet of water under high pressure into the exhaust pipe close up to the engine. The gases rushing out break up this sheet into minute drops, and are thus very effectually cooled. The only difficulty then is to separate the suspended water from the gas, and to collect and measure its amount and rise in temperature. The separation is by no means so difficult as I had anticipated, and could no doubt be effected in a box somewhat similar to that which I have shown in Fig. 2. It will be found, on calculating out the heat contained in the gas after leaving the calorimeter, that this item does not become seriously high so long as the temperature of the gases is below about 140deg. F. I find, however, that the radiation and conduction from this particular calorimeter become rather large at temperatures above 115deg. But it is easy to determine the amount of this by a separate experiment.

I append some typical indicator diagrams, sufficient to show the character of the explosion in each case. The whole of the experiments were carried out at the engineering laboratory, Cambridge, by my pupils, Messrs. G. Harrison and A. Blackie, of Peterhouse. They also reduced most of the observations, and I wish to express my indebtedness to them.

THE EFFECTS OF RECEIVER DROP IN A COMPOUND ENGINE.*

BY JOSEPH W. HAYWARD, M SC., CENTRAL TECHNICAL COLLEGE, SOUTH KENSINGTON.

This paper deals with the results of four experiments undertaken to demonstrate the effects of varying the point of cut-off in the low-pressure cylinder of a compound engine, other conditions being maintained constant. The tests were made at the Central Technical College. The engine employed was of the horizontal compound surface-condensing type, with cranks set at right angles; its high-pressure cylinder is fitted with an expansion valve, whose travel is controlled by the governor; its low-pressure cylinder is also fitted with an expansion valve, the lap of which was set to give the cut-off required for each experiment. The cylinder constants for this engine are as follows:

Cylinder.	H.P.	L.P.
Diameter (inches)	8·728	15·76
Stroke (inches)	22	22
Mean volume described by piston per stroke (cubic feet)	·7463	2·4485
Mean clearance volume (cubic feet)	·076	·1364

During the trials the barrel of each cylinder was jacketed with steam at boiler pressure, and the receiver was drained

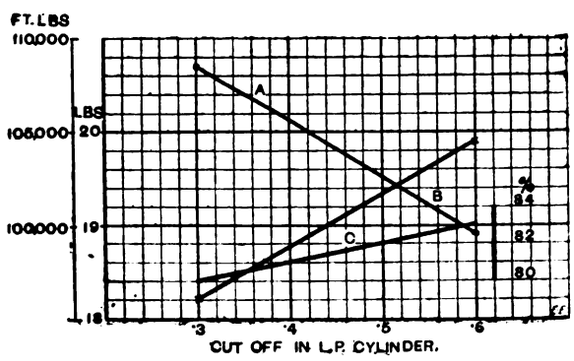

FIG. 1.

continuously through a steam trap. The shortest experiment lasted 1¼ and the longest 4¾ hours. A summary of the results appears in Table I.

Fig. 1 shows lines plotted between periods of admission to the low-pressure cylinder as abscissæ, and the following as ordinates: (*a*) work done upon the pistons per pound of steam used; (*b*) pounds of steam used per indicated horse-power per hour; (*c*) mechanical efficiency of engine.

* Paper read before Section G, British Association, Cambridge.

TABLE I.

Trial number	79	81	78	80
1 Cut off in low-pressure cylinder, front	·29	·39	·5	·62
,, ,, ,, back	·31	·41	·5	·58
,, ,, ,, mean	·3	·4	·5	·6
2 Mean boiler pressure, lbs. per square inch absolute	99·6	100·2	94·0	98·1
3 Mean back pressure, lbs. per square inch absolute	3·0	3·8	3·7	3·3
4 Revolutions per minute	98·18	98·08	97·30	97·98
5 Indicated horse-power, high-pressure	18·52	20·85	22·93	26·12
,, ,, low-pressure.	39·24	36·07	34·11	30·00
,, ,, total	57·76	56·92	57·04	56·12
6 Brake horse-power*	46·29	47·57	46·86	46·70
7 Mechanical efficiency of engine, per cent.	80	84	82	83
8 Cylinder feed per stroke, lb.	·0827	·0824	·0875	·0865
9 Lb. of jacket steam used per lb. of cylinder feed	·083	·103	·098	·097
10 Ft.-lbs. of work done per lb. of total feed	108,450	105,400	100,600	99,550
11 Lbs. of steam used per indicated horse-power per hour	18·22	18·78	19·72	19·88
12 Lbs. of steam used per brake horse-power per hour	22·8	22·6	24·0	23·9
13 Dryness fraction of steam at 80lb.	·61	·625	·63	·64
14 ,, ,, ,, 40 ,,	·73	·71	·75	·72
15 ,, ,, ,, 19 ,,	·83	·88	·86	·85
16 ,, ,, ,, 12½ ,,	·86	·91	·88	·86

* The resistance of a short line of countershafting is included in the engine friction.

The work done upon the pistons per pound of steam decreases continuously as the receiver drop increases, but the consequent loss is partially counterbalanced by an increase in mechanical efficiency. It was quite noticeable that the engine worked more smoothly during trial 80 than during trial 79, and, even with the latest cut-off used, more than half the power was developed in the low-pressure cylinder. The mean indicator diagram for the extreme trials, 79 and 80, are given in Fig. 2, and the same diagrams, reduced to a common scale of volume occupied per pound of working steam, are reproduced in Fig. 3.

Although the range of temperature in the high-pressure cylinder was 88deg. F. in trial 80, as against 62deg. F. in trial 79, the steam was 3 per cent. drier at 80lb. pressure in the former case than in the latter. This increase in dryness appears to a smaller extent in the intermediate trials (see Table I., line 13). It may be accounted for by the fact that condensation in the steam-

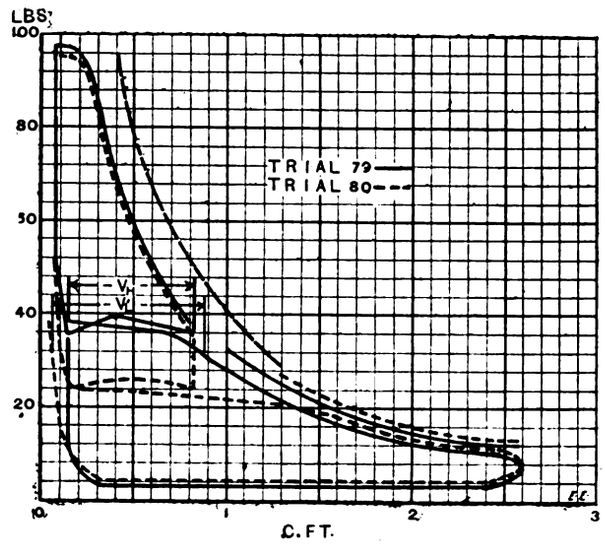

FIG. 2.

pipe and high-pressure valve chest is a function of the time alone; consequently, the greater the quantity of steam passing through these the drier a given weight of that steam will appear. In the low-pressure diagram for trial 80 the result of free expansion and reduction of temperature range is evident.

One of the chief difficulties in making comparable trials is to maintain the glands in the same condition throughout. Unfortunately, the packing in these was excessively tight

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during trial 79 and excessively loose during trial 81. In the former case, the back pressure was reduced to 3·0lb. per square inch with a hot-well temperature of 135deg. F., but the mechanical efficiency fell to 80 per cent. In the latter case, the mechanical efficiency rose to 84 per cent., but the back pressure was 3·8lb. per square inch, with a hot-well temperature of only 130deg. F.

In a recent paper dealing with "receiver drop"—see *Proceedings* of the North-East Coast Institution of Engineers and Shipbuilders, vol. xvi., 1900—Prof. Weighton states that, "For maximum economy of consumption, steam must be cut off at a certain point in the stroke in the larger cylinders of multiple-expansion engines. For any given cylinder this point depends solely upon the ratio between the capacities of that cylinder and the preceding cylinder, R, and is expressed as follows—viz.,

$$\frac{\text{Maximum economy cut-off}}{\text{stroke}} = \cdot 15 + \frac{I}{R}"$$

The general application of this conclusion to all engines is not borne out by the experiments under discussion. Prof. Weighton's formula gives the best point of cut-off at ·46 of the stroke, whereas Fig. 1 shows that it is not later than ·3 of the stroke.

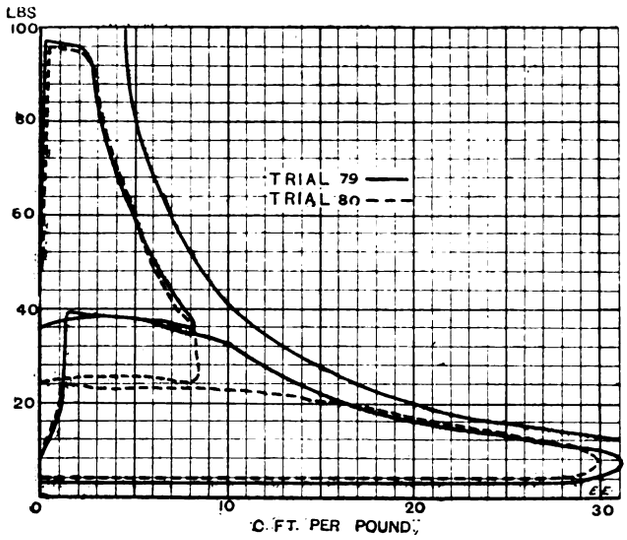

FIG. 3.

The author considers that the amount of clearance volume and the extent to which compression occurs in both cylinders of a compound engine must have an important influence over the receiver drop, and consequently over the best ratio of expansion in the low-pressure cylinder. For example, in trial 79 the volume, V_H (see Fig. 2), of the working steam after its expansion in the high-pressure cylinder was ·69 cubic feet. The volume, V_L, of the same steam at cut-off in the low-pressure cylinder was ·83 cubic feet.

$$\frac{V_L}{V_H} = 1{\cdot}20.$$

Had there been no compression, this ratio of free expansion would have become 1·15, and had there been neither clearance nor compression, it would have become ·99. A change in the above quantities in one cylinder only would have a still more marked effect. It is hoped that by further experiment evidence of the true extent of these influences may be obtained.

THE ACTION OF LIGHTNING STROKES ON BUILDINGS.*

BY KILLINGWORTH HEDGES, M.I.C.E., HON. SECRETARY, LIGHTNING RESEARCH COMMITTEE.

In a paper entitled "The Protection of Buildings from Lightning," which was read at the Glasgow meeting of the association in 1901, the author mentioned the establishment of the Lightning Research Committee, organised jointly by the Royal Institute of British Architects and the Surveyors' Institution, who have since investigated a very large number of occurrences from the reports furnished by their observers. It was decided after the first year to confine the committee's investigations to buildings which were fitted with conductors, and, following this course, the reports on about 40 protected buildings affected by lightning have been summarised by a sub-committee, and are having the attention of the General Committee, who will in due course issue a report.

The principal causes of the failure of the usual style of lightning rod as fitted on the buildings investigated, appear to be due to the following: (1) insufficient number of conductor and earth connections; (2) the absence of any system of connecting the metallic portions of the buildings to the lightning conductor, especially the interconnection of the finials, rain-water pipes, and gutters. In the author's opinion the frequent damage by side-flash from the conductors might be lessened by running a horizontal conductor along the ridge, or along the parapets of all the roofs, somewhat after the method which is almost universally adopted in Central Europe.

The lightning strokes may be divided into three classes: (1) Those where the conductor conveyed a portion of the flash to earth, but the side-flash to other unearthed metallic conductors damaged the building; the practice of running the conductor round the projecting masonry, often taking sharp bends, doubtless facilitated the deviation of the current from its direct path to the earth. (2) In several observations a metallic roof of large area received the flash, consequently became highly charged, and the single conductor failed to convey the whole of the stroke, a portion of which took a circuitous path—for instance, through a speaking-tube and an electric bell wire. (3) A flash struck the building at two points simultaneously, a lightning conductor taking one part of the stroke, but damage was caused by the other portion selecting an unprotected part of the roof.

Earth Connections.—With a few exceptions, these had the defect common to nearly all earth-plates which are simply buried in the ground close to the foundations of a building, and owing to drainage soon became dry, consequently are of very high resistance. Architects, as a rule, object to sufficiently deep holes being made near a structure; consequently the permanently moist ground is not reached. The tubular earth designed by the author does away with this objection, and can be kept moist by leading a small tube to the nearest rain-water pipe.

Interconnection with the Metal Work of a Building.—Although the utility of the external metal was specially put forward in the report of the Lightning Rod Conference in 1882, their recommendation has been apparently disregarded in all the cases under review. The Cavendish Laboratory (No. 64) stroke, which was fortunately unattended with danger owing to the gas in the gas-pipe which formed the path of the current being turned off, would have not taken this circuitous path had the leaden roof been connected to the conductors which ran down the tower only, also to the rain-water gutters and pipes, which should have been interconnected at the bottom and properly earthed. Again, at Bedford (No. 88) last year, St. Paul's Church was seriously damaged by the flash leaving the single conductor on the tower by the water on the roof and passing thence to earth by means of the rain-water pipes. In this case it is interesting to note that the lead pipes were not fused, but their round section was changed into an oval one; the iron water-pipes were broken. This incident and No. 68 (St. Pancras Church, Euston) show clearly that the damage was due not to direct stroke, but by a portion of the flash leaving the main conductor and taking a circuitous path round the unconnected metal work outside and inside the buildings.

Observation No. 2: Kea Church, Truro.—The copper sheathing of the spire, owing to its great capacity, could not discharge through the one excellent conductor to earth, consequently the flash divided, part going by the conductor and part by the alternative path formed by the copper covering of the spire to a rain-water pipe, thence sparking through a parapet wall to lead flashing down another pipe, and then along a very small copper wire used for training

* Paper read before the British Association at Cambridge.

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plants, to the main conductor. Similar effects were noted in Stoers Lighthouse (No. 54) and Devaar Lighthouse (No. 56), the divided flash in the former leaving the conductor for a telephone wire and in the latter for a speaking-tube. In these observations the conductors may be said to have acted to a certain extent, and if the structures had been entirely unprotected the damage would have been greater, but by proper attention to the necessities of each case, and increasing the number of the conductors, the risk would probably be nil, as there would be a definite path for the lightning to take.

Quite the most interesting case is that at Possingworth House (No. 67), struck in June and again in August, 1902, although the roof fairly bristled with air terminals, every chimney being protected, mostly with its own conductor and earth connection. It is probable that on the second occasion the flash divided, one part selecting a chimney stack, which it damaged, bending the air terminal to an angle of 45deg., while the other, neglecting the many points, fell on an unprotected statue much lower than the chimney and went to earth by the iron frame of a conservatory, showing the unreliability of a number of independent conductors which should have been interconnected by means of a horizontal wire led along the ridge; this would in all probability prevent any serious damage.

Sir Oliver Lodge has shown by an interesting experiment that a column of hot air is often selected by a flash although a lightning rod may be affixed to the side of the chimney. Most of our large stacks have a band of metal to which the air terminals are fitted, and from these two conductors should be led to earth. The method adopted in Germany appears to be simpler, and consists of a heavy iron frame rising to a sufficient height above the stack, and continued at the apex so as to form an aigrette. That lightning may prefer the smoke issuing from a chimney was shown by the stroke at the East London Waterworks, Sunbury, last year, the flash doing some damage to the capping before it arrived at the standpipe inside, which was a perfect earth in that it was in direct connection with the company's mains.

The general conclusions arrived at by the author are that there is very little advantage in placing isolated rods on an ordinary building without it has a high tower. A church, for instance, with a spire should have at least two conductors from top to earth. Even then, if any other part of the structure happens to be in the path of a discharge from a cloud to the ground, the stroke may disregard the protected towers or spire and fall on the building, choosing some lower point. If the suggestion put forward by Sir Oliver Lodge at the Bath meeting in 1888 were more closely followed, and the conductors so arranged that they form a protective network over all the roofs, a flash would in all probability be received by some portion of the system and pass without harm to the ground by one of the numerous earths to which the network would be connected.

The insurance offices appear to disregard the question of adequate protection, and are quite content if the single conductor which has not prevented serious damage, for instance, to a church is replaced, and, moreover, take no steps to have the earth connection tested periodically; also the few unconnected lightning rods erected on our national museums, picture galleries, and other public buildings contrast most unfavourably with the more scientific methods adopted on the Continent, more especially in Germany, where in some districts the local authorities have issued rules as to the erection and testing of lightning conductors, to which the various public bodies have to conform, and in some cities householders are subject to penalties if the system is allowed to get out of order.

REVIEWS.

The Steam-Turbine. By ROBERT M. NEILSON. Longmans, Green, and Co. 10s. 6d. net.

We have a lively recollection of being present, some 16 to 18 years ago, at—what was then a complete novelty—the first starting up of a Parsons steam-turbine. Our recollection is vivid, inasmuch as the speed of the machine was the—then unheard of—figure of 16,000 revolutions per minute, and on this speed being attained, the attendant hum was so alarming that most of those present, including the writer, incontinently fled. Since that day our knowledge of turbines has increased and speeds have been brought to more moderate values, except in the De Laval.

The literature of the steam-turbine is more or less scanty, and is scattered about in various publications. Engineers owe the author of the present volume a debt of gratitude for bringing into a compact and reasonable compass the history, theory, and latest practice of steam-turbines. The historical part is treated with admirable restraint, whilst the theory and practice is dealt with in a manner that renders it most valuable. The evolution of types is carefully traced showing the gradual weeding out of the unfit, until the Hon. C. S. Parsons enters the field in 1884, which, as it were, marks the epoch from whence the steam-turbine as a practical machine may be said to date: the progress since that time has been one of steady growth, and now it is all the fashion, if not the rage.

We are introduced to the theoretical work by a useful chapter on the "Points of resemblance and difference between the steam-turbine and other motors," and from the considerations there given one feels that the steam-turbine ought to score in efficiency "hands down"—whether it does so or not in practice will appear later. Incidentally we should like to point out a statement that appears somewhat ambiguous. It occurs on p. 58 and reads: "It should be borne in mind, however, that in a multiple-expansion turbine like a Parsons, *heat produced by friction raises the temperature of the steam and increases its energy*" (the italics are ours). The meaning—viz., that some portion of the heat of friction is recovered—we think might with advantage, especially to students, be rendered more simply and direct.

The chapter on vanes and velocities is good in the treatment of the subject matter, but the style is far too diffuse, with consequent lack of power, even in places leading to statements that are illogical—*e.g.*, on p. 74 we have

"Let the velocity . . . . . be represented by V_1 and the radius . . . . . by R_1.

Therefore velocity at any radius $r = \frac{V_1 \times r}{R_1}$."

In this same chapter we have a most tiresome reiteration of the word *therefore*, the effect on a reader trying to grasp the argument being irritating to a degree.

That controversial subject, entropy, is dealt with in a commendably brief chapter—we say commendably brief, because in our opinion it might have been omitted without loss. It may be heretical to say so, but we have never found "entropy" of any practical use. Prof. Perry, as the author tells us, calls it a "ghostly quantity." The truth of this description becomes apparent when the more or less intelligible statement, $d\,Q = \tau \times d\,\phi$, is put into words. We quote from Chapter vi., p. 82: "When heat is put into or taken out of a substance, any small part of the heat so dealt with is equal to the temperature at which it was put in, or taken out, multiplied by some quantity. This quantity is called change of entropy."

Advantageous as the steam-turbine is in many respects on the score of economy of steam, it does not shine greatly as would be imagined. From the test figures given on p. 199, we see that a 500-kw. turbo-alternator at full load and with 27·8in. vacuum gave a result of over 25lb. of steam per kilowatt. Recently the writer obtained with a 250-kw. reciprocating engine-alternator 24·4lb. of steam per kilowatt, 25in. vacuum, and no superheat, and we believe that only in large sizes—1,000 kw. and upwards and a 29in. vacuum—can the steam-turbine compete in steam consumption with a good reciprocating engine. As we have previously stated, this is hardly what would be expected, showing how much room for improvement there is remaining.

There are many interesting points that could be dealt with did space permit, but we must refer those interested in the subject to the book itself. We can cordially recommend it, it is full of valuable information, is well printed, and is illustrated with such a wealth of clear diagrams and blocks that make it a real pleasure to read.—G. W. G.

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TO CORRESPONDENTS.

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GAS-ENGINES.

Many years ago the late Sir Frederick Bramwell prophesied that steam-engines would in a certain time become extinct, and that they would be replaced entirely by the internal-combustion engine. His belief in his prophecy was so strong that he left the sum of £100 in order that a lecture might be given at the end of the period which he prophesied would be required for this radical engineering change to be effected. The developments of recent years lead one to believe that the gas-engine is likely to succeed in the future in ousting steam-engines at least for power purposes on land. With the increase in size of gas-engines, however, numerous mechanical difficulties have been met with which were predicted beforehand, and which tend to neutralise the advantages from the higher thermal efficiencies of the engines. Chief amongst these is the cooling question. The quantity of heat in a cylinder immediately after explosion is proportional to the volume of the charge, or, to put it roughly, to the cube of the engine dimensions. On the other hand, the cooling surface which is available for keeping the engine parts at reasonable temperatures only increases as the square of the dimensions. The result is that means of cooling which are quite effective in small engines become insufficient when the size and output is increased. In consequence, builders of large engines have found it necessary to provide water-jackets not only round the cylinder, but also in the cylinder ends, and even in the piston itself. In his interesting paper before the Mechanical Section of the British Association, Mr. Dugald Clerk described a new method he had invented for improving gas and oil engines in this respect. The paper is given in full in this week's issue, and is well worthy of careful study. In it it is clearly shown that the exceedingly high temperatures found in ordinary cylinders immediately after explosion is uneconomical for two reasons. In the first place, it is higher than the range of expansion in an ordinary engine can utilise, and hence results in the exhaust gases being too hot and carrying away an unduly large proportion of the heat. Secondly, it causes the mean temperature of the inside of the cylinder walls to be unnecessarily high, and hence increases the loss of heat into the jacket water. Mr. Dugald Clerk's invention consists in introducing at the end of the charging stroke a certain amount of inert gas under pressure. This raises the pressure of compression, but, owing to the presence of the inert gas, the temperature after explosion is greatly reduced — for instance, in one special case the temperature of the gas was reduced from 1,700deg. C. to 1,200deg. C. The curious point which will be of great interest to theorists on the perfect heat engine, is that with this reduction of maximum temperature there is an increase in the actual thermal efficiency of the engine of from 27·7 per cent. to 34·4 per cent. In the paper will be found a description of the ingenious method adopted by Mr. Dugald Clerk of abstracting a certain portion of the exhaust gases under pressure during the working stroke and returning the same into the cylinder after cooling at the end of the charging stroke. It is true that the engine has a few more parts, but the increase in output, as well as in the thermal efficiency, quite warrant extra expense. Thus, with a given engine the output was increased from about 23 b.h.p. to 28 b.h.p.—*i.e.*, over 20 per cent.—by returning a small portion of the exhaust gases into the charge, as explained above. Again, quite apart from the increased efficiency in output, we find a big reduction in maximum temperature, which with engines of a large output will decrease the trouble of cooling the working parts

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and increase the life of the same. On the same morning at Cambridge, Prof. B. Hopkinson read a paper on the "Calorimetry of Gases exhausted from an Internal-Combustion Engine." This we are also reproducing, as it should be studied simultaneously with Mr. Dugald Clerk's communication and the abstract of Prof. H. B. Dixon's remarks on his experiments on the specific heats of gases at high temperatures. These three communications were the subject of joint discussion of the most interesting character, in which theory and commercial practice were both referred to. For instance, Sir Andrew Noble carried the subject of the properties of gases after explosion up to the pressures and temperatures of that earliest form of gas-engine—the gun. Lord Kelvin gave some interesting remarks on the theory of combustion, with the result that the morning of Friday, Aug. 19, was the most instructive one spent in Section G during the Cambridge meeting.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MISMANAGEMENT OF THE BRITISH ASSOCIATION MEETING.

SIR,—With great pleasure those of your readers who were at the British Association this year will notice your censure of the organisation of Section G. Is it not an extraordinary thing that of all the sections into which the British Association is divided, the engineering section, which is that most closely connected with the commercial world, should show the most lamentable lack of business principle? So much is this the case that I notice in the special articles contributed to the *Manchester Guardian* by their Cambridge correspondent, twice—viz., on Tuesday and Thursday, Aug. 16 and 18—the engineering section is singled out as *the* badly-organised section. "The engineering programme appeared to have been arranged for the last three days by shuffling or balloting, Friday having the only syllabus which showed signs of intelligent forethought and arrangement," says this correspondent with strong common-sense, and all who were there will feel the truth of the statement. How was it, I may ask, that on Monday morning, for instance, the authors of the first two papers were allowed to read *in extenso*, from end to end, their contributions, instead of giving a reasonable *résumé*, with the result that papers quite as valuable, like those of Sumpner and Weekes, Thornton and Dr. Fleming, had to be rushed through without even time for a proper *résumé*, some with no discussion at all. How is it that with a committee boasting men of business and a recorder connected with a large engineering firm, such a medley as Wednesday's programme could have been put together? Last year exactly similar complaints were made, and I know that I am only voicing the opinion of many regular attendants of Section G when I say that steps should be taken to prevent such a muddle occurring again.—Yours, etc., B. A.

RE ARTIFICIAL LOADS.

SIR,—Your correspondent "Yrreb" has devoted so much attention to me in your last issue (one letter and parts of another) that I am compelled to acknowledge his lavish courtesy. Possibly, like Micawber, he finds relief for a surcharge of emotion in letter-writing.

I have very carefully considered the oil-can theory, and fully agree that if one did drop an oil-can between the electrodes of a water resistance, marked changes of load would occur. I must, however, reject this charmingly original suggestion on the ground that one cannot keep on dropping oil-cans into the tank. The unsteadiness of load was a recurrent phenomenon occurring during the use of running water.

I cannot claim the profundity of special knowledge that is vouchsafed to "Yrreb," but write as a general practitioner with a particularly unpleasant experience of the use of canal water for a testing tank. I am, however, only too glad to sit at the feet of "Yrreb" or any other sage so long as he has something useful to impart, and does not carp at other workers.

I admit that the tank suction was in the wrong place—it was in the canal. If we had taken it up to the fountain head, we might have got some decent water in place of the dilution of mill effluents we had to put up with. We did as well as we could, practically, and used the town supply.

As regards my capabilities and the measure of success which I have obtained, I am afraid I must leave that matter to those who by their actual acquaintance with me are more fitted than "Yrreb" to indulge in personal criticisms.

Finally, I would suggest to "Yrreb" that when he next seeks to accentuate the importance of his own publications by trying to depreciate the value of another man's work, which appeared to be the motive of his first letter, he should pay for his epistle at the usual advertisement rates.—Yours, etc., A M.I.C.E.

WIRELESS TELEGRAPHY.

SIR,—I notice that Mr. Blaine in his article on "Wireless Telegraphy" on p. 200 of your issue of Aug. 5, accredits the De Forest system of wireless telegraphy to Dr. Lee De Forest and Prof. C. E. Freeman. I merely wish to call your attention, and the attention of Mr. Blaine, to the fact that the receiving device or responder, which is the particularly novel element of the system, is due to Mr. De Forest and myself, as will appear from the copies of the United States letters patent 716,000, 716,203, and 716,334 of Dec. 16, 1902, which I am mailing you under separate cover.—Yours, etc., EDWIN H. SMYTHE.

Chicago, Aug. 16, 1904.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

VI.—ON THE TIME-ELEMENT.

MY DEAR YOUNG 'UN,—H. G. Wells has written a remarkable little story, which I daresay you have read, called the "Universal Accelerator." You will remember that a doctor invented a stimulant which affected every part of the body exactly equally, so that no out-of-balance strain was thrown upon any portion, the result being that for a time the whole existence of the man under the influence of the decoction was accelerated; he could think, act, speak in a thousandth of the time usually taken. Great stress was laid on the immense advantage which a man under this stimulating influence would have over his *entourage* which moved and thought at ordinary rates; and one finished the story with a half-sigh for the impossibility of the realisation of the dream of quick life. Behind the grotesqueness of the story lies one of the prime factors of success—rapidity; smartness. It is the hustler who gets the contracts nowadays. Our forefathers thought they were going strong when "Puffing Billy" did 10 miles an hour. Now we have rival electrical firms seeing who can break their necks quickest on the Marienfelde-Zossen railway at anything up to 120 miles an hour. Once upon a time contractors went slowly and did careful work. Nowadays they cannot, because "Time to be the essence of the contract" is written on every specification.

The Time-Element, then, is one of the most potent factors in your success or failure, and I want you to get hold of the importance of being "right *there*"—toe on the line, waiting for the starting pistol, whenever you begin to do anything.

In the shops where I was inducted into the mysteries of engineering there was no five minutes' grace after six o'clock. You had to be in on the stroke, or else the gates were slammed in your face and you lost a quarter. That was all right; but there was the added terror of an old Scotch foreman who was always there 10 minutes before time and kept his eye on the apprentices. When asked his opinion about a sluggard who was just able to squeak in as the gates closed, he would say: "Nae dom gude! Snoops

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TABLE A.

No. of specimen.	Analysis.						Specific resistance in 10^{-6} ohms at 15deg. C. before exposure in 1901.	Percentage variation of electrical resistance at 15deg. C.				Breaking load in pounds per square inch of cross-section.
	Si.	Fe.	Cu.	Ni.	Mn.	Zn.		During 1901-2, taken on value in 1901.	During 1902-3, taken on value in 1902.	During 1903 4, taken on value in 1903.	During 1901-4, taken on value in 1901.	
16	0·31	0·37	0·11	—	—	—	2·92	1·04	0·65	−0 18	1·50	26,600
4	0·38	0·25	0·16	—	—	—	2 88	1·86	1·10	1 81	4·83	25,700
13	0·38	0·25	1·58	—	—	—	3·34	3·49	1·79	0 88	6·25	39.000
14	0·40	0·31	1·86	—	—	—	3·25	5·24	1·52	1·00	7·91	40,600
15	0·40	0·40	2·61	—	—	—	3·34	7·20	2·77	3·06	11·51	43,500
1	0·38	0 22	0·17	—	—	0·62	2·86	3·54	1·05	2·34	7 07	28,100
2	0·43	0·28	0·30	—	—	1·20	2·94	2·67	3·09	0·00	5·84	30,500
5	0·43	0·39	0·09	—	—	2·04	3·07	2·33	1·14	0·70	4·21	26,000
7	0·37	0·25	0·05	0·75	—	—	3·05	1·22	0·73	1·68	3·66	29,700
8	0 35	0·29	0·09	1·19	—	—	3·24	2·10	0·11	2·05	4·28	33 700
20	0·37	1·10	0·06	2·25	—	—	3·18	1 55	0·23	0 27	2·05	38,600
24	0 35	1·16	0·09	—	—	—	2·97	0·765	0 76	0·15	1 68	31,300
3	0·37	0·28	0·59	—	—	0·59	3·06	2·52	0 82	1·28	4·67	30 500
6	0·39	0·31	0·63	—	—	1·20	3·12	2 02	0·12	1·41	3·68	30,900
17	0·35	0·53	0·10	0 83	—	0 90	3 03	0 63	0·50	0·72	1·89	31,700
12	0·31	0·59	0·19	1 09	—	0·73	3·33	1·26	1 02	0·00	2·24	31,700
18	0·43	0·40	0·21	1·13	—	1 94	3·24	2·29	1·07	0·75	4·14	34,500
19	0·25	0·29	0·11	2·01	—	1·77	3 26	2·60	0·81	1·81	5·31	36,200
11	0 39	0·56	0·24	2·31	—	0·38	3·48	1·95	0·425	1·90	4·31	34,500
22	0·37	0·43	1·08	1·29	—	—	3·41	−1·42	3·96	4 30	6·90	45,900
21	0 39	2·57	0·10	1·39	—	—	3·24	−0·97	3·28	7·14	9 50	42 200
10	0·32	0·54	0·02	—	0·05	—	3·09	0·783	0·31	1·02	2·12	29 000
9	0·31	0·35	0·03	—	0·35	—	3·30	1·94	−0·55	0·92	2·31	30 500
23	0·44	0·56	0·09	—	1·78	—	3·49	2·34	0·00	0·37	2·71	35 300
Al.*	0·14	0·31	—	—	—	—	2·76	not exposed	2·70	0·87	3·58†	28,200

* Commercial aluminium. † Taken on value in 1902.

in at the wicket like a lawyer gaein' ta heaven!" Which remark was very galling on a frosty morning, but was useful in impressing on us that in order to retain our places in the ever-increasing ranks of the army of engineers we had to *keep step*.

Now the pace is so fast in modern engineering, that in order to be up to time at the various points on the route one must do a considerable amount of bucking-up. There are two ways of getting along in a race: one is to scramble, the other is to scud. The man who scrambles generally gets a stitch in the side and sits down suddenly. The man who scuds begins to enjoy himself after he has got his second wind. But you can only scud when you have been in training for some time and are thoroughly fit. It is no good "slommocking" through engineering; you must train yourself to do things with a snap.

When a warship goes into action two or three preparations are made. All useless impedimenta—things likely to catch fire or get in the way—are thrown overboard. The decks are cleared for action and everything made snug; nothing is let flopping about for the enemy to make a mess of. Then provision is made to serve the guns with ammunition at the quickest possible rate, and the ship goes in with full steam up. If you have made up your mind to be above all things a successful engineer, don't try to be a footballer, an artist, a comic singer, and a husband as well. All these are good in their way, but a man of ordinary capacity for work hasn't time for them all; his movements will be hampered. Keep your ammunition where you can use it. In the bad old days a fitter could spend half the morning looking for his tools. There is no use for that man in the modern shop. He draws his heavy gear from the tool store, his ordinary kit is kept in tool racks; and if he doesn't work smartly, he gets the sack. Arrange your knowledge; index your notebooks. Store your technical papers after throwing away the advertisement leaves, and keep the index handy. Classify your books, so that you can turn up any subject at once.

I knew the chief of a lighting station who, when he wanted an item of information, used to make hay with the papers on his desk for a quarter of an hour before he found the scrap he was after. He wasn't a quick worker.

Classify your brains as well. Don't have a lot of vague ideas floating about, but nail them down under headings.

And, finally, keep your steam up; if you don't, your propeller will go slow, you will lose "way" and won't answer your helm. If you find your attention flagging in study in spite of well-meant efforts to concentrate, bustle out of doors and take a sharp walk. If you have a bicycle, do your reasonable best to get a hot bearing on the cyclometer. You need all the constitution you have got in order to satisfy the time-conditions of present-day engineering.—Yours, THE OLD 'UN.

THE ELECTRICAL CONDUCTIVITY OF CERTAIN ALUMINIUM ALLOYS AS AFFECTED BY EXPOSURE TO LONDON ATMOSPHERE, AND A NOTE ON THEIR MICROSTRUCTURE.*

BY ERNEST WILSON.

The physical properties of certain light aluminium alloys have formed the subject of communications,† and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effect of exposure to London atmosphere. The specimens are in the form of wire 0·126in. (3·2mm.) diameter, and were placed on the roof on June 11, 1901. They have been taken down in July of each of the years 1902 3 4, and their electrical resistance measured. The results are set forth in Table A.

It was shown that during the first two years' exposure the series of copper-aluminium alloys (Nos. 16, 4, 13, 14, 15) diminished conductivity to a greater extent the greater the percentage of copper. It will be seen that this process has progressed still further, but the yearly variation is not now so great as during the first year. This last year's exposure still confirms the conclusion previously arrived at, that copper alone should not be used in fairly large quantities when alloyed with aluminium to be exposed to London atmosphere. Of the nickel-copper-iron-aluminium alloys (Nos. 20, 21) the former (No. 20) has changed

* Paper read at the British Association, 1904.

† See *Journal* Institution of Electrical Engineers, 1902, Part 154, vol. xxxi.; British Association Reports, 1901, 1902, 1903; the *Electrician*, vol. xlviii., pp. 387, 389, vol. xlix., p. 868, and vol. li., p. 898; also *Journal* Society of Arts, Dec. 13, 1901.

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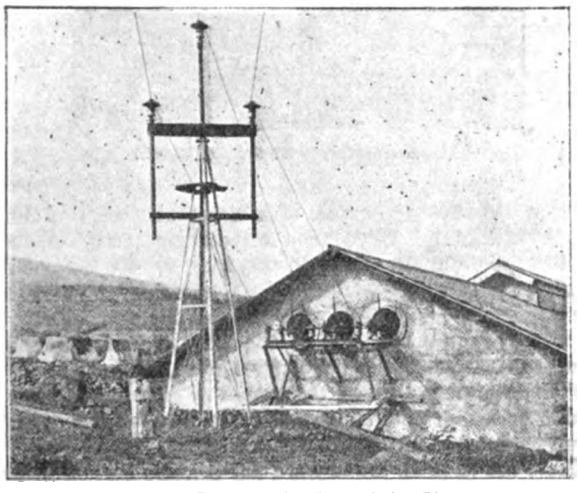
comparatively little, and it is richer in nickel; the latter (No. 21) is richer in iron and shows a gradually increased rate of deterioration. Each of these alloys has a comparatively high tensile strength. The nickel-copper-aluminium alloy (No. 22), which showed such remarkably increased tensile strength as compared with good commercial aluminium, has now (like No. 21) considerably diminished total conductivity. On the other hand, the manganese-copper-aluminium alloys (Nos. 10, 9, 23) have suffered comparatively small diminution in conductivity, and No. 23 has a comparatively high breaking load. The iron-copper-aluminium alloy (No. 24) has also shown little change in conductivity during the three years' exposure, and its breaking load is considerably higher than that of good commercial aluminium. The alloys (Nos. 17 and 20) have also suffered small diminution in electrical conductivity.

It was thought that an examination of the structure of these alloys by aid of micro-photography might throw some light upon the great difference which exists between some of their physical properties. Alloy No. 22 has a breaking load of 45,900lb. per square inch, as compared with about 28,000lb. per square inch for ordinary drawn commercial aluminium. After grinding and etching with various solutions, practically no structure could be discovered under a magnification of 800 diameters. Considering the remarkable crystalline structure exhibited by ordinary commercial aluminium near the surface of an ingot when allowed to solidify at an ordinary rate, the want of structure in these alloys may be attributed to the process of drawing down. The inference is that the great difference which exists between their tensile strengths and other qualities is probably not due to variation in structure.

I am indebted to the council of the Royal Society for a portion of the Government grant, which has enabled me to carry out these experiments in micro-photography, and I wish to acknowledge the help I have received from Mr. R. E. Shawcross.

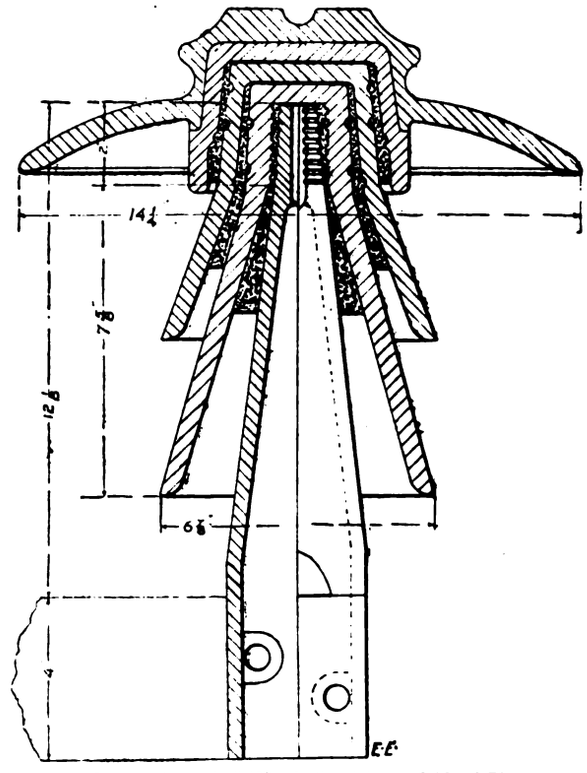
POWER TRANSMISSION IN MEXICO.

Some particulars are given in the *Electrical World* of New York of the 100-mile 60,000-volt transmission line of the Guanojuato power plant, which has been installed to supply energy for the mining and other industries of that city. American ingenuity and capital are responsible for the undertaking. The generating station is situated at the



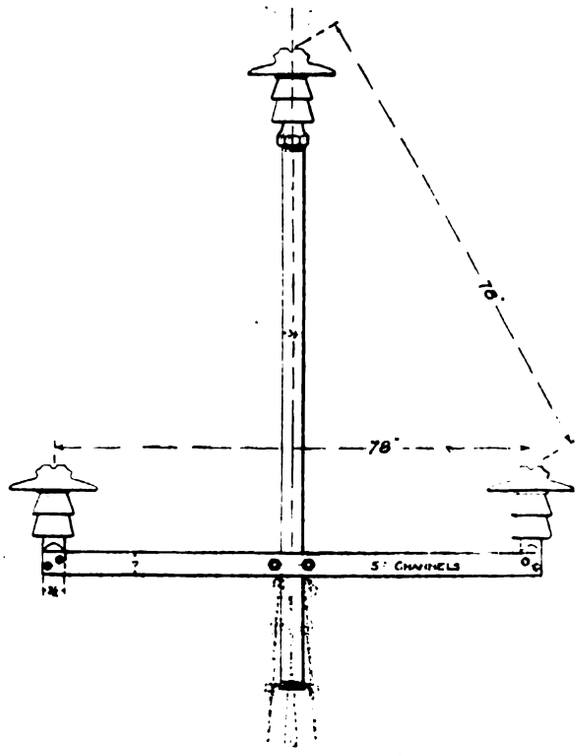
The First Tower of the Transmission Line.

little Indian village of El Platanal, near the city of Zamora, and for some 30 miles the line passes over rough mountainous territory, as it also does in approaching Guanajuato, but the intervening tract of about 60 miles consists of open country. The transmission apparatus is of a somewhat novel character, its distinctive features comprising the employment of metal pins, cross-arms, and special galvanised steel towers instead of strong ordinary poles for supporting the insulators, the substitution of hard-drawn copper cable in the place of the usual solid conductor for the transmission line, and the unusual length of the spans. While not exactly original, the design is probably unique in point of extent.



Cross-section of 60,000-volt Insulator and Metal Pin.

The conductors are 19-strand, hard-drawn copper cables about ⅜in. in diameter, equivalent in carrying capacity to No. 2 B. & S.G. wire, and weighing 1,340lb. per mile. This type of conductor was finally decided upon after much



Elevation of Cross Arm and Pipe.

study and many tests, because of its high conductivity, flexibility, and mechanical strength, the wires composing it having a tensile strength of over 55,000lb. per square inch. The cable was made and shipped in lengths of about two miles. The joints were made with special copper tube connectors 12in. long, and elliptical in cross-section. The two ends to be joined were passed through the connector in opposite directions, and three complete twists were given

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by means of special wrenches. No soldering was done. The cables are placed in grooves on top of the insulators, 78in. apart, at the points of an equilateral triangle, and are tied in with No. 14 soft copper wire, it being considered that the small wire wrapped about several times would make an easy tie, and not be apt to damage the small hard-drawn strands of the cable. Diagrams showing the proper sag to be allowed at various temperatures and for spans up to 1,320ft. were prepared, based on a maximum strain of 20,000lb. per square inch in the coldest weather and with the most severe wind.

The towers are special 40ft., four-post, galvanised steel structures, weighing about 1,500lb., made of 3in. by 3in. by $\frac{3}{16}$in. angles, braced and stayed with smaller angles and rods. Each post terminates in an anchor, consisting of a piece of angle iron 30in. long secured at right angles. One of these towers is shown in the accompanying diagram.

The advantages of long spans, with consequent reduction in number of supports and of insulators required, were so obvious that it was at once decided to adopt that type of construction. After careful study and many calculations and estimates, the 40ft. towers spaced 12 to the mile were determined upon. The towers are spaced 440ft. apart, 12 per mile, except near Guanajuato, where the nature of the ground necessitated the use of a few 60ft. towers and spans up to 1,320ft. in length.

The No. 9 B.B. double galvanised iron wires for a telephone circuit are fastened on the transmission towers 10ft. below the copper power cables. They are tied to regular glass insulators placed on 12in. painted oak brackets bolted to tower legs. The telephone wires are transposed one complete revolution every four towers; the power cables are not transposed. High-resistance instruments are used, and the telephone service is quite satisfactory. The climatic conditions for high-voltage transmission are usually good, and during the dry season, when the water is lowest, and when all the losses should be kept at a minimum, the atmospheric conditions are very favourable.

We reproduce diagrams illustrating a cross-section of the 60,000-volt insulator and main pin and an elevation of cross-arm and pipe. The enterprise presented several local difficulties, but the task of harnessing the rapid and boisterous Duero was completed in about a twelvemonth, which is accounted distinctly a record for an undertaking of such magnitude in Mexico.

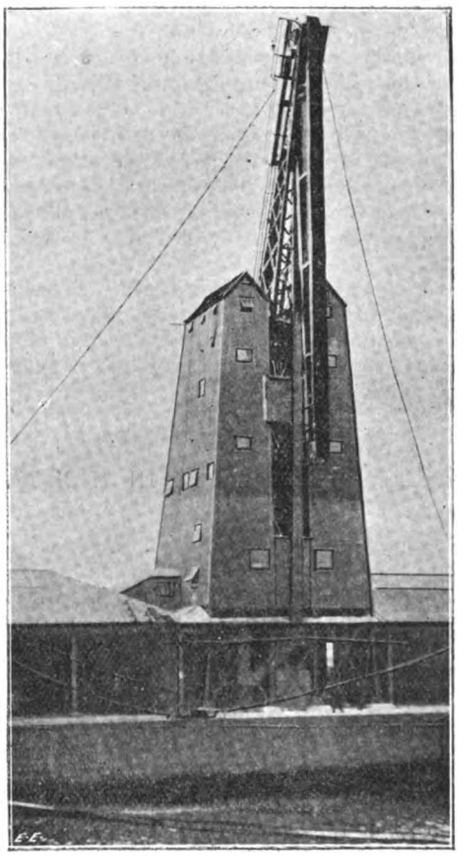
ELECTRICITY AND GRAIN ELEVATORS.

BY G. T.

The new grain elevator which has just been erected at Leith Docks demonstrates the great benefit to the owner by the adoption of motors. There are so many appliances to control in a narrow space that steam-engines would be impossible unless much more room was afforded in the designer's plans. As this is the first grain elevator to be built in Scotland, and as the likelihood is that others may follow, a description of the motive power will be of interest. The elevator tower is built of steel, and rises to a height of 78ft. The outside leg is that which lifts the grain from the ship's hold. It is lowered and raised by a balanced girder worked by a 5-h.p. motor. This girder is 84ft. long, and the combined weight of the outside elevator leg, girder, and balancing material is 60 tons. Yet it is handled with ease by one man in the conning tower, who has an electric switch at his hand, and can move about the 74ft. leg with its endless band of small buckets by a touch of the hand, without requiring to take his eyes off the ship's hold. He can swing the leg a distance of 27ft. from the quay wall, can lower the bottom to a depth of 31ft. below quay level, and can raise it until it is 44ft. above the quay level. The movements are noiseless, and the motor is on one of the platforms inside the narrow tower, and is reversible, with the drum alongside on which is coiled the wire rope.

A 50-h.p. motor is used for driving the endless band of buckets which scoop up the grain in the ship's hold and carry it to the top of the leg, whence it is shot down a tube to a receptacle at the bottom of the tower. Another motor, one of 40 h.p., is then turned on to move another endless band of buckets, which lift the grain to the top of the tower inside. There is also a 25-h.p. motor installed for operating the trimming gear in the ship's hold. That gear consists of four large shovels, which draw the grain from the far depths of the hold to the place where the buckets in the elevator leg are working. Smoothness and rapidity are the essentials in the working of these buckets, and they travel at the rate of 500ft. per minute.

There is a fifth motor in operation in connection with the elevator. This is used for driving the broad rubber band conveyor which carries the grain from the elevator tower to the warehouse. The distance is over 600ft., and therefore the pull on a 1,200ft. endless band of rubber weighing (without any grain) nearly two tons is considerable. The motor in this case is the most powerful, and is of 60 h.p. The current is obtained from the Leith Docks authorities, and the elevator is lighted by both arc and incandescent light. For the smaller elevator, which has been erected at some distance from the ship elevator, and is to be used for discharging lighters, there are also five small motors installed.



New Grain Elevator at the Leith Docks.

In the warehouse, which is a great structure of brick with bins like a honeycomb for receiving the grain, there are no fewer than 16 motors—viz., four of 40 h.p, one of 15 h.p., and 11 small motors each working up to 5 h.p. The large ones are necessary for driving the elevators which lift the grain to the top of the bins in the warehouse. These run at 640 revolutions per minute, giving a speed of 600ft. per minute; while the smallest motors are for the conductor belts, and run at 960 revolutions per minute. A motor works a swing lift capable of carrying 10cwt.

There are thus no fewer than 26 electric motors in position in connection with this new system of discharging grain at Leith. From first to last the grain is handled by motor power, and in the warehouse it travels along the whole length of the building, top or bottom, and can be sacked at the rate of 4,000 sacks per hour. The feature of the electric power installation is the skilful manner in which the space has been utilised and the wonderful ease in working. Messrs. Spencer and Co., Limited, of Melksham, fitted up the elevators; and Messrs. James Milne and Son, Limited, Edinburgh, supplied all the machinery in the warehouse.

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THE BRITISH ASSOCIATION.

Address to the Mathematical and Physical Section.

BY PROF. HORACE LAMB, LL D, D SC, F.R S, PRESIDENT OF THE SECTION.

The losses sustained by mathematical science in the past twelvemonth have perhaps not been so numerous as in some years, but they include at least one name of world-wide import. Those of us who were students of mathematics 30 or 40 years ago will recall the delight which we felt in reading the geometrical treatises of George Salmon, and the brilliant contrast which they exhibited with most of the current text-books of that time. It was from him that many of us first learned that a great mathematical theory does not consist of a series of detached propositions carefully labelled and arranged like specimens on the shelves of a museum, but that it forms an organic whole, instinct with life, and with unlimited possibilities of future development. As systematic expositions of the actual state of the science, in which enthusiasm for what is new is tempered by a due respect for what is old, and in which new and old are brought into harmonious relation with each other, these treatises stand almost unrivalled. Whether in the originals, or in the guise of translations, they are accounted as classics in every university of the world. So far as British universities are concerned, they have formed the starting point of a whole series of works conceived in a similar spirit, though naturally not always crowned by the same success. The necessity for this kind of work grows, indeed, continually; the modern fragmentary fashion of original publication and the numerous channels through which it takes place make it difficult for anyone to become initiated into a new scientific theory unless he takes it up at the very beginning and follows it diligently throughout its course, backwards and forwards, over rough ground and smooth. The classical style of memoir, after the manner of Lagrange, or Poisson, or Gauss, complete in itself and deliberately composed like a work of art, is continually becoming rarer. It is, therefore, more and more essential that from time someone should come forward to sort out and arrange the accumulated material, rejecting what has proved unimportant, and welding the rest into a connected system. There is perhaps a tendency to assume that such work is of secondary importance, and can be safely left to subordinate hands. But in reality it makes severe demands on even the highest powers; and when these have been available the result has often done more for the progress of science than the composition of a dozen monographs on isolated points. For proof one need only point to the treatises of Salmon himself, or recall (in another field) the debt which we owe to such books as the "Treatise on Natural Philosophy" and the "Theory of Sound," whose authors are happily with us.

A modest but most valuable worker has passed away in the person of Prof. Allman. His treatise on the history of Greek geometry, full of learning and sound mathematical perception, is written with great simplicity and an entire absence of pedantry or dogmatism. It ranks, I believe, with the best that has been done in the subject. It is to be regretted that, as an historian, he leaves so few successors among British mathematicians. We have amongst us, as a result of our system of university education, many men of trained mathematical faculty and of a scholarly turn of mind, with much of the necessary linguistic equipment, who feel, however, no special vocation for the details of recent mathematical research. Might not some of this ability be turned to a field, by no means exhausted, where the severity of mathematical truth is tempered by the human interest attaching to the lives, the vicissitudes, and even the passions and the strife of its devotees, who through many errors and perplexities have contrived to keep alive and trim the sacred flame, and to hand it on burning ever clearer and brighter?

Of the various subjects which fall within the scope of this section there is no difficulty in naming that which at the present time excites the widest interest. The phenomena of radioactivity, ionisation of gases, and so on, are not only startling and sensational in themselves, they have suggested most wonderful and far-reaching speculations, and, whatever be the future of these particular theories, they are bound in any case deeply to influence our views on fundamental points of chemistry and physics. No reference to this subject would, I think, be satisfactory without a word of homage to the unsurpassed patience and skill in the devising of new experimental methods to meet new and subtle conditions which it has evoked. It will be felt as a matter of legitimate pride by many present that the University of Cambridge has been so conspicuously associated with this work. It would, therefore, have been natural and appropriate that this chair should have been occupied, this year above others, by one who could have given us a survey of the facts as they at present stand, and of their bearing, so far as can be discerned, on other and older branches of physics. Whether from the experimental or from the more theoretical and philosophical standpoint, there would have been no difficulty in finding exponents of unrivalled authority. But it has been otherwise ordered, and you and I must make the best of it. If the subject cannot be further dealt with for the moment, we have the satisfaction of knowing that it will, in due course, engage the attention of the section, and that we may look forward to interesting and stimulating discussions, in which we trust the many distinguished foreign physicists who honour us by their presence will take an active part.

It is, I believe, not an unknown thing for your president to look up the records of previous meetings in search of inspiration, and possibly of an example. I have myself not had to look very far, for I found that when the British Association last met in Cambridge, in the year 1862, this section was presided over by Stokes, and, moreover, that the address which he gave was probably the shortest ever made on such an occasion, for it occupies only half a page of the report, and took, I should say, some three or four minutes to deliver. It would be to the advantage of the business of the meeting, and to my own great relief, if I had the courage to follow so attractive a precedent; but I fear that the tradition which has since established itself is too strong for me to break without presumption. I will turn, therefore, in the first instance, to a theme which, I think, naturally presents itself—viz., a consideration of the place occupied by Stokes in the development of mathematical physics. It is not proposed to attempt an examination or appreciation of his own individual achievements; this has lately been done by more than one hand, and in the most authoritative manner. But it is part of the greatness of the man that his work can be reviewed from more than one standpoint. What I specially wish to direct attention to on this occasion is the historical or evolutionary relation in which he stands to predecessors and followers in the above field.

The early years of Stokes's life were the closing years of a mighty generation of mathematicians and mathematical physicists. When he came to manhood, Lagrange, Laplace, Poisson, Fourier, Fresnel, Ampère, had but recently passed away. Cauchy alone of this race of giants was still alive and productive. It is upon these men that we must look as the immediate intellectual ancestors of Stokes, for, although Gauss and F. Neumann were alive and flourishing, the interaction of German and English science was at that time not very great. It is noteworthy, however, that the development of the modern German school of mathematical physics, represented by Helmholtz and Kirchhoff in linear succession to Neumann, ran in many respects closely parallel to the work of Stokes and his followers.

When the foundations of analytical dynamics had been laid by Euler and d'Alembert, the first important application was naturally to the problems of gravitational astronomy. This formed, of course, the chief work of Laplace, Lagrange, and others. Afterwards came the theoretical study of elasticity, conduction of heat, statical electricity, and magnetism. The investigations in elasticity were undertaken mainly in relation to physical optics, with the hope of finding a material medium capable of conveying transverse vibrations, and of accounting also for the various phenomena of reflection, refraction, and double refraction. It has often been pointed out, as characteristic of the French school referred to, that their physical speculations were largely influenced by ideas transferred from astronomy—as, for

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instance, in the conception of a solid body as made up of discrete particles acting on one another at a distance with forces in the lines joining them, which formed the basis of most of their work on elasticity and optics. The difficulty of carrying out these ideas in a logical manner were enormous, and the strict course of mathematical deduction had to be replaced by more or less precarious assumptions. The detailed study of the geometry of a continuous deformable medium which was instituted by Cauchy, was a first step towards liberating the theory from arbitrary and unnecessary hypothesis; but it was reserved for Green, the immediate predecessor of Stokes among English mathematicians, to carry out this process completely and independently, with the help of Lagrange's general dynamical methods, which here found their first application to questions of physics outside the ordinary dynamics of rigid bodies and fluids. The modern school of English physicists, since the time of Green and Stokes, have consistently endeavoured to make out, in any given class of phenomena, how much can be recognised as a manifestation of general dynamical principles, independent of the particular mechanism which may be at work. One of the most striking examples of this was the identification by Maxwell of the laws of electromagnetism with the dynamical equations of Lagrange. It would, however, be going too far to claim this tendency as the exclusive characteristic of English physicists. For example, the elastic investigations of Green and Stokes have their parallel in the independent though later work of Kirchhoff; and the beautiful theory of dynamical systems with latent motion which we owe to Lord Kelvin stands in a very similar relation to the work of Helmholtz and Hertz.

But perhaps the most important and characteristic feature in the mathematical work of the later school is its increasing relation to and association with experiment. In the days when the chief applications of mathematics were to the problems of gravitational astronomy, the mathematician might well take his materials at second hand; and in some respects the division of labour was, and still may be, of advantage. The same thing holds in a measure of the problems of ordinary dynamics, where some practical knowledge of the subject-matter is within the reach of everyone. But when we pass to the more recondite phenomena of physical optics, acoustics, and electricity, it hardly needs the demonstrations which have involuntarily been given to show that the theoretical treatment must tend to degenerate into the pursuit of mere academic subtleties unless it is constantly vivified by direct contact with reality. Stokes, at all events, with little guidance or encouragement from his immediate environment, made himself from the first practically acquainted with the subjects he treated. Generations of Cambridge students recall the enthusiasm which characterised his experimental demonstrations in optics. These appealed to us all, but some of us, I am afraid, under the influence of the academic ideas of the time, thought it a little unnecessary to show practically that the height of the lecture-room could be measured by the barometer, or to verify the calculated period of oscillation of water in a tank by actually timing the waves with the help of the image of a candle-flame reflected at the surface.

The practical character of the mathematical work of Stokes and his followers is shown especially in the constant effort to reduce the solution of a physical problem to a quantitative form. A conspicuous instance is furnished by the labour and skill which he devoted from this point of view to the theory of the Bessel's function, which presents itself so frequently in important questions of optics, electricity, and acoustics, but is so refractory to ordinary methods of treatment. It is now generally accepted that an analytical solution of a physical question, however elegant it may be made to appear by means of a judicious notation, is not complete so long as the results are given merely in terms of functions defined by infinite series or definite integrals, and cannot be exhibited in a numerical or graphical form. This view did not originate, of course, with Stokes; it is clearly indicated, for instance, in the works of Fourier and Poinsot, but no previous writer had, I think, acted upon it so consistently and thoroughly.

We have had so many striking examples of the fruitfulness of the combination of great mathematical and experimental powers that the question may well be raised, whether there is any longer a reason for maintaining in our minds a distinction between mathematical and experimental physics, or at all events whether these should be looked upon as separate provinces which may conveniently be assigned to different sets of labourers. It may be held that the highest physical research will demand in the future the possession of both kinds of faculty. We must be careful, however, how we erect barriers which would exclude a Lagrange on the one side or a Faraday on the other. There are many mansions in the palace of physical science, and work for various types of mind. A zealous, or over-zealous, mathematician might indeed make out something of a case if he were to contend that, after all, the greatest work of such men as Stokes, Kirchhoff, and Maxwell was mathematical rather than experimental in its complexion. An argument which asks us to leave out of account such things as the investigation of fluorescence, the discovery of spectrum analysis, and the measurement of the viscosity of gases, may seem audacious; but a survey of the collected works of these writers will show how much, of the very highest quality and import would remain. However this may be, the essential point, which cannot, I think, be contested, is this, that if these men had been condemned and restricted to a mere book knowledge of the subjects which they have treated with such marvellous analytical ability, the very soul of their work would have been taken away. I have ventured to dwell upon this point because, although I am myself disposed to plead for the continued recognition of mathematical physics as a fairly separate field, I feel strongly that the traditional kind of education given to our professed mathematical students does not tend to its most effectual cultivation. This education is apt to be one-sided, and too much divorced from the study of tangible things. Even the student whose tastes lie mainly in the direction of pure mathematics would profit, I think, by a wider scientific training. A long list of instances might be given to show that the most fruitful ideas in pure mathematics have been suggested by the study of physical problems. In the words of Fourier, who did so much to fulfil his own saying, "L'étude approfondie de la nature est la source la plus féconde des découvertes mathématiques. Non-seulement cette étude, en offrant aux recherches un but déterminé, a l'avantage d'exclure les questions vagues et les calculs sans issue; elle est encore un moyen assuré de former l'analyse elle-même, et d'en découvrir les éléments qu'il nous importe le plus de connaître, et que cette science doit toujours conserver: ces éléments fondamentaux sont ceux qui se reproduisent dans tous les effets naturels."

Another characteristic of the applied mathematics of the past century is that it was, on the whole, the age of linear equations. The analytical armoury fashioned by Lagrange, Poisson, Fourier, and others, though subject, of course, to continual improvement and development, has served the turn of a long line of successors. The predominance of linear equations, in most of the physical subjects referred to, rests on the fact that the changes are treated as infinitely small. The electric theory of light forms at present an exception, but even here the linear character of the fundamental electrical relations is itself remarkable, and possibly significant. The theory of small oscillations, in particular, runs as a thread through a great part of the literature of the period in question. It has suggested many important analytical results, and it still gives the best and simplest intuitive foundation for a whole class of theorems which are otherwise hard to comprehend in their various relations, such as Fourier's theorem, Laplace's expansion, Bessel's functions, and the like. Moreover, the interest of the subject, whether mathematical or physical, is not yet exhausted; many important problems in optics and acoustics, for example, still await solution. The general theory has, in comparatively recent times, received an unexpected extension (to the case of "latent motions") at the hands of Lord Kelvin; and Lord Rayleigh, by his continual additions to it, shows that, in his view, it is still incomplete.

When the restriction to infinitely small motions is abandoned, the problems become, of course, much more arduous

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The whole theory, for instance, of the normal modes of vibration which is so important in acoustics, and even in music disappears. The researches hitherto made in this direction have, moreover, encountered difficulties of a less patent character. It is conceivable that the modern analytical methods which have been developed in astronomy may have an application to these questions. It would appear that there is an opening here for the mathematician; at all events, the numerical or graphical solution of any one of the various problems that could be suggested would be of the highest interest. One problem of the kind is already classical—the theory of steep water-waves discussed by Stokes; but even here the point of view has perhaps been rather artificially restricted. The question proposed by him, the determination of the possible form of waves of permanent type, like the problem of periodic orbits in astronomy, is very interesting mathematically, and forms a natural starting point for investigation; but it does not exhaust what is most important for us to know in the matter. Observation may suggest the existence of such waves as a fact; but no reason has been given, so far as I know, why free water-waves should tend to assume a form consistent with permanence, or be influenced in their progress by considerations of geometrical simplicity.

I have tried to indicate the kind of continuity of subject-matter, method, and spirit which runs through the work of the whole school of mathematical physicists, of which Stokes may be taken as the representative. It is no less interesting, I think, to examine the points of contrast with more recent tendencies. These relate not so much to subject-matter and method as to the general mental attitude towards the problems of Nature. Mathematical and physical science have become markedly introspective. The investigators of the classical school, as it may perhaps be styled, were animated by a simple and vigorous faith; they sought as a matter of course for a mechanical explanation of phenomena, and had no misgivings as to the trustiness of the analytical weapons which they wielded. But now the physicist and the mathematician alike are in trouble about their souls. We have discussions on the principles of mechanics, on the foundations of geometry, on the logic of the most rudimentary arithmetical processes, as well as of the more artificial operations of the calculus. These discussions are legitimate and inevitable, and have led to some results which are now widely accepted. Although they were carried on to a great extent independently, the questions involved will, I think, be found to be ultimately very closely connected. Their common nexus is, perhaps, to be traced in the physiological ideas of which Helmholtz was the most conspicuous exponent. To many minds such discussions are repellent, in that they seem to venture on the uncertain ground of philosophy. But, as a matter of fact, the current views on these subjects have been arrived at by men who have gone to work in their own way, often in entire ignorance of what philosophers have thought on such subjects. It may be maintained chiefly, indeed, that the mathematician or the physicist, as such, has no special concern with philosophy, any more than the engineer or the geographer. Nor, although this is a matter for their own judgment, would it appear that philosophers have very much to gain by a special study of the methods of mathematical or physical reasoning, since the problems with which they are concerned are presented to them in a much less artificial form in the circumstances of ordinary life. As regards the present topic I would put the matter in this way: that between mathematics and physics on the one hand and philosophy on the other there lies an undefined borderland, and that the mathematician has been engaged in setting things in order, as he is entitled to do, on his own side of the boundary.

Adopting this point of view, it would be of interest to trace in detail the relationships of the three currents of speculation which have been referred to. At one time, indeed, I was tempted to take this as the subject of my address; but, although I still think the enterprise a possible one, I have been forced to recognise that it demands a better equipment than I can pretend to. I can only venture to put before you some of my tangled thoughts on the matter, trusting that some future occupant of this chair may be induced to take up the question and treat it in a more illuminating manner.

If we look back for a moment to the views currently entertained not so very long ago by mathematicians and physicists, we shall find, I think, that the prevalent conception of the world was that it was constructed on some sort of absolute geometrical plan, and that the changes in it proceeded according to precise laws; that, although the principles of mechanics might be imperfectly stated in our text-books, at all events such principles existed, and were ascertainable, and, when properly formulated, would possess the definiteness and precision which were held to characterise, say, the postulates of Euclid. Some writers have maintained, indeed, that the principles in question were finally laid down by Newton, and have occasionally used language which suggests that any fuller understanding of them was a mere matter of interpretation of the text. But, as Hertz has remarked, most of the great writers on dynamics betray, involuntarily, a certain *malaise* when explaining the principles, and hurry over this part of their task as quickly as is consistent with dignity. They are not really at their ease until, having established their equations somehow, they can proceed to build securely on these. This has led some people to the view that the laws of Nature are merely a system of differential equations. It may be remarked in passing that this is very much the position in which we actually stand in some of the more recent theories of electricity. As regards dynamics, when once the critical movement had set in, it was easy to show that one presentation after another was logically defective and confused, and no satisfactory standpoint was reached until it was recognised that in the classical dynamics we do not deal immediately with real bodies at all, but with certain conventional and highly idealised representations of them, which we combine according to arbitrary rules, in the hope that if these rules be judiciously framed the varying combinations will image to us what is of most interest in some of the simpler and more important phenomena. The changed point of view is often associated with the publication of Kirchhoff's lectures on mechanics in 1876, where it is laid down in the opening sentence that the problem of mechanics is to describe the motions which occur in Nature completely and in the simplest manner. This statement must not be taken too literally; at all events, a fuller, and I think a clearer, account of the province and the method of abstract dynamics is given in a review of the second edition of Thomson and Tait, which was one of the last things penned by Maxwell, in 1879. A "complete" description of even the simplest natural phenomenon is an obvious impossibility; and, were it possible, it would be uninteresting as well as useless, for it would take an incalculable time to peruse. Some process of selection and idealisation is inevitable if we are to gain any intelligent comprehension of events. Thus, in astronomy we replace a planet by a so-called material particle — *i.e.*, a mathematical point associated with a suitable numerical coefficient. All the properties of the body are here ignored except those of position and mass, in which alone we are at the moment interested. The whole course of physical sciences and the language in which its results are expressed have been largely determined by the fact that the ideal images of geometry were already at hand at its service. The ideal representations have the advantage that, unlike the real objects, definite and accurate statements can be made about them. Thus two lines in a geometrical figure can be pronounced to be equal or unequal, and the statement is in either case absolute. It is no doubt hard to divest oneself entirely of the notion conveyed in the Greek phrase, ἀεὶ ὁ θεὸς γεωμετρεῖ, that definite geometrical magnitudes and relations are at the back of phenomena. It is recognised, indeed, that all our measurements are necessarily to some degree uncertain, but this is usually attributed to our own limitations and those of our instruments rather than to the ultimate vagueness of the entity which it is sought to measure. Everyone will grant, however, that the distance between two clouds, for instance, is not a definable magnitude; and the distance of the earth from the sun, and even the length of a wave of light, are in precisely the same case. The notion in question is a convenient fiction, and

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is a striking testimony to the ascendancy which Greek mathematics have gained over our minds, but I do not think that more can be said for it. It is, at any rate, not verified by the experience of those who actually undertake physical measurements. The more refined the means employed, the more vague and elusive does the supposed magnitude become; the judgment flickers and wavers, until at last in a sort of despair *some* result is put down, not in the belief that it is exact, but with the feeling that it is the best we can make of the matter. A practical measurement is, in fact, a classification; we assign a magnitude to a certain category, which may be narrowly limited, but which has in any case a certain breadth.

By a frank process of idealisation a logical system of abstract dynamics can doubtless be built up, on the lines sketched by Maxwell in the passage referred to. Such difficulties as remain are handed over to geometry. But we cannot stop in this position; we are constrained to examine the nature and the origin of the conceptions of geometry itself. By many of us, I imagine, the first suggestion that these conceptions are to be traced to an empirical source was received with something of indignation and scorn; it was an outrage on the science which we had been led to look upon as divine. Most of us have, however, been forced at length to acquiesce in the view that geometry, like mechanics, is an applied science; that it gives us merely an ingenious and convenient symbolic representation of the relations of actual bodies; and that, whatever may be the *a priori* forms of intuition, the science as we have it could never have been developed except for the accident (if I may so term it) that we live in a world in which rigid or approximately rigid bodies are conspicuous objects. On this view the most refined geometrical demonstration can be resolved into a series of imagined experiments performed with such bodies, or rather with their conventional representations.

It is to be lamented that one of the most interesting chapters in the history of science is a blank: I mean that which would have unfolded the rise and growth of our system of ideal geometry. The finished edifice is before us, but the record of the efforts by which the various stones were fitted into their places is hopelessly lost. The few fragments of professed history which we possess were edited long after the achievement.

It is commonly reckoned that the first rude beginnings of geometry date from the Egyptians. I am inclined to think that in one sense the matter is to be placed much further back, and that the dawn of geometric ideas is to be traced among the prehistoric races who carved rough but thoroughly artistic outlines of animals on their weapons. I do not know whether the matter has attracted serious speculation, but I have myself been led to wonder how men first arrived at the notion of an outline drawing. The primitive sketches referred to immediately convey to the experienced mind the idea of a reindeer or the like; but in reality the representation is purely conventional, and is expressed in a language which has to be learned. For nothing could be more unlike the actual reindeer than the few scratches drawn on the surface of a bone: and it is, of course, familiar to ourselves that it is only after a time, and by an insensible process of education, that very young children come to understand the meaning of an outline. Whoever he was, the man who first projected the world into two dimensions, and proceeded to fence off that part of it which was reindeer from that which was not, was certainly under the influence of a geometrical idea, and had his feet in the path which was to culminate in the refined idealisations of the Greeks. As to the manner in which these latter were developed, the only indication of tradition is that some propositions were arrived at first in a more empirical or intuitional, and afterwards in a more intellectual way. So long as points had size, lines had breadth, and surfaces thickness, there could be no question of exact relations between the various elements of a figure, any more than is the case with the realities which they represent. But the Greek mind loved definiteness, and discovered that if we agree to speak of lines *as if* they had no breadth, and so on, exact statements became possible. If any one scientific invention can claim pre-eminence over all others, I should be inclined myself to erect a monument to the inventor of the mathematical point, as the supreme type of that process of abstraction which has been a necessary condition of scientific work from the very beginning.

It is possible, however, to uphold the importance of the part which abstract geometry has played, and must still play, in the evolution of scientific conceptions, without committing ourselves to a defence, on all points, of the traditional presentment. The consistency and completeness of the usual system of definitions, axioms, and postulates has often been questioned, and quite recently a more thorough-going analysis of the logical elements of the subject than has ever before been attempted has been made by Hilbert. The matter is a subtle one, and a general agreement on such points is as yet hardly possible. The basis for such an agreement may perhaps ultimately be found in a more explicit recognition of the empirical source of the fundamental conceptions. This would tend, at all events, to mitigate the rigour of the demands which are sometimes made for logical perfection.

Even more important in some respects are the questions which have arisen in connection with the application of geometry to purposes of graphical representation. It is not necessary to dwell on the great assistance which this method has rendered in such subjects as physics and engineering. The pure mathematician, for his part, will freely testify to the influence which it has exercised in the development of most branches of analysis—for example, we owe to it all the leading ideas of the calculus. Modern analysts have discovered, however, that geometry may be a snare as well as a guide. In the mere act of drawing a curve to represent an analytical function, we make unconsciously a host of assumptions which are difficult not merely to prove, but even to formulate precisely. It is now sought to establish the whole fabric of mathematical analysis on a strictly arithmetical basis. To those who were trained in an earlier school, the results so far are in appearance somewhat forbidding. If the shade of one of the great analysts of a century ago could revisit the glimpses of the moon, his feelings would, I think, be akin to those of the traveller to some mediæval town, who finds the buildings he came to see obscured by scaffolding, and is told that the ancient monuments are all in process of repair. It is to be hoped that a good deal of this obstruction is only temporary, that most of the scaffolding will eventually be cleared away, and that the edifices when they reappear will not be entirely transformed, but will still retain something of their historic outlines. It would be contrary to the spirit of this address to undertake in any way the critical examination and revision of principles; we must acknowledge that it tends ultimately to simplification, to the clearing up of issues, and the reconciliation of apparent contradictions. But it would be a misfortune if this process were to absorb too large a share of the attention of mathematicians, or were allowed to set too high a standard of logical completeness. In this particular matter of the "arithmetisation of mathematics" there is, I think, a danger in these respects. As regards the latter point, a traveller who refuses to pass over a bridge until he has personally tested the soundness of every part of it is not likely to go very far; something must be risked, even in mathematics. It is notorious that even in this realm of "exact" thought discovery has often been in advance of strict logic, as in the theory of imaginaries, for example, and in the whole province of analysis of which Fourier's theorem is the type. And it might even be claimed that the services which geometry has rendered to other sciences have been almost as great in virtue of the questions which it implicitly begs as of those which it resolves.

I would venture, with some trepidation, to go one step further. Mathematicians love to build on as definite a foundation as possible, and from this point of view the notion of the integral number, on which (we are told) the mathematics of the future are to be based, is very attractive. But as an instrument for the study of Nature, is it really more fundamental than the geometrical notions which it is to supersede? The accounts of primitive peoples would seem to show that, in the generality which is a

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necessary condition for this purpose, it is in no less degree artificial and acquired. Moreover, does not the act of enumeration, as supplied to actual things, involve the very same process of selection and idealisation which we have already met with in other cases? As an illustration, suppose we were to try to count the number of drops of water in a cloud.*

I am not thinking of the mere practical difficulties of enumeration, or even of the more pertinent fact that it is hard to say where the cloud begins or ends. Waiving these points, it is obvious that there must be transitional stages between a more or less dense group of molecules and a drop, and in the case of some of these aggregates it would only be by an arbitrary exercise of judgment that they would be assigned to one category rather than to the other. In whatever form we meet with it the very notion of counting involves the highly artificial conception of a number of objects which for some purposes are treated as absolutely alike, whilst yet they can be distinguished.

The net result of the preceding survey is that the systems of geometry, of mechanics, and even of arithmetic, on which we base our study of Nature, are all contrivances of the same general kind: they consist of series of abstractions and conventions devised to represent, or rather to symbolise, what is most interesting and most accessible to us in the world of phenomena And the progress of science consists, in a great measure, in the improvement, the development, and the simplification of these artificial conceptions, so that their scope may be wider and the representation more complete. The best in this kind are but shadows, but we may continually do something to amend them.

As compared with the older view, the function of physical science is seen to be much more modest than was at one time supposed. We no longer hope by levers and screws to pluck out the heart of the mystery of the universe. But there are compensations. The conception of the physical world as a mechanism, constructed on a rigid mathematical plan, whose most intimate details might possibly some day be guessed, was, I think, somewhat depressing. We have been led to recognise that the formal and mathematical element is of our own introduction; that it is merely the apparatus by which we map out our knowledge, and has no more objective reality than the circles of latitude and longitude on the sun. A distinguished writer not very long ago speculated on the possibility of the scientific mine being worked out within no distant period. Recent discoveries seem to have put back this possibility indefinitely; and the tendency of modern speculation as to the nature of scientific knowledge should be to banish it altogether. The world remains a more wonderful place than ever; we may be sure that it abounds in riches not yet dreamed of; and although we cannot hope ever to explore its innermost recesses, we may be confident that it will supply tasks in abundance for the scientific mind for ages to come.

One significant result of the modern tendency is that we no longer with the same obstinacy demand a mechanical explanation of the phenomena of light and electricity, especially since it has been made clear that if one mechanical explanation is possible there will be an infinity of others Some minds, indeed, revelling in their new-found freedom, have attempted to disestablish ordinary or "vulgar" matter altogether. I may refer to a certain treatise, which by some accident does not bear its proper title of "Ether and *no* Matter," and to the elaborate investigations of Prof. Osborne Reynolds, which present the same peculiarity, although the basis is different. Speculations of this nature have, however, been so recently and (if I may say it) so brilliantly dealt with by Prof. Poynting before this section that there is little excuse for dwelling further on them now. I will only advert to the question whether, as some suggest, physical science should definitely abandon the attempt to construct mechanical theories in the older sense. The question would appear to be very similar to this, whether we should abandon the use of graphical methods in analysis. In either case we run the risk of introducing extraneous elements, possibly of a misleading character; but the gain in vividness of perception and in suggestiveness is so great that we are not likely altogether to forego it, by excess of prudence, in one case more than in the other.

We have travelled some distance from Stokes and the mathematical physics of half a century ago. May I add a few observations which might perhaps have claimed his sympathy? They are in substance anything but new, although I do not find them easy to express. We have most of us frankly adopted the empirical attitude in physical science; it has justified itself abundantly in the past, and has more and more forced itself upon us. We have given up the notion of causation, except as a convenient phrase; what were once called laws of Nature are now simply rules by which we can tell more or less accurately what will be the consequence of a given state of things. We cannot help asking, How is it that such rules are possible? A rule is invented in the first instance to sum up in a compact form a number of past experiences, but we apply it, with little hesitation, and generally with success, to the prediction of new and sometimes strange ones. Thus the law of gravitation indicates the existence of Neptune, and Fresnel's wave-surface gives us the quite unsuspected phenomenon of double refraction. Why does Nature make a point of honouring our cheques in this manner; or, to put the matter in a more dignified form, how comes it that, in the words of Schiller,*

> "Mit dem Genius steht die Natur im ewigen Bunde,
> Was der eine verspricht, leistet die andre gewiss"?

The question is as old as science, and the modern tendencies with which we have been occupied have only added point to it. It is plain that physical science has no answer; its policy, indeed, has been to retreat from a territory which it could not securely occupy. We are told in some quarters that it is vain to look for an answer anywhere. But the mind of man is not wholly given over to physical science, and will not be content for ever to leave the question alone. It will persist in its obstinate questionings, and however hopeless the attempt to unravel the mystery may be deemed, physical science, powerless to assist, has no right to condemn it.

I would like, in conclusion, to read to you a characteristic passage from that address of Stokes in 1862 which has formed the starting point of this discourse:

"In this section, more perhaps than in any other, we have frequently to deal with subjects of a very abstract character, which in many cases can be mastered only by patient study, at leisure, of what has been written. The question may not unnaturally be asked, If investigations of this kind can best be followed by quiet study in one's own room, what is the use of bringing them forward in a sectional meeting at all? I believe that good may be done by public mention, in a meeting like the present, of even somewhat abstract investigations; but whether good is thus done, or the audience merely wearied to no purpose, depends upon the judiciousness of the person by whom the investigation is brought forward."

It might be urged that these remarks are as pertinent now as they were 40 years ago, but I will leave them on their own weighty authority. I will not myself attempt to emphasise them, lest some of my hearers should be tempted to retort that the warning might well be borne in mind not only in the ordinary proceedings of the section, but in the composition of a presidential address!

The Electrolytic Production of Water-Jackets on Automobile Engines.—*L'Industrie Electrique* describes a novel method employed by Messrs. Napier for keeping down the over-all dimensions and the weights of their engines to a minimum. The water-jackets of these engines are made of thin copper deposited in position electrolytically. The outside of the cylinder is given a coating usually of a mixture of wax and plumbago of just the thickness of the space required for the water to circulate in. Those parts of the cylinder to which the water-jacket is to adhere are left bare, and the whole cylinder is then put into the electrolytic bath, and a uniform coating of the required thickness is deposited. The whole is then heated to melt out the wax, and the operation is complete. The same method should prove serviceable in many other cases.

* Applied by Herschel to the discovery of Neptune.

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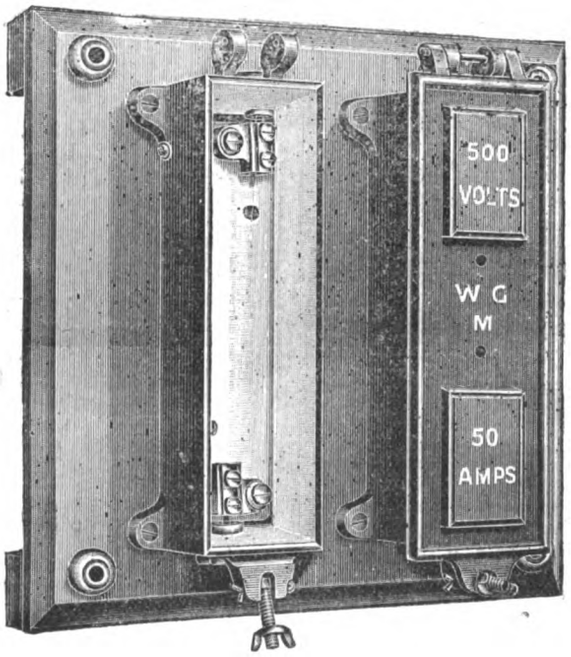
TRADE NOTICES AND NOVELTIES.

G.E.C. Specialities.

The progress sheet issued by the General Electric Company, Limited, 71, Queen Victoria-street, E.C., for August illustrates a new type of "Stanley" measuring instrument, known as the "Aperiodic," which has been designed to suit the requirements where absolutely dead-beat instruments are a necessity. It is claimed that on fluctuating loads readings may be made with this instrument with the strictest accuracy. All ammeters and voltmeters of the new type are ruby jewelled and calibrated throughout their range by direct comparison with standards. We also note that another addition has been made to the firm's extensive list of "Freezor" fans. This is a portable fan, which is being supplied in two sizes—viz., 12in. and 16in., with a current consumption of 55 and 110 watts respectively. A form of "Quadrant" tumbler switch is illustrated with a detachable key or lever, and an announcement appears that the company are now making oval tube "Union" conduit, in three sizes, both close joint and brazed, prices being given.

"Vitro" Fuse Boxes.

We illustrate herewith a new type of fuse box, known as the "Vitro," which is being introduced by Messrs. Ward and Goldstone, Dutton-street, Strangeways, Manchester. "Vitro" fuse boxes are enamelled inside with vitreous glass enamel, applied to the iron at an intense heat, and which covers the iron with a surface similar to white porcelain, and of equal insulating properties to that of china. It is claimed that this lining stands heat and compression much better than asbestos, which latter is unsatisfactory owing to its retention of damp and a tendency to buckle, also that the insulating properties of asbestos are very poor compared with vitreous enamelling.



With reference to these claims, it is stated that the enamelling will withstand the heat and compression which occurs on a dead short-circuit of heavy current on high voltages.

Miniature Arc Lamps.

The Union Electric Company, Limited, 151, Queen Victoria-street, E.C., are issuing a new list of their miniature arc lamps to the trade. Attention is called to a few more important features of these lamps. They embody all the well-known good qualities of the firm's larger arc lamps, the mechanism alone being carried out on a smaller scale. The working parts, all of which are interchangeable, are surrounded by a durable bronze metal protecting cover, which maintains its handsome appearance even in the most trying atmospheres for a long period. It is claimed that these lamps are unique in their long-burning qualities, 22 hours of burning being obtained with satisfactory and economical working while using small-size carbons. Special finishes have been designed to adapt the lamps for many classes of interior and exterior illumination.

Car-Lighting Resistances.

The A.E.G. English Manufacturing Company, Limited, 4, New Compton-street, Charing Cross-road, W.C., have sent us some particulars of their car-lighting resistances. In these resistances use is made of the high temperature coefficient of iron, which makes it possible to keep the current constant within a certain range of voltages. They are made for four currents: 0·4, 0·8, 1, and 1·2 amperes. The following example will explain their working. Several trains on the Prussian State railways are equipped with the system. A battery of 30 cells is charged from a dynamo on the locomotive. No accumulator switches are employed, the regulating of the pressure being done by the car-lighting resistances only, of which there is one to every incandescent lamp. The highest pressure obtained is $30 \times 2{\cdot}5 = 75$ volts; the lowest $30 \times 1{\cdot}85 = 55$ volts. The resistances, therefore, have to regulate between 55 and $75 - i.e.$, 20 volts. They, however, do not regulate from 0 to 20 volts, but from 10 to 30 volts, or generally, if the difference of pressure (in the above case 20 volts) is called x, from $\frac{x}{2}$ to $\frac{3x}{2}$. In the above-mentioned case 45-volt lamps have to be used, so that at the lowest $(45+10=55$ volts) as well as at the highest pressure $(45+30=75$ volts), the resistance remains inside its range of regulating capacity. The variation of current these car-lighting resistances are subject to does not exceed 4 per cent. either way—*i.e.*, a 1-ampere 20-volt resistance will, at 10 volts, not take less than 0·96, and at 30 volts not more than 1·04 amperes. For tramways these resistances have also been used with great success. In a case like this, where the voltage varies from 450 to 550 volts, the resistances regulate from 50 to 150 volts. Four incandescent lamps of 100 volts were therefore used in series. The tramway resistances are made for 0·4 ampere only. The life of the car-lighting resistances is, under normal conditions, several thousand hours. They are constructed on similar principles to the firm's Nernst lamp resistances. To avoid mistakes, the different size resistances are supplied with different caps.

Show Card.

The Simplex Steel Conduit Company, Limited, Westinghouse-building, Norfolk-street, Strand, W.C., are issuing a flexible trade show card illustrating the majority of the fittings supplied by them, together with a sample of their tubing, giving an idea of the style and finish of the same. This card should prove of use to the firm's customers for reference purposes.

STOCKTON-ON-TEES ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account and general balance sheet for the year ended March 31, 1904, as issued by the Stockton-on-Tees electricity department.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,831	13	7
Distribution of electricity	202	9	8
Building repairs	24	10	6
Rent of site, rates, and taxes	378	15	8
Management expenses, salaries, etc.	643	13	6
Special charges—insurances	42	2	2
	3,123	5	1
Balance carried to net revenue account	2,309	3	2
	£5,432	8	3

Cr. Income.	£	s.	d.
Sale of current	4,487	14	11
Public lamps	806	13	4
Meter rents	113	5	3
Fittings accounts	17	11	6
Guarantees	7	3	3
	£5,432	8	3

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages—Public Works Loan Commissioners	24,813	4	4
Sundry mortgagees	24,280	0	0
Floating liabilities—Sundry creditors	1,353	15	4
Security for payment of electricity accounts	27	10	0
Mortgage debt extinguished	3,668	15	8
Sinking fund accumulations uninvested	1,321	14	4
	£55,464	19	8

Cr. Assets.	£	s.	d.
Capital expenditure on works, plant, etc.	49,843	1	6
Engineer—cash in hand	10	0	0
District fund—loss for year	968	10	11
Rentals account	1,796	16	8
Fittings account	34	11	1
Stock of stores in hand	411	1	11
Treasurer—cash in hand	2,400	17	7
	£55,464	19	8

APPOINTMENTS VACANT.

Demonstrator in Engineering, London County Council Paddington technical institute, Saltram-crescent, W. Salary, £150 per annum. Applications by Sept. 14. See advertisement.

Shift Engineer, Ipswich Corporation electric supply and tramways departments. Salary, £90 per annum. See advertisement.

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ST. HELENS ELECTRICITY ACCOUNTS.

The following are abstracts of the revenue account and general balance-sheet, with statement of electricity generated, sold, etc., presented by Mr. E. M. Hollingsworth, Corporation electrical engineer, for the year ended March 31, 1904. The capital account shows a total expenditure to date of £138,080.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	4,351	11	10
Distribution of electricity	1,367	3	9
Rents, rates, and taxes	364	13	5
Management expenses—salaries, etc.	1,542	16	6
Interest on loans, etc.	4,105	0	1
Sinking funds, repayment of loans, etc.	4,775	4	11
Superannuation fund	10	12	11
Subway charges	114	12	7
Special charges—insurances, etc.	51	9	5
Total expenditure	16,683	5	5
Balance—profit for the year	2,599	14	6
	£19,282	19	11

Cr. Income.	£	s.	d.
Sale of current, less discount and bad debts	15,957	7	11
Public lighting	196	3	1
Sale and repair of lamps	70	8	5
Motor account	201	15	4
Fitting account	172	17	11
Rents receivable (traction)	2,505	8	3
Hire purchase and free wiring	5	12	9
Other items, interest, etc.	52	14	3
Interest—technical education *re* purchase of plant	17	4	7
Interest, gas account, ditto	103	7	5
	£19,282	19	11

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	126,808	1	11
Sundry creditors	1,878	2	7
Balance at credit of net revenue account	3,176	6	9
Sinking fund account	5,577	13	9
Reserve fund account	85	0	10
Deposits (consumers)	589	4	5
Parr's Bank, Limited (overdraft)	11,921	7	6
Due to treasurer	1	16	7
Stock redemption fund	1,290	0	6
Premium on stock	354	4	5
Loans repaid from revenue account	6,705	13	7
Loans repaid from sinking fund	1,000	0	0
Stock redeemed	1,080	0	0
	£160,467	12	11

Cr. Assets.	£	s.	d.
Capital account—amount expended on works	138,080	13	6
Stores on hand	5,203	17	10
Sundry debtors for current supplied	5,412	6	4
Other debtors	4,124	5	7
Suspense account	46	15	5
Stock redemption fund	2,022	0	6
Sinking funds	5,577	13	9
	£160,467	12	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			2,397,237
Quantity sold	Public lamps	47,077	2,093,883
	By contract	1,387,279	
	Private consumers by meter.	659,527	
Quantity lost in batteries			148,254
Quantity used on works			95,628
Total quantity accounted for			2,337,765
Quantity not accounted for			59,472
Number of public lamps			35
Total maximum supply demanded (kilowatts)			916

NEW COMPANIES REGISTERED.

Elsworth Automobile Company, Limited.—Capital, £10,000. Objects: to acquire the business carried on by A. Elsworth at Dudley Hill and 28, Manningham-lane, both in Bradford; to adopt an agreement between A. Elsworth and G. E. Levie; and to carry on the business of manufacturers of and dealers in motorcars, motor cycles, and motor vehicles and lorries of all kinds.

Lien Registered.

Fleetwood and District Electric Light and Power Syndicate, Limited.—A charge, dated Aug. 16, 1904, to secure £500, and further advances up to £700 (created under authority of the High Court by W. Cash, the receiver appointed by the Court), has been registered. Property charged: all the company's undertaking and assets (in priority to trust deed dated Oct. 1, 1899, and certain subsequent debentures created or issued thereunder). Holder: W. C. Johnson, 32, Hyde Park-gardens, London.

LEGAL INTELLIGENCE.

CAR OBSTRUCTION.

Thos. Frederick Hazeldine appeared at Brighton Police Court on Tuesday on a charge of obstructing a Corporation tramcar in Dyke-road on August Bank Holiday.

Mr. Hugh Talbot (town clerk) appeared to prosecute, and Mr. J. Percival Hughes, barrister, instructed by Mr. H. E. Trangmar, represented the defendant.

The **Motorman** deposed that just as his car reached the stopping place opposite the Dyke-road Hotel the char-a-banc driven by the defendant started, and, crossing the line behind the car, got on the track in front and drove up Dyke-road. When witness restarted defendant was about 12 yards ahead of the tramcar, and witness accordingly sounded his gong. Defendant took no notice, however, although witness sounded the gong repeatedly, and continued on the track in front of the car until the end of the journey, delaying the car three minutes. There was no traffic to prevent the defendant pulling to the offside and letting the car pass.

Cross-examined by Mr. Hughes, witness denied that he was behind time. He could not say with certainty that the car would have cleared the char-a-banc if defendant had pulled to the near side. Unless defendant had gone to the offside he was not certain he could have cleared him at any point of the route.

The **Conductor**, in giving corroborative evidence, admitted that there was a good deal of traffic about.

Frederick Noel Hudson, assistant surveyor in the tramways department, produced a plan of the route, showing the trees on each side of the road, and gave evidence with the object of showing that there was room for defendant to have pulled to one side and let the car pass.

Defendant deposed that, except at certain points, the trees on the near side of the road would have stopped him pulling to the near side, and it was not possible without danger to pull to the off side, owing to the traffic. He made his horses travel faster so as not to delay the car, and when he came to a place where he could pull in to the near side, he stopped and did so; but the car also stepped and so witness drove on. He did not at any point wilfully obstruct the car. He had orders not to pull to the off side, as it was dangerous.

The **Driver** of the mail coach from London to Brighton said he had driven the char-a-banc in question up the Dyke-road, and found it was not safe to do anything but keep going, and that to pull to the off side would be dangerous, while the trees interfered with pulling to the near side.

Mr. Hughes, for the defence, contended that there was nothing wilful on the part of the defendant, who had a perfect right to use the road fairly and reasonably. An important principle was involved, which it might be necessary for even a higher court to consider—viz., as to whether a tramcar had the right to so monopolise the use of the road so that other vehicles, who had an equal, if not greater, certainly a prior use to the road, should get out of the way.

The Bench retired to consider the case, and, on returning, the **Chairman** said the conclusion they had arrived at was that there had been an obstruction, and that it was wilful. Defendant would be fined 10s. and costs, or 14 days in default.

The **Magistrates** refused to state a case, as they had decided on the facts adduced.

Mr. Hughes intimated his intention of appealing.

RECKLESS MOTORMAN.

At Aberdeen Police Court Robert Quirie was fined 20s. for driving an electric car carelessly and recklessly, whereby it collided with a brougham. Accused denied that he was driving recklessly, or exceeding the normal speed. He applied the electric brake, but it did not take the necessary effect, as the wheels skidded on the rails. Then he applied the hand brake. All this was done before the collision. The coachman had deliberately turned the horse when the car was coming, and if he had been a little smarter he would have got clear. As it was, the brougham was almost clear.

Corroborative evidence was given by the conductor and a passenger.

In summing up, the **Procurator-Fiscal** said the real fault was that the motorman did not apply the brake in time, thinking, probably, that the horse and brougham would get out of the way. If the gong had been sounded previously, there might have been no accident. The drivers of the tramway cars should be exceedingly careful for the sake of passengers and vehicular traffic.

COMPANIES' MEETINGS AND REPORTS.

YORKSHIRE ELECTRIC POWER.

The third ordinary half-yearly meeting was held at the Hotel Metropole, Leeds, on Tuesday. Mr. A. G. Lupton presided over a large attendance of shareholders. Particulars of the report were given in our last issue.

In moving the adoption of the report and balance-sheet, the **Chairman** said that since the last half-yearly meeting the directors had had a busy and somewhat anxious time. The administration expenses during the half-year had been swelled by law charges to the amount of over £900, and he regretted to say there was still a further amount which would appear in the next balance-sheet under the same heading. When the Company's Act was drafted, clauses were included for the protection of local authorities, so that the company could in no case without their consent go into the areas

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of those authorities who had obtained distributing powers to compete with them. All the rights and privileges which ought to belong to those local authorities were thus amply protected, but in spite of that in several cases during the last session of Parliament local authorities had promoted Bills asking to supply electricity outside their own areas, and to risk the money of their ratepayers by entering into competition with the company. It had been the duty of the directors to oppose those Bills, and so to protect the interests of the shareholders who had invested the large amount of the capital of the Company in laying down plant for that very supply, and he was glad to say that the committees of Parliament before whom the Bills were fought had upheld the action of the directors in the most decisive manner. The directors hoped that now that the Company was at work local authorities would support and make use of the Company rather than waste the money of both sides in payments to the legal profession for profitless fighting. A more satisfactory side of the half-year's work was the progress made with the central supply station at Thornhill, the building being now completed, whilst the plant was being pushed on and erected with all speed. He had every confidence that their promise of being ready to supply current this year would be carried out. He anticipated that when the cheap supply of electric power for small industries was thoroughly understood they would see a very considerable spread of population in all those industries throughout the areas of the local authorities, and one step would be taken to relieve the congestion of population in our big cities. The Company had already arranged the routes for some 12 miles of cables, and further lines were being considered. The Chairman added that payments on account of contracts had not come on quite so rapidly as anticipated, and there was no use in drawing money from the shareholders to lie in the bank. So far as he could foretell, the next call that would be required would fall due for payment early in November.

Mr. Callender seconded the motion, which was carried *nem. con.*

A vote of thanks to the chairman concluded the business.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The report for 1903 shows, after payment of interest due on loan account and other charges, a balance to credit of £1,946. From this is deducted the debit balance brought forward from the previous year of £324, leaving a net balance to the credit of profit and loss account of £1,621 to be carried forward. During the 12 months a net profit on the operation of the tramways was made of 512,195dol., from which was written off the sum of 179,469dol., being for amortisation of the horse account, and sundry incidental expenses in connection with construction outlay. The net profit for 1902 was 271,058dol. The above large amortisations, being of exceptional character, will not reappear in future accounts. The number of passengers carried was 52,427,359, an increase of 7,251,442. During 1903 the electric lighting department earned a net profit of 179,723dol., against 113,390dol. in 1902. This result, although showing an advance on the previous year, still falls far short of the expected development of the lighting business, which the directors hope yet to realise, the capacity of the plant being far in excess of the present consumption. As indicated in last year's report, the capital of the Company was increased by the creation of £100,000 additional 6 per cent. cumulative preference shares, ranking *pari passu* with the existing preference shares; £50,000 of the above shares have since been issued.

BURY, ROCHDALE, AND OLDHAM TRAMWAY.

The report of the Bury, Rochdale, and Oldham Tramway Company, Limited, for the half-year ended July 31 last, to be submitted at to-day's meeting at Manchester, shows a gross profit of £2,651. The directors recommend the addition of £1,307 to debenture interest fund, which, with the sum of £15 balance brought forward, enables the payment of £2. 11s. 8d. per cent. per annum, and leaves £13 to be carried forward, and the appropriation of £1,344 as dividend for the shareholders, which, with £35 balance brought forward, enables the payment of 6½ per cent. per annum, and leaves £14 to be carried forward. As regards the sale of the Company's undertaking, since the issue of the last report an arbitration of the whole of the Company's property has taken place, Mr. H. Graham Harris being the referee appointed by the Board of Trade. It will be remembered that he awarded the Company £159,075, exclusive of a sum of £3,600 for street improvements, which was still in dispute, but which the authorities have since agreed to pay. An arrangement was also come to with the Urban Council of Whitefield in regard to the short length of tramway in that district, the Council agreeing to pay the sum of £350, making a total of £163,025. The directors are unable to say whether the sale will be completed within three months from the publishing of the award, but if not, the purchase money will, after the expiration of that period, carry interest at the rate of 5 per cent. per annum, which interest will take the place of the £5,300 now receivable in lieu of profits on working.

PERSONAL.

Mr. R. H. Wilkinson, late general manager of the Oldham Corporation tramways, has been appointed manager of the Huddersfield tramways at a salary of £350 per annum.

The Portsmouth Electric Light Committee have recommended that the salary of Mr. W. S. Foale, the superintendent of the Corporation electric light station, be increased from £300 to £400 per annum.

Mr. F. A. Bond, chief assistant at the Ilford Urban District Council's electricity department, has been appointed by the Heston and Isleworth Council as their resident electrical engineer.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Swansea.—The Corporation invite tenders for two negative tramway boosters. Tenders by noon on Sept. 7. See advertisement.

Lemberg.—The Government Railways require tenders for accumulator battery at the central station at the railway station. Tenders by Sept. 4.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

The Hague (Holland).—The Council of the Hague require tenders for the supply of from 8,000 to 9,000 tons of steel rails, including appurtenances, for electric tramways. Tenders by Sept. 22.

Madrid.—Tenders are required by the Post and Telegraph Department for 70 tons of 4mm. galvanised iron wire, about £16 per ton, and 70 tons of 2mm. bronze wire, about £94 per ton, by Sept. 3.

Madrid.—Tenders are required by the Post and Telegraph Department for 9,000m. telegraph cable of 7 rubber-insulated wires, 2,000m. ditto of 28 paper-insulated wires, and 11,000m. cable of 7 steel wires by Sept. 6.

Belmez (Spain).—The Municipality require tenders for electric lighting of Belmez Pueblo Nuevo del Terrible, and Pennarroya for seven years by Sept. 17. Particulars from the Alcadia Constitutional, Belmez, Cordoba, Spain.

Aberdeen.—The Tramways Committee invite tenders for the supply and delivery of 20 top-deck car-covers. Drawings and specifications may be had from Mr. J. Alex. Bell, city electrical engineer, Aberdeen. Tenders by Sept. 27. See advertisement.

Wallasey.—The Urban District Council invite tenders for the supply and erection of high-tension switchgear (which must be of British manufacture) for a sub-station. Tenders to Mr. N. W. Cook, clerk and solicitor, Public Offices, Egremont, Cheshire, by Sept. 14.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Londonderry.—The Corporation invite tenders for the wiring, fittings, lamps, connections, etc., for the electric lighting of the Guildhall. Specifications and further particulars may be had on application to the Electrical Engineer, Strand-road, Londonderry. Tenders to Mr. F. H. Miller, town clerk, before mid-day on Sept. 6.

Edinburgh.—Tenders will be received for the supply of 600 tons (more or less) of cable ropes, for the Edinburgh and District Tramways Company, Limited. Specification may be obtained of Mr. John E. Pitcairn, general manager, 1, South Charlotte-street, Edinburgh, and tenders must be lodged with him in accordance with specification by Sept. 19.

Tschatschak (Servia).—The Electricity Company Owtschar und Kablar in this town require two turbines of 750 h.p. each, two generators for three-phase currents, and other plant for the erection of a hydro-electric central station, and equipment of lines of distribution within 40 miles, by Oct. 2. Specifications, etc., may be obtained from the Manager of the Company.

Swansea.—The Corporation invite tenders for the supply and delivery of two negative tramway boosters. General conditions, specification, and forms of tender can be obtained from the borough electrical engineer, Mr. C. A. L. Prusmann, Strand, Swansea, on payment of £1. 1s. Tenders to Mr. Jno. Thomas, town clerk, Town Hall, Swansea, by noon on Sept. 7.

Leeds.—The Guardians invite tenders for the wiring installation and subway and underground concentric mains for the electric lighting to the several proposed new hospital blocks and other extensive existing buildings at the workhouse, Beckett-street, Leeds. Send names to Messrs. Thomas Winn and Sons on or before Sept. 12 when specifications and full particulars will be forwarded. Each application must be accompanied by a deposit of £3. 3s.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

West Ham.—The Town Council invite tenders for the supply, delivery, and erection of all poles, fittings, wires, and pillars required for the electrical equipment of approximately 3 miles 3 furlongs of tramway track in the county borough of West Ham. Specification, etc., may be obtained from the Borough Electrical Engineer, Electrical Works, Canning Town, E., on deposit of a £5 Bank of England note. Tenders to Mr. Fred. E. Hilleary, town clerk, Town Hall, Stratford, E., by 4 p.m. on Sept. 13.

London, N.—The Edmonton Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. They are prepared to consider offers based upon certain alternative arrangements, particulars of which are set out in the form of tender. Particulars and form of tender may be obtained at the office of Mr. William Francis Payne, clerk, Town

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Hall, Edmonton. Tenders must be addressed to the Clerk, and delivered by 12 noon on Sept. 27.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Barking (Essex).—The Urban District Council invite tenders for the construction of light railways as follows: (Contract No. 1 and 1A) rails, fishplates, and bolts; (2 and 2A) permanent way construction); (3 and 3A) overhead line equipment; (4 and 4A) underground feeder cables, etc. Specification may be obtained of Mr. H. Hargreaves, clerk, Public Offices, Barking, Essex, on depositing a cheque for £5. 5s. Applicants to state the contract for which they propose tendering. Tenders to Chairman of the Electricity and Tramways Committee, Council Offices, Barking Town, by 12 noon on Sept. 20.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

Madrid.—The call for tenders for the service of the electric lighting of Pueblo Nueva del Terrible and Penarroya was without result. The conditions of tender have therefore been modified in certain respects, and a new adjudication is announced to take place on Sept. 18. Tenders are also required for the supply of 25,000 porcelain telegraph insulators, No. 1 of the Spanish type. Tenders, which must be accompanied by a proof that 5 per cent. of the amount has been deposited, will be received at the office of the Direction General of Posts and Telegraphs, No. 10. Carretas, 2° Madrid, up to Sept. 16. The *Gacetas* containing the above notices may be seen by persons interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

RESULTS OF TENDERS.

Pontypool.—The tender of the Pontypool Electric Light Company has been accepted for one year's labour connected with the maintenance of the electric installation in the market, the amount being £5. 5s.

Stoke-upon-Trent.—The Guardians have accepted the tenders of Morley Electrical Engineering Company, Leeds, for motors at £147, cable at £98. 7s., tubes at £32. 17s.; and Dean and Lowe, Stoke, for junction boxes, etc., at £15. 16s.

Dartford.—The Urban District Council have accepted the tender of the Western Electric Company, North Woolwich, at £850. 6s. 10d., for carrying out an extension of underground and pilot cables drawn into existing spareways, and for the laying of private and public lighting cables, together with all necessary roadwork, junction boxes, etc.

Wimbledon.—The Urban District Council have received the following tenders for boiler-house extensions, with Bennis stokers:

	A.			
Richardsons, Westgarth, and Co., Limited	3,615	£4,890	0	0
Musgrave and Son	3,615	5,023	10	0
R. Hornsby and Son	3,615	5,023	10	0
E. Le Bas and Co.	3,615	4,885	0	0
Babcock and Wilcox	3,654	4,870	0	0
Stirling Company (U.S.A.)	3,678	4,975	0	0
Richardsons, Westgarth, and Co., Limited	4,000	5,083	0	0
Babcock and Wilcox (accepted)	4,020	5,069	0	0
Stirling Company (U.S.A.)	4,095	5,100	0	0
Stirling Boiler Company (Meldrum stokers).....	4,100	5,365	0	0

A. Heating surface in square feet of each boiler. The specification called for not less than 4,000 square feet of heating surface.

BUSINESS NOTES.

TRACTION.

Durham.—The Durham Miners' Association favour an electric service by the County Council.

Tyneside Tramways Co.—A further issue of £40,000 5 per cent. mortgage debentures is announced. The subscription list closes on the 10th inst.

Newport (Mon.).—The number of passengers carried on the tramways last week was 126,444, the receipts amounting to £533. 10s. 8d., against £473. 5s. 4d. last year.

Yarmouth.—The extension from St. Peter's-road to Queen's-road was commenced by the Corporation on Monday, and already considerable progress has been made with the work.

Cardiff.—The number of passengers carried on the tramways last week was 503,099, the receipts being £2,194. 6s. 1d. The receipts for the corresponding period last year amounted to £2,035. 5s. 10d.

Newcastle.—The cars of the Tyneside Company made their appearance on the Corporation lines last Monday. The municipal trams commenced running on the company's rails some days previously.

New York Underground.—The cost of constructing and equipping the Manhattan section, which has been completed, and is expected to be opened in two or three weeks, amounts to something over £11,000,000.

Manchester.—The Corporation have inaugurated a system of payment of fares by "tokens" in the form of celluloid discs, which can be purchased at the rate of 5s. and 2s. 6d. for packets of 60 1d. and ½d. "tokens" respectively.

Pudsey.—There is stated to be a considerable amount of antagonism to the proposed municipal electric tramway on the part of tradesmen, who contend that it will take their customers to the large adjoining towns of Leeds and Bradford.

King's Norton.—At a public meeting a resolution calling upon the District Council to negotiate with the Birmingham Corporation instead of the company for the working of the lines in King's Norton and Northfield was unanimously carried.

London County Council.—The work of widening the roads from New Cross by way of Brockley to Forest Hill for the new tramlines was begun on Monday, and a commencement is to be made shortly on the line from Camberwell-green to Denmark-hill and Lordship-lane.

Llanelly.—A special meeting of the Council will be held to-day in reference to the electric traction and lighting scheme, when the agreement with the British Insulated and Helsby Cables, Limited, will be discussed, and, it is hoped, an end put to the long-standing deadlock.

Devonshire Light Railways.—The Light Railways Commissioners have submitted to the Board of Trade for confirmation an order made by them authorising the construction of light railways in the county of Devon from Newton Ferrers to Yealmpton, and from Kingsbridge to Slapton, and to Salcombe.

Wirral Railway and Electrification.—At the half-yearly meeting of the Wirral Railway Company held at New Brighton on Monday, Mr. T. H. Jackson (the chairman) said the directors had not lost sight of the possibility of electrical development, but they were waiting for further evidence of its efficiency.

Alsace-Lorraine Electric Railway.—It is reported that a Belgian company has obtained a concession, in accordance with an understanding between the French and German Governments, to construct an electric railway from Moyeuvre la Grande to Joeuf and Homecourt. This will be the first railway connecting Alsace-Lorraine with an exclusively French district.

Dover.—The annual report of Mr. E. Carden, the Corporation electric tramways manager, records gross receipts of £11,840, against working expenses of £6,442. After allowing for interest, sinking fund charges, and general expenses, a net profit of £920 remains. The mileage totalled 280,901, the service being considerably interfered with through alterations to the lines. The energy consumed totalled 319,413 units.

Perth.—Trials were made with the petrol cars on Tuesday, the first one, it is reported, running smoothly and easily. A second car was less successful in dealing with the inclines, though stated to have given every satisfaction on the level sections. The promoters of the system are confident that they can provide an efficient service for £10,000, including new rolling stock. The lowest offer for the trolley electric system is stated to have been £43,000.

Brighton.—A report of the general manager, Mr. T. B. Holliday, deprecating the suggestion of a councillor that a portion of the trams on all routes should run to the railway, has been approved by the Tramways Committee. The manager considers that such an arrangement would disorganise the traffic, but adds that when there is an extension to the eastern part of the borough cars could be run through from the eastern terminus to the railway station.

Falkirk.—It was recently reported that the company which in 1901 obtained parliamentary powers to make and work electric tramways in this district, had made arrangements for selling its rights to a member of an Edinburgh firm of electrical engineers, who intended promoting a limited company to undertake the business. It is now stated that this transaction has been challenged by a member of the original company as being *ultra vires*, and that, if an attempt is made to carry it out, it will be opposed.

Burnley.—The tradesmen of Nelson are complaining at the charges which the Corporation make for carrying parcels on the tramways. To send a parcel to Brierfield, a Nelson tradesman has to pay 3d., whilst the same parcel can be sent to Burnley for 2d. No extra labour is involved, as the receiving office at Brierfield is in line with the regular stopping place at the centre. Rather than submit to the anomaly, the tradesmen are sending the parcels on the car by their assistants, who can travel the return journey for 2d.

Sheffield.—It is expected that at the next meeting of the Corporation there will be a discussion in reference to the powers for tramway construction conferred by the Corporation's Acts of 1897 and 1900. Nearly all the routes comprised in the former measure are in use, but several included in the latter have not been undertaken. The *Sheffield Daily Telegraph* has "reason to believe that the Tramways Committee will recommend the Council to allow the unused powers under the 1897 Act to lapse, and to defer the whole question of extensions for three years, when the term of the second Act expires."

Derby.—A trial trip was made on Tuesday on the Burton-road route. The Board of Trade inspection of the routes comprised in the first contract which have not yet been opened will take place on Tuesday next, after which they will be opened for the use of the public. The opening of the new tramway offices and waiting-rooms in Victoria-street is expected to be almost simultaneous with the opening of the remaining routes. The Tramways Committee received on Tuesday a

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deputation of inhabitants who requested that the Market-place should be adhered to as the terminus for the cars on the Midland Railway Station route instead of selecting Victoria-street for the purpose. The committee promised that their representations should have careful consideration, and an early answer will be given.

Maidstone.—The following particulars were given at last week's meeting of the Council in reference to the progress of the new tramways. The number of units used between July 14 and Aug. 21 (inclusive) was 9,862, and the numbers carried were 57,640 ½d. passengers, 144 100 1d. passengers, 14,400 2d., and 19,250 3d. passengers. The total, exclusive of season-ticket holders, was 235,390. This worked out at an average of 6,726 a day, or 47,082 passengers a week. The fares amounted to £1,130, and the season tickets to £45. 1s. 6d., while there was £25 for advertisements on the tickets. In the first week £194. 16s. 3d. was taken, in the second £174. 6s., in the third £242. 3s. 7d. (bank holiday week), in the fourth £183. 17s. 1d., and in the fifth £177. 0s. 3d. Some of the speakers advocated a line in the St. Paul's district.

Hull.—The American Consul having reported to the United States Department of Commerce and Labour on the excellent results achieved by the municipal trams, the subject has been commented upon by several American journals, including the *Scranton Tribune*, which states: "The results in Hull are due to limiting capitalisation to actual cost of track and equipment, without any inflation for franchise values or the enrichment of promoters and speculators working through venal councilmen. They are enhanced by a public sentiment for honesty and economy in city administration. None of these things is yet dominantly present in American cities. They may come in time; if they don't, we shall have to shut up shop. But they are not in sight. Our over-capitalisations are the direct result of our civic carelessness and lack of assertive honesty, and from it come the high fares and relatively inferior service which our public has to put up with in order to pay for bribery, stock-watering, and skin-game financiering. We can undoubtedly do as well as Hull when we have the general determination, and when we can extricate ourselves from our entanglements through past mistakes; but this is some distance off."

Belfast.—In reference to the proposed appointment of Mr. Andrew Nance as manager of the Corporation tramways, the Belfast Trades and Labour Council passed the following resolution last Saturday by 26 votes to 11 after a somewhat heated discussion: "That this meeting hereby calls upon the Corporation to make their appointment of tramway manager after advertisement, selecting the best applicant, the appointment to be made on merit, and we strongly protest against the attempt now being made to foist Mr. Nance into the position of manager, a position which all his previous attitude towards municipalisation of the tramways absolutely unfits him for." A deputation subsequently attended before the Tramways Committee requesting that no appointment to the managership should be made without advertising. The town clerk having submitted replies he had received from Birmingham, Leicester, Leeds, Bradford, Manchester, Liverpool, and other cities relative to the salaries of their tramways managers and the conditions attached to the appointment in the different cases, the committee discussed the following resolution, which was several times amended, and finally carried by 10 votes to 2: "That it be a recommendation to the Corporation to appoint Mr. Andrew Nance as manager of the tramways undertaking on the terms contained in his proposal, but modified as follows—viz., that all actions as manager be subject to and under the control of the committee, and that the appointment be terminated at six months' notice on either side, and without any right to pension, and that an agreement be prepared accordingly by the town clerk."

Heywood.—A meeting of the Tramways Committee was held on Thursday of last week to consider the terms submitted by the Corporations of Rochdale and Bury for the construction and working of the lines in the borough. The terms now proposed include the payment by Rochdale and Bury of Heywood's share of the purchase price of the old undertaking, the leasing of the new lines to the two Corporations for a period of 30 years, the Heywood Corporation to construct their own section and maintain it, and the Rochdale and Bury Corporations to pay 10 per cent. per annum on the total cost of construction to cover maintenance and interest. The difference between these terms and those which according to Heywood were originally offered, is that the lease is extended from 21 to 30 years, and it is also contended by Heywood that in the first proposals the pavement of the track was to be granite throughout. The present terms provide for a granite track from Heywood Market-place to Crimble-lane on the Rochdale side, and from the Market-place to the summit on the Bury side, the remainder to be laid with ordinary setts unless Heywood chooses to pay the difference in the cost of substituting granite. After discussing these terms the Tramway Committee decided to approach the Bury and Rochdale Tramways Committees with a view to a joint conference. Just as we go to press we learn that a conference has been held in the Council chamber, Heywood, between representatives of the Tramways Committees of Heywood, Bury, and Rochdale in reference to the further proposals made by Bury and Rochdale. The questions of the term of lease and which authority should supply the electric power were discussed. The points in dispute were not settled, and a further conference will be held.

Salford.—The annual report of the general manager of the Corporation tramways for the year ended March 31 has just been issued. The total length of tramways now worked by the Corporation is 59½ miles (single track). The stock of cars on March 31 was 150, of which 100 are of the double-decked single-truck type, and 50 double-decked bogie cars, all the cars having staircases of the reversed type. Several experiments having been successfully tried during the year with outer deck coverings fitted to the cars, it was decided to equip 20 of the single-truck cars with covers of an approved type. These cars were much appreciated, and an early addition to them is contemplated. Considerable maintenance works have been carried out during the year. The traffic returns show largely increased gross receipts, although a decrease in the earnings per car mile has resulted, due to the unfavourable weather. The number of passengers for the year was 36,956,405, an increase of 8,805,730 as compared with the preceding year. The receipts were £53,936. 5s. more last year than in the previous year—£198,422. 7s. 6d., against £144,486. 2s. 6d. The year's working resulted in a gross profit of £60,106. 14s. 11d., to which must be added the sum of £242. 2s. 9d. for interest on investments, making a total available balance of £60,348. 17s. 8d., and this has been dealt with as follows: payment to local authorities for running powers, etc., £10,903. 4s. 5d.; interest and sinking fund charges, £34,005. 14s. 2d.; contribution in relief of rates, £12,000; reserve and renewals fund, £3,439. 19s. 1d. The amount now standing to the credit of the reserve and renewals fund is £12,202. 10s. 4d. Some fatal accidents occurred during the year, besides which there was a large number of minor injuries through passengers attempting to board or leave the cars whilst in motion. All the cars are provided with lifeguards of the gate and cradle type, and on many occasions these have been the means of saving lives.

Live-Rail Dangers.—The following views have been expressed in reference to the recent Board of Trade reports. Mr. R. Bell, M.P., secretary of the Amalgamated Society of Railway Servants, in the course of an interview, agreed that it might be unnecessary to provide boarding for the "live" rails in certain sections of the line where there was little traffic. The platelayers would certainly need less protection in that way than any other of the employés on the line. They would naturally be best acquainted with the "live rail," and would be most able to avoid all danger from it. The classes which needed most protection are those who were employed in other branches of work, such as porters, guards, drivers, and firemen, who only went occasionally on the line. If they were in danger they ought to be protected. However difficult it might be to protect the line, it must be done where there is danger to the men employed at work other than dealing with the repairs of the line itself. A prominent official of the Board of Trade remarked to a *Daily Chronicle* representative: "You must understand that the Board of Trade has no control over the method of laying the lines. It is only when an accident occurs that our inspectors can hold an enquiry and make recommendations. I must say that, as a rule, the Board finds the railway companies very ready to fall in with suggestions, and to do all that is possible to ensure the safety of the public. Electricity is still a very new method of traction, but it has evidently come to stay, and probably in a comparatively short time it will be in general use on all suburban railways, if not for long-distance traffic. Consequently the best methods of guarding 'live' rails will be carefully considered both by the Board and the companies. It is important to notice that of these accidents only one occurred to a railway employé, the other two happened to trespassers on the line. People are constantly killed or injured on ordinary railways through walking on the line, crossing where they ought not, and so on." Mr. H. A. Watson, general superintendent of the Tyneside line, stated to a representative of the *Yorkshire Post* that the North-Eastern Company were earnestly considering various methods for adequately safeguarding the public against the dangers of the "live" rail. Mr. Cunningham, manager of the Central London Railway, remarked that there was but little danger on that line, but he welcomed investigation into such dangers, as he was convinced that protection against them would be greatly facilitated hereby.

LIGHTING AND GENERAL.

Pittenweem.—The telephone system is being extended by the Post Office from Leven to Anstruther.

Ashford.—The Ashford electric lighting order received the Royal assent just before the prorogation.

Buncrana (Ireland).—At a public meeting resolutions were passed in favour of an electric lighting scheme.

Sales.—Particulars will be found in another column of a sale of private electric light plant by Messrs. Brackett and Sons at Finchley; also of an electrical contractor's business for sale.

Ravensthorpe.—Terms have been discussed between the Urban District Council and the Yorkshire Electric Power Company in regard to the supply of energy by the latter in the event of the Council obtaining a lighting order.

Stockton-on-Tees.—The income for the year ending March 31 amounted to £5,432, against which have to be placed £3,123 for working expenditure and £3,278 absorbed by interest and sinking fund charges, leaving a deficit of £969.

Northampton Institute.—Full day courses in the theory and practice of the engineering, electrical, and horological engineering subjects will commence on Monday Oct. 3, 1904. The examination will take place on Wednesday and Thursday, Sept. 28 and 29. The evening technical courses in all branches of electrical and mechanical engineering will commence on Monday, Sept. 29, 1904. Particulars appear in another column.

Hampstead.—The annual report of Mr. G. H. Cottam, the borough electrical engineer, chronicles further records. 575 customers being connected during the year, and number of lamps totalling 32,489. The income aggregated £58,051, and after payment of all charges a surplus of £5,796 remains, out of which £3,212 are to be contributed to the local rates. The energy sold consisted of 678,585 units, which is an advance upon any previous year. The charges for power have been revised with a view to encouraging a day load. Considerable additions to the mains were made during the year, and three new sub-stations have been erected. The new customers for power include the contractors for the Charing Cross and Hampstead Railway.

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Barnstaple.—The engineer is preparing a report as to the cost of lighting High-street with arc lamps.

Todmorden.—The laying of the electric cable for the Corporation electric lighting works in course of construction at Millwood has been begun.

Mile End.—The Guardians will shortly require a dynamo in connection with the electric lighting of the old school buildings. The estimate is £500.

Chester.—At the expiration of the vacation the question of a refuse destructor is to again come before the Town Council in the shape of a report by the city surveyor and the electrical engineer.

Leeds.—The Corporation Lighting Committee on Tuesday resolved that all the tramway routes in the city should be lighted by electric arc lamps for a mile from the junction of Briggate and Boar-lane.

Yorkshire Electric Power Co.—With regard to a note that appeared in a former issue, we are informed by this company that electric power will be available from the Thornhill station in December next.

Fire.—With regard to a fire which occurred at the works of Messrs. J. G. Statter and Co., Newhall-street, Birmingham, we are informed that it was only a small affair, and that the damage was slight and entirely covered by insurance.

Stourbridge.—The District Council on Monday dismissed the Electric Power Committee's recommendation that steps be taken to procure a provisional order under the Electric Lighting Acts in regard to the parishes of Pedmore, Hagley, Clent, and Belbroughton.

W. T. Henley's Telegraph Works Co.—The directors of W. T. Henley's Telegraph Works Company, Limited, have declared an interim dividend on the ordinary shares at the rate of 10 per cent. per annum, less income tax, for the half-year ending June 30 last.

St. Pancras.—The Guardians have decided that the workhouse shall be lighted throughout with electric light, and that a sum of £550, being a moiety of the estimated cost of wiring, etc., be included for this purpose in the next precept for rates made on the Borough Council.

Tiverton.—From the account of the Local Government Board enquiry in our issue of the 26th ult. it appeared as if Mr. J. S. Enright had attended as representative of Messrs. Frank Suter and Co., Limited, while as a matter of fact Mr. Enright is the consulting engineer to the Town Council, and gave technical evidence on their behalf.

Stock Exchange.—The Stock Exchange Committee have appointed Sept. 7 special settling day for the North Wales Power and Traction Company's 34,100 shares of £5 each, £4 paid, Nos. 1 to 34,000 and 37,401 to 37,500, and have ordered the Metropolitan District Railway Company's £500,000 4 per cent. perpetual debenture stock to be quoted in the official list in lieu of the scrip now quoted.

Keighley Association of Engineers.—About 20 members of the Keighley Association of Engineers last week visited the works of Sir William Gray and Co., Limited, shipbuilders and engineers, West Hartlepool, where a great expenditure is now being made in installing electric driving to replace the original steam power plant. These works employ about 1,200 men, and 2,000 are engaged in the shipyards.

Stockport.—The Guardians have decided with regard to installing the electric light in the infirmary buildings to advertise for competitive schemes, with reports and estimates of cost, of an electric lighting installation both with Guardians' own plant and with Corporation supply. The schemes sent in are to be submitted to an assessor. A premium will be awarded to the one highest in order of merit.

Llanwrtyd Wells.—It is proposed to form a company to generate electricity for the purpose of lighting the village, and also for traction purposes to convey visitors to and from the village to the Wells, a distance of about half-a-mile. It is thought that there is sufficient water to drive a dynamo to generate the necessary power. The capital of the company will be about £2,000, divided into £10 shares.

Hammersmith.—The Guardians have received from Messrs. R. Waygood and Co. an estimate for supplying two electric lifts to the new infirmary at Wormwood Scrubbs—viz., two lifts at £380 each, £760; two enclosures at £55 each, £110—total, £870; £11 extra per lift to be charged if wiring below the balusters is required. The acceptance has been left with the Building Committee and the architect.

Southwark.—At the last meeting of the Guardians a specification for installing incandescent governed lights to the wards and corridors and other suitable places in the infirmary was considered. The cost of installing incandescent light is £400, and it was suggested that the Board might consider the advisability of having electric light in the infirmary. After the initial cost of the installation a saving would be effected of £250 or £300 a year. The matter was referred to committee.

Wellingborough.—In consequence of a report on the proposed agreements with the Electric Power Distribution Company, Limited, and the County of Northampton Electric Power and Traction Company, Limited, respectively, the surveyor has been instructed to prepare plans and estimates at once with a view to applying to the Local Government Board for a loan for the purpose of providing the machinery necessary for enabling the Council to generate its own electrical energy.

Angus Electric Light and Power Co.—The shareholders, in special meeting, have decided to alter the name of the company to the North of Scotland Electric Light and Power Company, Limited, to increase the ordinary share capital to £100,000, and to issue £25,000 of debenture stock. This step has been taken in view of arrangements being made for taking over the provisional order for supplying electricity in Inverness, and for extensions to the supply of Montrose and Brechin.

Radcliffe.—The ceremony of switching on the electric light in the market hall, which is the first public building to be lighted by current from the electricity station, was performed on the 19th ult. by Mr. J. H. Lund, chairman of the Electricity Committee. The market has been fitted up with 20 clusters of lamps, five lamps each, of 25 c.p., in each cluster, a wonderful improvement in the lighting. The installation has been put in by Mr. Wm. Brierley, of Church-street.

Hackney.—The Guardians have decided that the Electrical Standardising Institute, of Charing Cross-road, be engaged as clerk of the works to supervise the work to be executed by Messrs. Wm. Wallace and Co., Limited, in connection with a system of electric fire-alarm bells at the workhouse, infirmary, and children's homes, at an inclusive fee of 5 per cent. on the value of the work executed. The institute will test all fittings and wire, and supervise and pass all work, visiting the site daily for the purpose.

Colliery Contracts.—Messrs. Graham, Morton, and Co., Limited, Leeds, report the following contracts: (1) Doncaster Corporation gas-works, for the supply of a coal elevating and conveying plant for unloading the barges and distributing the load to the stores; (2) a large plant on this system for H.M. Government at the Royal Gunpowder Factory, Waltham Abbey; and (3) a contract for the supply and erection of a large complete coal-screening plant for the Wheldale Colliery Company, Limited, Castleford.

An American Earl's Court.—We have received from the Edison Electric Illuminating Company, of Brooklyn, N.Y., a copy of the August number of their monthly publication, "The Brooklyn Edison," which is interesting in view of the exceptional illumination features described therein, relating to Coney Island. Enormous sums have recently been spent on this pleasure resort, and the lavish yet most artistically arranged use of the incandescent electric lamp is one of the foremost factors of its success. The illustrations in the booklet giving details of the electric lighting of Dreamland and Luna Park fully bear out the enthusiastic reports we have seen anent this place lately.

Whitehaven.—The Harbour Commissioners have agreed to the last proposal of the Town Council in regard to the harbour lighting contract—viz, that the price for electric energy be 3½d. for lighting and 4d. for motor power; that the Town Council provide and maintain all the means of lighting of an agreed scheme; that the Town Council pay £12. 10s. a year, half the premium on a policy insuring the harbour against possible accident owing to failure of light from any cause, and that the Harbour Commissioners agree to pay a minimum of £350 a year for their energy, whether they consume to that value or not, the £350 to merge in the charge per unit if a greater value be consumed.

Barking.—The accounts of the District Council's electricity department, of which Mr. A. Hugh Seabrook, A.M.I.E.E., A.M.I.Mech.E., is the engineer and manager, again show a surplus. The cost of generating was £2,493, while £4,103 was received for current at rates from 1½d. to 4½d. per unit, £2,443 for public lighting. The gross receipts were £6,619, and the gross expenditure £4,019, leaving £2,900 to be carried to net revenue account. The interest on mortgage debt amounted to £1,371, and the instalments of money borrowed to £1,487. About 10 per cent. of the amount borrowed has been repaid. The following statement is appended: quantity generated in Board of Trade units, 664,246; quantity sold—public lighting (estimated), 214,268; private lighting and power, 231,810; traction, 41,656—total sold, 487,734; quantity used on works, 125,087; quantity used in distribution, 51,425; maximum demand on feeders, 375 kw.

Barnsley.—An enquiry will be held to-day into the Council's application for sanction to borrow £6,868 for electric lighting. At the last meeting of the Council the Electricity and Lighting Committee recommended that incandescent electric lamps be supplied at the works for cash, at cost price, to anyone desiring them. A view being expressed that the proposal savoured somewhat of municipal trading, and that it was not desirable that the Corporation should enter into competition with local tradesmen, the Mayor said the reason they had decided to adopt that course was that there were a large number of inferior lamps being sold in the borough, and justice was not done to the Corporation's works, which were blamed for the inequality of the energy they were sending out. They had been blamed for the electricity being more expensive when they knew they were not to blame, but an inferior type of lamp was. They had adopted the step in justice to themselves and for the credit of the light. The minute was agreed to.

Maidstone.—The Electricity Committee reported at the last meeting of the Urban District Council that they had prosecuted a person for stealing electricity, with the result that the defendant was fined 40s. or a month's imprisonment. They recommended that the salary of Mr. Saunders be increased from £2 to £2. 5s. per week, and that the Finance Committee be requested to take the necessary steps to raise another £6,000 for extension of plant, mains, etc. The recommendations were adopted. The profits for the year ending March 31 last (the second year of working) have been enough to clear off the charges for the year for interest and repayment of principal, but there is a deficiency of £1,275, owing to the way in which repayment of principal has to be made. If three years' grace had been allowed the town would only actually have lost £716 on the first year's working, and on the second year would have made, after the payment of interest, a clear profit of £899, in all equal to a dividend of 5 per cent. They have made a gross profit on the year of £2,508, and there has been a considerable increase all round, the revenue for the past year showing an increase of £1,257 on that of the previous year, while the extra total works costs has only been £220. In the year 1902 the cost averaged nearly 2½d. per unit, but in 1903 it averaged less than 1¾d. Over 20 per cent. of the output was now supplied for power, and the increase in the number of units generated amounted to over 50 per cent.

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Aberdeen.—The electric light accounts for the year from July 31, 1903, to July 31, 1904, have just been issued in proof, as prepared for submission to the Town Council by Mr. P. M. Cran, C.A., the gas treasurer, and certified by Mr. James Milne, C.A., the auditor. The *Aberdeen Daily Journal* says: "We find that with regard to loan capital, the total amount authorised by the Secretary of State to be borrowed is £250,000, but the Corporation is still within that amount, as there remains a balance of £12,964. Under the heading of capital account, we find that the amount of expenditure on buildings, machinery, mains and services, less depreciation, and adding expenditure for the year to July 31, 1904, is £220,742. The revenue account shows the total revenue to be £38,209, as compared with £30,336 for the previous year, while the expenditure amounts to £17,135, leaving a balance of £21,073 to be carried to net revenue account. The principal item of revenue is £24,394 derived from the sale of electric current, the sum of £2,782 being got for public lighting. The cost to the Corporation for taxation is £9,517. On the expenditure side the largest item is that of fuel, which cost £6,251; taxes swallow up £2,370; main and service repairs absorb £1,824; wages at generating station, £1,821; and repairs on plant, £1,204; repairs on meters, and depreciation, £672. For oil, waste, water, and engine-room stores the figure paid is £465; repairs on buildings, £332; management, £289; proportion of engineers' salary, £458; general establishment charges, £251; special services, £362; and abatements, £227. The amount of reserve fund at July 31, 1904, was £13,196. From a statement of the amount of electricity generated, etc., it appears that the demand for the current continues largely to increase. For 1904 the quantity generated in Board of Trade units was 4,158,141, as compared with 2,987,487 in 1903. In the latter year the quantity used in the public lamps was 1,085,306, and for 1904 it is 1,698,314. For electric traction the quantity used was 1,698,314, as compared with 1,085,906 last year. The quantity of electricity served out to private customers as gauged by meter was 1,581,909, as compared with 1,274,790 for 1903. In the works the total quantity of electricity used was 324,164, as compared with 160,004 in the previous year. The total quantity accounted for is 3,863,190, and not accounted for, 294,951, the loss being 7·09 per cent., the lowest percentage since the inauguration of the works in 1894. The number of public lamps in the city is 187 arc lamps, the same as last year. The price of electricity per Board of Trade unit is 6d. and 2½d., 6d. and 2d., 3d. and 1d., 2½d. and 1·64d. Deducting depreciation, the total expenditure on land and buildings, machinery, accumulators, mains and services, electrical instruments, etc., amounts to £220,742."

COLONIAL NOTES.

India.—With regard to the electric installation at the general offices, E.I.R., *Indian Engineering* says that the sanction of the Government of India has been granted to putting the work in hand without delay. Some 100 additional fans and 200 additional lights will be provided. The installation will cost about Rs.60,000. In their new contract with the Bombay Telephone Company, the Bombay Municipality have, in view of the introduction of electric traction on the Bombay tramways, stipulated that whenever necessary the company shall lay their wires underground. The company has very readily assented to this reasonable proviso, intended as much for their own convenience as for the protection of the public, and have already pulled down the overhead wires in the crowded streets opposite the Crawford Market and substituted underground wires.

Auckland (N.Z.).—Mr. Goodman has reported on a scheme for installing an electric lighting and power service for the city. He estimates the expenditure at £74,000, and the yearly profits obtainable at £6,000. He says the only possible motive power was steam, the water power from the Waitakerei being insufficient and the Waikato too far away. The question will be fully discussed at an early special meeting of the City Council.

PROVISIONAL PATENTS, 1904.

AUGUST 22.

18141. Improvements in electric block systems for railways. Frederick Chadwick Robinson, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, Aug. 22, 1903, being date of application in United States.) (Complete specification.)

18162. Improvements in arc lamps. Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London.

18163. Improvements in arc lamps. Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London.

18173. Improvements in vapour electric apparatus. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18174. Improvements in speed-changing mechanism. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18181. Improvements in telegraph transmitters. Willis Joseph Roussel and Alphonse King, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18185. Improvements in means for controlling electric power distributing systems. Joseph Louis Routin, 18, Buckingham-street, Strand, London. (Complete specification.)

18199. Improvements in and relating to controllers for electric circuits. Charles Cornfield Garrard, 18, Southampton-buildings, Chancery-lane, London.

18201. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18202. Improvements in electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18203. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18204. Improvements in transformers, especially adapted for use on electric vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

AUGUST 23.

18208. Improvements for effecting telephonic intercommunication. John Young, 21, Gloucester-walk, Campden-hill, Kensington, London.

18225. Improvements in electrical switches. Julius Peschek, 5, Budge-row, London.

18252. Improvements in automatic electric telegraphic transmitters. Oster Henn, 21, Glockengiesserwall, Hamburg, Germany. (Complete specification.)

18255. Improvements relating to the parallel running of dynamo machines. The Honourable Charles Algernon Parsons and George Gerald Stoney, 18, Southampton-buildings, Chancery-lane, London.

18280. Improvements in magneto-electric machines. Frederick Richard Simms, 4, South-street, Finsbury, London.

18293. Improvements in controllers for electrically-operated capstans and the like. William Harding Scott, 47, Lincoln's-inn-fields, London.

AUGUST 24.

18306. Improvements in apparatus for electric advertising. Joseph Culshaw, 64, Barton-arcade, Manchester.

18316. Improvements in electrical measuring instruments. Kenelm Edgcumbe and Edgar Isaac Everett, 151, Great Saffron-hill, London.

18317. Improvements in electrical switches. John Alexander Kennedy McGregor and Harry Wren, 5, Corporation-street, Birmingham.

18322. A system of electric lighting for railway trains. Henri Pieper and Gustave L'Hoest, 24, Temple-row, Birmingham. (Complete specification.)

18342. Improvements in electric incandescent lamps. James Wiley Phelps, 46, Lincoln's-inn-fields, London. (Complete specification.)

18343. Improvements in electric incandescent lamps, connections and switch mechanism therefor. William Joshua Phelps, 46, Lincoln's-inn-fields, London. (Complete specification.)

18356. Improvements in electrolysers. Friedrich Ludwig Bartelt, 6, Bream's-buildings, Chancery-lane, London.

18358. Improvements in electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18359. Improvements in incandescent electric lamp sockets. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18361. Improvements in resistances for electrical apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18369. Improvements in trolleys for electric cars. George Raeburn Robson, 37, Chancery-lane, London.

18378. Improvements in and relating to combined electric switches and fuses. Benjamin Shuttleworth Hornby, 322, High Holborn, London.

18383. An improved indicating device for electrical fire-alarms. Reinhold Hoenicke, 18, Buckingham-street, Strand, London. (Complete specification).

AUGUST 25.

18403. An improved electrolytic process and apparatus therefor. Clinton Paul Townsend, Olun House, Surrey-street, Strand, London. (Complete specification.)

18429. Improvements in selective telephone call mechanism. Henry Ivins Hawxhurst, 18, Buckingham-street, Strand, London. (Complete specification.)

18439. Improvements relating to the charging of accumulators or secondary batteries. Robert Shaw McLaren, 7, Southampton-buildings, Chancery-lane, London.

18446. Improvements in vapour electric apparatus. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18447. Improvements in or relating to vapour electric lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18448. Improvements in vapour electric apparatus. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

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AUGUST 26.

18464. An improvement in electric trolley heads, with wire-finding apparatus attached. John Thomas Cherry and Edward Henry Clive, 2, Bedford-park, Plymouth.

18469. Improvements in trolleys for electric tramways and railways. John Ernest Bentley, 51, Deansgate-arcade, Manchester.

18496. An improved switch for electric circuits. James George Farquhar, 55, Chancery-lane, London.

18499. Improved system of cable connections with electrified railways. John Stirling Wood, William Stirling Wood, and James Robert Wood, 4, Stanley-street West, North Shields.

18501. Improvements in primary batteries. George Wallace and Wallace J. L. Sandy, 132, Coldharbour-lane, London.

18520. Improvements connected with coin-freed gas, electric, or other meters. Frederick John Beaumont, 173, Fleet-street, London.

18538. Improvements in wireless signalling systems. George Cecil Dymond, 6, Lord-street, Liverpool. (Gesellschaft für Drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

AUGUST 27.

18546. Improvements in electric incandescent lamps, whereby two or more lamps are governed by one central connecting cap or the like. Max Byng and William James Crawshaw, 71, Queen Victoria-street, London.

18561. Improvements in live rail protection for electric railways James Linkleter, Tyneside Works, Tynemouth.

18592. Improvements in electric railways. Edgar Alfred Carolan, 83. Cannon-street, London. (The General Electric Company, United States.)

18594. Improvements in galvanic batteries. Lothar Fiedler and Frederic Julius Gerard, 22, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 15, 1904.

1903.

11828. Electric telegraphy. Muirhead.

11828a. Electric telegraphy. Muirhead. (Date applied for under Patents Rule 9, May 23, 1903.)

11921. Electric welding of turbine blades. De Ferranti.

17351. Electric railways. Westinghouse.

18318. Electric incandescent lamp. Wallace.

18354. Electromagnetic rail brakes. Wilde.

18624. Electric lamps of the character known as vapour lamps or vapour arc lamps. Bastian and Salisbury.

19657. Working of points and plough guides on electric or cable tramways or railways. Stewart.

20645. Arc lamps. Upton, Elliott, and Pratt.

22497. Electrical switch. Makin.

22634. Terminals for stranded electrical and other wires. De Veulle.

22981. Welding by electricity and apparatus therefor. Harmatta.

24626. Plates for secondary batteries. Thompson. (Pflüger Accumulatoren-Werke Actien-Gesellschaft.)

27736. Electrical means for starting prime movers for electric generators. Johnson. (Elektricitäts Aktien-Gesellschaft vorm. W. Lahmeyer und Co.)

1904.

5663. Annunciators for electric bells and the like. Henning.

8012. Line selectors of intercommunication telephone apparatus. Walloch. (Date applied for under International Convention, Sept. 25, 1903.)

8965. Section insulators for overhead trolley wires. Siemens Bros. and Co., Limited, Simpson, and Wheat.

9307. Alternating-current meters on Ferraris's principle. Morck.

12187. Telephone and telegraph systems. Ritter.

12691. Apparatus for the simultaneous transmission of telephonic and telegraphic or other currents over the same line. Turchi.

13427. Brake and means for suspension for overhead electrically-driven locomotives. Fairweather. (Brown Hoisting Machinery Company.)

13468. Electric switches. Scott. (Date applied for under International Convention, July 31, 1903.)

14066. High-voltage galvanic battery. Gournay.

15043. Electric telephonic transmitters and like instruments. Lake. (Submarine Signal Company.)

15283. Electric burglar and fire alarm. Ali.

15296. Electric elevators. Phillips. (Vogel.)

15699. Electrical resistances. Boehm.

15874. Electrical fire extinguisher. Ruppert.

15981. Telephone directories. Brownell.

16179. Electrical transformers. Peck and Fortescue. (Date applied for under International Convention, Aug. 8, 1903.)

16294. Electric lamp guards. Dickinson.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅜-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	5¾-6¼
— 6 per cent. Cum. Pref., 1-100,000	5	5½-6
— 4½ per cent. Mortgage Debentures	100	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	101-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	2¾-3¼
— 4 per cent. Mortgage Debenture Stock	100	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	½-1
— Non. Cum., 6 per cent. Pref.	2	1-1¼
— 4½ per cent. 1st Debenture Stock	100	96-99
— 4½ per cent. 2nd Debenture Stock	100	70-75
Callender's Cable, Debentures	100	101-105
— Ordinary	5	9½-10½
— 5 per cent. Pref.	5	5-5½
Crompton and Co.	3	1¼-2
— 5 per cent. Debentures	100	90-95
Edison and Swan United, "A" Shares, 1-99,261	3	½-¾
— "A" Shares, 01-017,139	5	1-2
— 5 per cent. Debentures	100	79-83
— 4 per cent. Deb. Stock, Red.	100	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	1-1¼
— 7 per cent. Cumulative Pref.	2	2-2¼
— 4 per cent. Perp. 1st Mort. Deb.	100	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9-9½
— 4 per cent. 1st Mort. Deb. Stock	100	93-98
W. T. Henley's Telegraph Works, Ordinary	5	11-12
— 4½ per cent. Preference	5	5-5½
— 4½ per cent. Debentures	100	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	18¼-19¼
— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	10-10½
Telegraph Construction and Maintenance	12	36-38
— 5 per cent. Bonds	100	101-104
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	¾-1
— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	103-107
Bournemouth and Poole, Ordinary	10	11¼-12¼
— 4½ per cent. Cum. Pref., 7,501-15,000	10	9½-10½
— 6 per cent. Cum. Second Pref., 15,001-22,500	10	10½-11½
— 4½ per cent. Debenture Stock, Red.	100	102-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	100-103
Brompton and Kensington, Ordinary	5	10¾-11¼
— 7 per cent. Preference	5	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	7¼-7¾
— Nos. 20,001-30,000	5	7-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	12½-13½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-109
Charing Cross and Strand, Nos. 1-70,000	5	7½-8
— 4½ per cent. Cum. Pref.	5	5¼-5¾
— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5
— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	102-104
Chelsea Electricity Supply	5	6½-7
— 4½ per cent. Debentures	100	106-109
City of London, Ordinary	10	10½-10¾
— 6 per cent. Cumulative Pref.	10	13-14
— 5 per cent. Debenture Stock	100	120-125
— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	102-105
County of London Electric Supply, Ordinary	10	7½-8½
— 6 per cent. Cum. Pref.	10	11½-12
— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	101-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	6-6½
— 6 per cent. Cum. Pref.	5	6-6½
— 4½ per cent. First Mort. Deb.	100	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	1½-2½
— 5 per cent. Debenture Stock, Red	100	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¾-6½
— 4½ per cent. First Deb. Stock, Red.	100	99-102
Havana Electricity, Limited, 1-15,000	10	9½-10½
Hove Electric Lighting, Limited, Ord. 1-13,000	5	7½-8½
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	101-103
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	⅜-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	12-13
— per cent. Debenture Stock Red	100	102-105
Kensington and Knightsbridge and Notting Hill	100	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10½
London Electric, Ordinary	3	1¼-1¾
— 6 per cent. Pref.	5	5-5½
— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan Ordinary	10	15½-16½
— 4½ per cent. First Mortgage Debenture Stock	100	109-113
— 3½ per cent. Mortgage Debenture, Red.	100	96-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.	100	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
— Preference	4	100-103
Notting Hill Electric Lighting	10	14-15
— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)	100	100-103
Oxford Electric, Ordinary, 1-96 and [illegible]-14,310	5	5¾-6½
— 4 per cent. Debenture Stock	100	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2¾-3¼
— 4 per cent. Debenture Stock	100	83-88
South London, Ordinary		3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
— 7 per cent. Pref.	5	8-9
— 3½ per cent. Deb.	100	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	4½-5
— 5 per cent. Cumulative Preference, 50,001-80,000	5	4¾-5¼
Westminster, Ordinary	5	12½-13½
— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½
Electric Railways.—		
Central London, Ordinary	100	87-89
— 4 per cent. Pref.	100	100-102
— " " deferred	100	80-82
— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	106-109
City and South London, Consolidated Ordinary	100	40-42
— 4 per cent. Debenture Stock	100	105-108
— 5 per cent. Pref. Stock '91	100	121-124
— " " " '96	100	117-120
— " " " '01	100	117-120
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
— Ordinary, 1-50,000	10	3¾-4
— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	97-98
Waterloo and City, Ordinary	100	86-89

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Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 —	—
—— Permanent 6 per cent. Debenture Stock, 1888	100 —	137-141
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	99-101
Barcelona Tramways, Limited, Ord., 1-20,000	10 ..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9-10
—— 5 per cent. Deb., Red., 1-600	100 ..	96 99
—— 4½ per cent. Red. Deb. Stock	100 ..	91-96
Bath Elec. Tramways, Ld, Pref. Ord. Shs., 75,001-100,606	1 ..	11/16-13/16
—— 5 per cent. Cum. Pref. Shares. 1-59,394	1 ..	¼-1
Belfast Street Tramways, Ord., 1-26,600	10 ..	10½-11½
Blackpool and Fleetwood Tramroad	10 —	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 —	1½-2½
—— 5 per cent. Cum. Pref., Nos. 1 75,000	5 —	3⅜-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 —	96-101
British Columbia Electric Railway Co., Ord. Def.	100 —	99-102
—— Ord Pref.	100 ..	99-102
—— Non-Cum. 5 per cent. Pref.	10 —	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 —	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 —	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10 —	8⅜-9½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100 —	116-119
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅛-3⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5⅛-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 —	105-108
—— Prov. Cert., all paid	100 —	101-104
Calcutta Tramways, Limited, 1-102,268	5 ..	7¼-7⅞
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	104-107
Cape Electric Tramways, Nos. 1-480,000	1 —	1⅜-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 —	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 —	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 —	100-103
Cork Electric Tramways and Lighting Co. Ordinary	10 —	9½-10
—— 5 per cent. Cum. Pref.	10 —	11-12
—— 4 per cent. Debentures	100 —	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97

Name.	Amount paid.	Last price
	£	£
Imperial Tramways Ordinary	all —	18-19
—— 6 per cent. Cum. Pref.	all —	14-14½
—— 4½ per cent. Deb Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 —	3¼-4
—— 4 per cent. Debenture Stock	100 —	88-91
Kidderminster and District Lighting and Traction, Pref.	5 —	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	10¼-10⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	103-105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb Stk., Red.	100 ..	100-103
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	¼-1
—— 4½ per cent. Deb. Stock, Red.	100 ..	98-100
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000 ..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	103-105
New General Traction, Ordinary	5 —	⅛
—— 6 per cent. Cum. Pref.	5 —	1-2
—— 5 per cent. Mortgage Debentures, 1-1,715 (Rgd.)	100 —	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	12-12½
—— 5 per cent. Cum. Pref.	10 —	9⅜-9⅞
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk.	100 —	99-102
Potteries Electric Traction, Ordinary 20,001-40,000	10 —	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8¼-8¾
—— 4½ per cent. Debenture Stock	100 —	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.
Telephones.—		
National Telephone, Preferred	100 —	04-106
—— Deferred Stock	100 —	89-92
—— 6 per cent. Cum. First Pref.	10 —	12-14
—— 6 per cent. Cum. Second Pref.	10 —	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 —	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100 —	97-99
—— 4 per cent. Deb. Stock, Red.	100 —	104-106
Oriental Telephone and Electric Company	1 —	15/16 1/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 6	1,664	1,378	+ 285	+14,755*h*	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Aug. 27	38	—	—	—	1½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 28	1,061	1,058	+ 3	+ 151	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 27	4,870	5,038	- 168	+11,402	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 26	1,011	891	+ 120	+ 1,933	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 25	2,822	1,989	+ 833	+ 3,488	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 29	1,851	1,436	+ 415	—	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 23	2,095	1,735	+ 360	—	38	38	March 31*g*	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 24	1,497	1,439	+ 58	—	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 20	4,951	4,112	+ 839	+17,026	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 28	1,375	1,092	+ 283	+ 2,305*h*	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 26	4,931	5,030	— 49	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 27	1,053	870	+ 183	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 28	434	509	+ 75	+ 7,970	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 20	2,189	2,038	+ 101	+ 1,375	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 27	222	230	— 8	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 27	5,480	5,499	— 19	— *h*	6	6	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City & South London Railway	,, 28	2,257	2,403	— 146	— *h*	6⅜	6⅜	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 25	489	619	— 129	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 26	263	259	+ 4	—	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 27	296	289	+ 7	—	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 26	141	139	+ 2	— *h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 26	4,429	4,450	— 19	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 25	1,913	1,616	+ 307											
Dundee City Tramways	,, 24	977	843	+ 131	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 27	759	734	+ 25	+ 1,383	10·75	10·75	March 31*g*	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 27	13,981	13,784	+ 197	— *h*	124	124	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	,, 24	335	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 24	3,253	3,084	+ 171	+ 2 460	31⅔	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 27	1,264	1,230	+ 34	—	34	34	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 27	2,155	1,814	+ 341	+ 6,193	25	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	July 9	528	552	— 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Aug. 25	150	184	— 34	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 24	276	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 27	5,577	5,492	+ 85	+ 7,815	77	77	March 25*g*	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 27	1,373	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 20	10,441	10,473	— 32	+11,774	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 27	1,638	1,626	+ 12	— *h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	July 2	13,329	11,515	+1,814	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Aug. 27	426	332	+ 94	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 27	12,485	11,681	+ 804	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 26	2,125	1,415	+ 710	+ 2,938*h*	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 27	131	114	+ 17	+ 957	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 27	3,584	3,510	+ 74	—	38½	38½	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 27	533	473	+ 60	+ 2,109	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,025	+ 466	+ 3,951	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·65
Rotherham Corporation	Aug. 25	475	536	— 61	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 27	282	—	—	—	7⅜	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 29	4,646	4,388	+ 252	+ 2,568*h*	53½	53½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	July 28	1,031	1,109	— 77	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Aug. 24	633	532	+ 101	+ 1,055	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 26	591	380	+ 210	+ 5 620	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 28	1,446	1,235	+ 211	+ 713	18·48	18·48	,, 31*g*	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	,, 27	848	795	+ 53	+ 1,950	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·05
West Ham Corporation	,, 25	1,147	—	—	—	1¾	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 24	748	465	+ 283	+ 9,508	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

McMillan Memorial Fund.—The secretary of the Institution informs us that the subscriptions received to the 5th inst. amount to £1,709. 16s. 10d.—viz., members, £923. 1s. 4d.; associate members, £265. 3s.; associates, £262. 16s. 4d.; students, £52 1s. 3d.; foreign members, £24. 18s.; subscriptions from non-members, £181. 16s. 11d.—total, £1,709. 16s. 10d.

Society of Chemical Industry.—Sir William Ramsay presided on Wednesday at a banquet in New York, given under the auspices of the Society of Chemical Industry. The guests included the most celebrated American scientists. The American newspapers are paying generous tributes to Sir William's brilliant achievements. His successor as president of the society is Mr. William Nichols, of New York.

International Association of Municipal Electricians.—The ninth annual convention of this association will be held at St. Louis on the 13th and 14th inst. The Exhibition authorities are making great preparations, and several special electrical features have been arranged. For Thursday, Sept. 15, a joint session of this association and Section G of the congress has been fixed. This section is devoted to "electrical communication," and several papers of great interest will be read and discussed.

North-East Coast Institution of Engineers and Shipbuilders.—We have received a copy of this institution's *Transactions*, dated August, which contains a list of the papers read during the past session, the names of all the members, the constitution and by-laws of the institution, and memoirs of Messrs. J. Bulmer, W. T. Courtier-Dutton, S. Fox, J. Nixon, P. Salmon, A. G. Schaeffer, J. L. Thompson, and T. Whitfield. The twenty-first session will open early next month, and members are invited to present papers on a variety of specified subjects.

Municipal Tramways Association.—The second annual conference of this institution is to be held at Liverpool on the 27th inst. The list of papers includes "How to Effect Economy in Current Consumption," by Mr. P. Fisher; "Arrangement of Men's Duties," by Mr. J. B. Hamilton; "Methods of Dealing with Mixed Systems of Traction," by Mr. A. L. C. Fell; "Cars: their Equipment and Maintenance," by Mr. J. Aldworth; and "Overhead Equipment: its Construction and Maintenance," by Mr. J. M. McElroy. The Corporation of Liverpool has invited the members to dinner, so that with the association's banquet and an excursion it is evident that the social phase is not to be neglected.

Huddersfield's Enterprise. — The Corporation earned the distinction of pioneers in municipal tramways, and they have now inaugurated the system of coal haulage over the tramway lines to which we referred a few weeks ago. The idea is not by any means new, the Corporation having obtained the necessary powers as far back as 1880, and in America the cars have for years been utilised during the "small hours" for similar purposes; but until the advent of Mr. H. N. Thomas the project hung fire. The Corporation's late manager, however, interested himself in the subject, and the scheme has now arrived at fruition, the trial trip run last week proving quite successful. The Corporation have already entered into a seven years' contract with Messrs. Martin, Sons, and Co., Limited, a large manufacturing concern, to convey all the coal required by that firm. The slack hours of the morning will be utilised for this purpose, the afternoon being restricted to passenger traffic. This enterprise opens up an extensive vista of industrial possibilities. More details will be found in our editorial columns.

The Institution of Civil Engineers.—The council of the Institution of Civil Engineers have, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1903-1904: Telford premiums to Arthur Hill, C.I.E. (Bombay), F. A. Hurley (Cairo), E. M. De Burgh (Greystones), H. H. Dare, M.E. (Sydney, N.S.W.), William Marriott (Melton Constable), T. G. Gribble (London), W. H. Haigh (Cardiff). For students' papers the awards are: a Millar scholarship, tenable for three years, and the James Forrest medal to C. W. L. Alexander, B.E., Birmingham; Miller prizes to J. M. Clark, M.A., B.Sc. (Glasgow), L. G. Crawford (Barrow-in-Furness), W. H. Dickenson, B.Sc. (Jesmond-on-Tyne), William Lawson (Newcastle-on-Tyne), C. G. Du Cane, B.A. (Middlesbrough), C. Gribble (York), J. E. Lister (Sheffield), J. M. Kennedy (London), H. Middleton (Newcastle-on-Tyne), J. D. Morgan (Handsworth).

New Publications.—In addition to the tenth edition of Prof. Jamieson's elementary manual on "Steam and the Steam-Engines," which we reviewed in our issue of July 1, we understand that Messrs. Chas. Griffith and Co. will bring out on Sept. 15 the sixth edition of the same author's manual on applied mechanics, which is a companion book to the former. They also hope to issue this month the fourteenth enlarged and thoroughly revised edition of Jamieson's text-book on "Steam and Steam-Engines," including steam turbines and boilers, and a seventeenth edition of Munro and Jamieson's pocket book of electrical rules and tables, with the submarine cable and other sections up to date. "The Engineering Telegraph Code," by Jas. Stevens (London: J. Stevens. 40s.) This is the second edition of this valuable work, which may claim to rank as a standard publication. The volume has been entirely rewritten, revised, and enlarged, and will doubtless continue to be of great service to engineers, manufacturers, merchants, contractors, and others.

Light Motorcar Trials.—The highly successful trials for small cars held by the Automobile Club came to a conclusion last Saturday evening, when 26 cars out of the 35 that started on the previous Monday morning finished the twelfth and last run between five and six o'clock. The judges have issued the following provisional list of non-stop awards: Class A (cost not to exceed £125), the 6-h.p. Speedwell, which did seven non-stop runs, was the only car in this section to qualify. No car qualified for the non-stop award in Class B (£125-£150). In Class C (£150-175), the 6-h.p. Siddeley gains first place with the full 12 runs. A pair of 6-h.p. Wolseleys, which ran as a team, and are judged on the average, came second, having performed 12 and 11 runs respectively; and a 6-h.p. Humber, with 11 runs, is placed third. The remaining cars which qualified in this section were a pair of 7-h.p. Alldays, a trio of 7-h.p. Star cars, a 6-h.p. Mobile, a 9-h.p. Speedwell, and a 9-h.p. Brown. In Class D (£175-£200) a 10-h.p. Croxsted gained the maximum score possible, a 7-h.p. Humber was second, and the team of 7-h.p. Alldays was placed third, the other cars to qualify in this division consisting of the team of Star cars, a 9-h.p. Mobile, and a 9-h.p. Anglian. In their final report the judges will make awards for excellence in design or construction.

A Japanese Power Plant.—An electric power plant has recently been installed at Iyo. The water power is provided by the rapids of the River Islute, the actual head approximating some 100ft., with a steady flow of about 50 cubic feet per second. Across the stream is placed a straight stone weir 132ft. long, which dams up the water

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to a height of 4ft. from the canal bottom. The water enters the canal about 1,000 yards from the reservoir, which is located near the power-house. The present plant in the power-house comprises a waterwheel, supplied by J. M. Voith, Heidenheim, Germany, an electric generator, and a switchboard. The waterwheel develops 280 h.p. at 600 revolutions per minute, a suction pipe 15ft. long being used. Regulation of speed is accomplished by Voith's governor to within 3 per cent. The turbine is connected directly through a leather coupling to a three-phase generator of the revolving-field type, developing 260 kw. at 3,500 volts, the frequency being 60 periods per second when running at 600 revolutions per minute. The exciter is wound for 110 volts, and is placed on the same shaft as the generator. The three-phase transmission line consists of No. 3 B.W.G. wires, fixed to petticoat insulators. Telephone wires are also strung on the poles. Both the primary and secondary wires enter the transformer chamber, which contains two 10-kw. converters, by way of a vertical pipe 20ft. above the roof of the tower.

The Testing of Transformer Oil.—The usefulness of an oil as an insulation material is not determined by measurements of its insulation resistance, says the *Zeitschrift für Elektrotechnik*, but by measurements of the voltage required to break down a given thickness. A pair of polished balls should be supported at a fixed distance below the surface in a vessel containing about 200 cubic centimetres, and having a diameter about 3cm. The presence of water or air-bubbles or small fibres greatly affects the results obtained. For the purpose of determining the flashing point of the oil, a weighed quantity of it should be heated for about 12 hours in a water bath at 100deg. C., and the amount evaporated noted. The point at which steaming commences should be as high as possible, as the flashing point occurs at about the same temperature. The effect of water is so important, that the presence of only ·06 of 1 per cent. reduces the breakdown voltage by half. Further additions of water have little effect. The presence of water may be qualitatively determined by adding a little cupric sulphate to the oil. When free from water this sulphate is pure white, but becomes blue when in contact with water. A good transformer oil may be distinguished by the following properties: (1) it should be a pure mineral oil obtained from crude petroleum by frictional distillation without chemical treatment; (2) the flash-point should not be below 180deg. C., and the oil should not burn steadily under 200deg. C.; (3) the oil should be free from alkalies, moisture, or acids; (4) after being heated for eight hours the evaporation should not exceed ·2 of 1 per cent.; (5) the oil should be as fluid as possible, and should have a light-yellow colour.

Electric Lighting in Paris—For the purpose of electric lighting Paris is divided into sections, for each of which the City Council granted a concession to a different company. These concessions begin to expire in 1907, and the Council is not disposed to renew them on the old terms, there being a strong tendency towards municipalisation. A few years ago the city authorities unsuccessfully endeavoured to negotiate with the electric light companies, and it is now necessary to come to an early decision on the subject. The question of the city taking over the electric lighting concessions is somewhat complicated. The various conduits and "canalisations," extending over some 400 miles, made by the electric companies to carry their wires and cables become, by the terms of the agreement, the property of the city at the expiration of the present concessions. On the other hand, the generating stations and sub-stations, and the connecting wires to the consumers remain the property of the companies, who are not obliged to sell, though it is certain that the authorities would refuse permission to construct fresh conduits. With the question of the gas supply on their hands the City Fathers have had little time hitherto for looking into the subject of electric lighting, but a technical committee has now been appointed to consider the matter. It is expected in some quarters that, unless the Council desires to spend a large sum on new plant, the matter will be compromised by a renewal of the concessions upon enhanced terms; but the Council appears to be in a strong position for forcing, if so disposed, the hands of the companies in relation to the sale of their generating stations and connecting wires.

A New Controller Regulator.—An invention has recently been patented by Mr. S. W. Williams, of Michigan, for the automatic regulation of street car controllers when the vehicles are being accelerated, some particulars of which are given in the *Street Railway Journal* of New York. The object of the device is to so limit the operation of the controller handle as to prevent its being thrown around from the series starting notches into the parallel position so quickly as to start the car with a shock or jerking, and at the same time permit the propulsion current to be thrown off the motors instantly. A mechanism interposed between the operating handle and the car controller staff accomplishes this, the handle being so restricted in its forward movement by an arrangement of ratchets and pawls that the motorman cannot possibly throw the power on fully at once. The mechanism permits him to throw the current on to the motors a notch at a time, a considerable delay between notches being made compulsory by the mechanism to permit the motors to accelerate properly. If, however, it is found desirable to throw off the current instantly, the arrangement of ratchets is such as to permit this to be done in the usual manner. Additional features are incorporated in the regulator which permit the controller to be instantly reversed and thrown on to the third reverse notch in case of impending danger. This is a very valuable provision, as in emergency stops the first or second notch of the controller is not sufficiently effective. An additional precaution provided for in this mechanism is that for locking the controller when it is desired to leave the car temporarily. This is very simply provided for in connection with the regulator mechanism.

The New Patent Regulations.—Some comments on the order just issued by the Board of Trade bringing into force as from Jan. 1 next the system of examination of patents embodied in the Act of 1902, and reducing the period of provisional protection from nine to six months, have been received by us from Messrs. W. P. Thompson and Co, patent agents, who have devoted considerable attention to legislation of this character. They remark that the system of examination thus instituted is much less perfect than those of other countries, as the examiner has merely to search through the British patents of the immediately preceding 50 years to see if in these there be in his opinion any anticipation of the invention set forth in the complete specification. This report is forwarded to the comptroller, and if the comptroller be of the opinion (from this report) that the invention is partly or wholly anticipated, the applicant is informed of the anticipation, and has the option of a personal hearing or of amending the specification to the satisfaction of the comptroller, or, in default of either, the comptroller determines whether a reference to any, and if so, what prior specifications must be made in the specification by way of notice to the public. Against his decision there will be an appeal to the Law Officer. The examiner's report will be kept strictly secret from all but the applicant and his agent, but this examination must not

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be held in the slightest to guarantee in any way the novelty of the invention or the validity of the patent, as, of course, the prior publication of the invention in other documents open to the public in England prior to the date of the application, or the prior public use of the invention, would be equally as fatal to the validity of the patent as the publication of the invention in a prior British specification.

Manchester Municipal School of Technology.—The Manchester Municipal School of Technology has issued, in a tolerably bulky volume, its syllabus for the session 1904-5, the description of the various courses being preceded by a statement of the object of the school. In this it is pointed out that the successful career of a student depends very largely upon his previous education, for unless this has been thorough and liberal no satisfactory progress can be attained in any of the departments of the school. It is impossible to obtain full benefit from the courses of instruction unless the student has mastered the fundamental principles by adequate previous preparation. The courses of instruction are directed more especially to the requirements of the industries of South-East Lancashire, of which Manchester is the commercial centre. To day students who have reached their sixteenth year the school offers courses, each of three years' duration, in mechanical engineering, electrical engineering and technical physics, municipal and sanitary engineering, general and industrial chemistry—general technical chemistry, bleaching, dyeing, printing, and finishing of textiles, manufacture of paper, brewing, metallurgy; manufacture of textiles, photography, and the printing crafts and architecture and the building trades. There is besides a special day course for selected apprentices in the employ of engineering firms. Students are required to pass an entrance examination in subjects of general knowledge. As at present arranged, the diploma of the school will be awarded to those students who have satisfactorily fulfilled and complied with the conditions of the three years' course in any of the above-named departments. The school also offers to evening students systematic courses of technical instruction, and training in all the chief and in many of the minor industries of the city and district. The day session will commence on the 19th inst. and the evening lectures on the 26th inst.

New School of Metallurgy.—The School of Metallurgy at Bournbrook, in connection with the Birmingham University, was formally opened on Monday afternoon. The erection of the building cost £10,000. Prof. J. Turner, in the course of his address, observed that there was no more ready index to the progress of civilisation in any nation than that afforded by the knowledge of the worth and value of its metallurgical products; and it was of the utmost importance that our metallurgical industries should be encouraged and developed, if Great Britain was to keep her position amongst the nations of the world. England used to be spoken of as the chief coal and iron producer of the world, and the country occupied a prominent position as a producer of other metals. We still led in gold, because of the Transvaal and Australia; but we were now second in coal, third in iron, fifth or sixth in other metals, and we only produced about one-twentieth part of the world's output of tin, lead, and zinc. Our two chief competitors had been the United States and Germany, and the reasons for their progress were varied. In America we had the necessities of a new country, the rapid development of its railways, the opening up of enormous fields of ore deposits and coalfields. Having briefly alluded to the question of tariffs, the professor dealt with the influence of education on metallurgical progress and the lines we should follow in order to obtain the best results. He mentioned what was being done in America and Germany, and said that at Birmingham two styles of training had been recommended—that adopted by Dr. Percy at the Royal School of Mining and the one in vogue at the newer schools of mining and metallurgy in America. The older schools of metallurgy were either too exclusively theoretical or too exclusively practical. At Bournbrook they would combine theory with practice. Students would analyse their ore, decide which was the best process of extraction, and then extract the ore. No course so ambitious had been attempted in England before, and he was quite sure they would get some useful experience from it.

Dundee.—Previous references have been made in these columns to the proposals of a London syndicate for the supply of energy for motive purposes, and the borough electrical engineer, Mr. H. Richardson, has just issued his report upon the question of whether it would be advisable for the Corporation to give their consent to the scheme. Mr. Richardson prefaces his views with the remark that the millowners have never approached the Corporation for the supply of energy in bulk at special rates, although on no occasion have the authorities intimated that they would decline such an application. The report proceeds to state that, whether the company are allowed to come into Dundee or not, the Town Council will in the near future have, in consequence of the increase of business, to face the erection of a new power station on a different site. The space under the pavement of the streets is so much taken up with town's property that it would be impossible to make room for a company's cables, and under the agreement formulated by the company the Corporation would be deprived of all profitable work, and would be handicapped by being forced to supply unprofitable loads which the company refused to take. Besides this, there is the probability of electrolytic troubles due to leakages from the two systems, and these would constitute a very serious inconvenience and danger. As regards the charges, Mr. Richardson points out that the Corporation was already in a position to reduce the price of current for power purposes, and a reduction was only being delayed until a sliding scale had been decided upon. The company's charges had been put forth at about $\frac{7}{8}$d. per unit, but this charge would be made only in exceptional cases, the real prices which the company said they were going to charge varying from 1$\frac{1}{2}$d. down to $\frac{7}{8}$d. The only scheme which he could advise the Council not to oppose would be one under which the company should start their supply at 5 a.m. and shut down at 6 p.m. promptly, no system of storage being permitted in connection with any consumer's plant, thus restricting the syndicate to the object first announced by them—the supply of energy for mills only.

Trade Marks in China.—Some weeks ago we referred to the important treaty entered into between Great Britain and China, by which the latter undertakes to establish divisional offices for the registration of patents, attention to which was directed by Messrs. W. P. Thompson and Co., patent agents. These gentlemen now state that, from advices just to hand, they learn that the regulations for carrying the undertaking into effect have been officially published. The British Government has assented to them, and the Japanese Government raises no objection, so that the regulations will no doubt be put into force if they are assented to by the United States Government. Briefly, the regulations are as follows: Any person desiring to use a trade mark in China must first register the same according to these regulations. The Board of Commerce shall establish a bureau of registration. Every application must contain a statement giving a general description of the trade mark, the class and particular kind of goods for

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which it is to be used. The application will be placed on file for three months and advertised by the bureau, and if no one petitions against it, it will be registered. If two persons apply for similar trade marks, the first applicant will receive registration, but in the case of a trade mark already registered in a foreign country, the date of such foreign registration will be recognised if application in China be made within four months. During the first six months of the establishment of the bureau, applications can be made for registration of trade marks already registered abroad, and the bureau shall recognise such trade marks as entitled to precedence. Any mark which has been publicly applied in China to a special article for more than two years before application for registration, cannot be registered. Suits for infringement by foreigners against Chinese are tried by a local magistrate and the consul sitting together, but if both parties to the suit be foreigners, the consular court has jurisdiction. Penalties for infringement are very severe. It is believed that the new treaty will prove very useful, as trade marks that are registered will be more efficaciously protected from infringement, but omission to register may involve loss of rights.

Revised Board of Trade Regulations.—In our issue of the 26th ult. we alluded briefly to the drafts of new regulations issued by the Board of Trade governing the supply of electrical energy, to supersede those promulgated in 1896, the Board being of opinion that the experience which has been gained during that period renders a revision desirable. The regulations are classified according to the character of the undertaking, as mentioned in our previous notice. The general trend of the proposed alterations is in the direction of greater liberality. In regard to pressures, the distinction between alternating and continuous current has been abandoned, and the following four standards have now been fixed for either type: low pressure, up to 250 volts; medium pressure, from 250 to 650 volts; high pressure, from 650 to 3,000 volts; and extra high pressure, exceeding 3,000 volts. Hitherto it has been necessary to obtain the express permission of the Board before supplying current at the consumer's terminals at any pressure greater than 250 volts; but now, on the consumer undertaking to observe reasonable precautions, such as earthing the frame of the motor, laying wires in earthed metal casing as far as possible, and providing suitable switches and protective devices, he may be supplied at any pressure up to 650 volts for such purposes as motor driving or series arc or incandescent lighting. A notice is also required to be fixed at every motor switchboard and motor, forbidding unauthorised persons to touch the apparatus. Special permission must be obtained for the introduction of medium pressures into consumers' premises for other purposes than those abovementioned, as well as for the introduction of high pressures. Extra high pressures may be supplied to factories, mines, and traction works, subject to the consent of the Board and the provisions of the Factory Acts and Mines Regulation Acts. In other respects the proposed new regulations do not materially differ from the existing ones. They are distinctly rational in character, and may be expected to exercise a beneficial effect upon the service and the industry. A code that is immutable as the laws of the Medes and Persians is obviously open to drawbacks; and a judicious provision has been inserted empowering the Board to vary the regulations under special circumstances.

Electricity in India.—The applications of electric power in the mill industries of India—jute and cotton—have not as yet, remarks the *Indian and Eastern Engineer*, reached that stage of development (which, however, we may before long anticipate) when the advantages of electricity will have generally supplanted the old type of transmission gear for the main mill drives, but it is being extensively adopted as an auxiliary for light and small power purposes, such as fans for offices and small motors for pumping purposes. Our contemporary gives some particulars concerning a plant of this description recently installed by Messrs. Burn and Co., of Howrah and Calcutta (whom, we note, have a number of Indian electrical contracts for various purposes in hand), for the Kankinarrah jute mills. This plant consists of three sets, the engines being of the Bellis-Morcom enclosed type, direct coupled to three generators made by the Clayton Engineering Company, each capable of dealing with 500 16-c.p. lamps at 225 volts pressure, or of supplying the equivalent amount of energy for other purposes. Steam is supplied to the engines at 160lb. pressure, but the cylinders are provided of sufficient area to enable the dynamos to supply full current at 126lb. pressure, an elasticity of generating power which is of great value under a variable load on the main boilers. All switches, measuring instruments, and cut-outs are mounted on marble slabs 1in. thick, polished and mounted in polished teakwood mouldings set 2ft. away from the wall, each end forming a hinged door so as to enable inspection and addition at the back of the board. Three circuit breakers are provided and adjusted to release with 10 per cent. overload. This pattern of circuit breakers is specially designed for switchboard work, and is so constructed as not only to release at the set current, but should the circuit be overloaded, it cannot be held closed. All the positive leads are taken to the left-hand side, and the negative to the right-hand side of the board. The circuit breakers are constructed so as to be a switch and circuit breaker combined. The three voltmeters are on the right-hand side, and the three ammeters on the left-hand side, all permanently in circuit with their own machines. The switchboard is so arranged that all the three engines can be run in parallel to supply all the light required during the evening in the mill and compound and bungalows, or if only part of the light is required, two engines only are worked, and during the day one engine only is run for the fans in the bungalows, offices, etc. All outside lights in the compound are of 32 c.p., and are in watertight pendants. The fans supplied consist of 28 of Messrs. Burn and Co.'s standard improved pattern, which are specially designed to run cool, and consume a small current. The armature is of considerable size—6½in. in diameter—drum wound on a hollow frame, and thus excellent ventilation is provided for. There are six field-magnet coils, all series wound, and the bearings are all self-aligning, and are automatically lubricated. The commutator is of extra large dimensions—2in. in diameter—formed of hard-drawn copper bars insulated with mica, and large carbon brushes are held by spiral springs against the commutator. The general arrangements allow of any extensions being provided with a minimum of disturbance to the existing plant.

Underground Temperatures. — At the recent meeting of the British Association at Cambridge the several distinguished scientists appointed to the Committee for Investigating the Rate of Increase of Underground Temperatures Downwards in Various Localities of Dry Land and under Water presented their twenty-third report. The investigations cover a wide area, and the report, in merely abstract form, extends over several pages, so we propose to briefly recapitulate some of the results. A preliminary report respecting the Calumet and Hecla mine puts the rate of increase at 1deg. F. in 120ft. to 130ft. Two of the Bendigo gold mines were tested, at depths of 3,000ft. and 3,645ft. respectively, each showing an increase

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at the rate of 1deg. in 80ft. The mean surface temperature inferred from observations at 182ft. and 247ft. in neighbouring shallow shafts was 61·4deg. Electric resistance platinum thermometers were used in this instance. Tests on mines at Ballarat, Maldon, and Port Jackson yielded very similar results. A shaft, some 3,300ft. deep, was recently sunk at the collieries of Rouchamp, in the eastern division of France, and investigations showed the increase in rock temperature to work out at the rate of 1deg. in 46ft. Regular observations have been taken in the Simplon Tunnel, and on its completion, which is imminent, the results will be at once communicated to one of the London societies. The recently published report of the Royal Commission on Coal Supplies, which contains a quantity of evidence on temperatures in deep coal-mines, is dealt with at some length. At the Rams mine, Pendleton, the temperature at 3,483ft. below the surface was found to be 100deg., showing an increase of 53deg. over the surface temperature, or 1deg. in 66ft. At the Agecroft Colliery, in the same district, the deepest observation was made at 2,940ft., where the temperature was found to be 92 5deg., showing an increase of 1deg. in 65ft. In the North Staffordshire coalfield, Mr. W. N. Atkinson, H.M. inspector of mines, found the following temperatures at the greatest depths reached: Sneyd Colliery, Burslem, 87 5deg. at 2,625ft.; Glebe Colliery, 83½deg. at 2,295ft.; Great Fenton Colliery, 85deg. at 2,400ft. Assuming 48deg as the surface temperature, the mean rates of increase are: Sneyd, 1deg. in 66·5ft.; Glebe, 1deg. in 65·1ft.; Great Fenton, 1deg. in 64·9ft. The method of observation was to drill a hole, insert a bottle of water, and after leaving it in the hole, plugged with clay, for 24 hours or more, take it out, and put a thermometer into the water in the bottle. In the Sneyd Colliery observations were thus taken at 13 depths during the sinking of a shaft, beginning with 1,104ft. and ending with 2,625ft., and the increase shown was fairly regular. The Glebe and Great Fenton observations were also in sinking shafts. Tests made in other mines show large variations, the increase of temperature in the case of the Hamstead Colliery in South Staffordshire amounting to no more than 1deg. in 110ft. Prof. H. Höfer, of Austria, has recently issued a circular recommending for temperature observations during the sinking of mining shafts the use of maximum thermometers divided to fifths of a degree Centigrade, to be inserted in holes bored to the depth of at least 2m. in the floor or side, and well plugged. The observations are to begin at 25m. from the surface, to be repeated at intervals of 50m. till a coal seam is approached, and then at shorter intervals through and a little beyond the seam. This process is to be repeated for every seam that is traversed. A main purpose of such investigation is to determine the influence of coal seams on the temperature of their surroundings.

The Poulsen Telegraphone. — In our issue of April 26, 1901, we gave a description of an electromagnetic phonograph, termed the "Telegraphone," designed to record and audibly reproduce telephone messages, the apparatus being the invention of a Danish engineer, Mr. V. Poulsen. Since its inception the inventor has been engaged in improving the device, and a syndicate has been formed at Copenhagen for its exploitation. Some new facts relating to the system are communicated to the *American Telephone Journal* by Dr. A. Gradenwitz. The principle on which the apparatus is constructed is indicated by the following description: On a cylinder is wound a steel wire or band, running in front of the poles of an electromagnet, to the poles of which a microphone is connected. On speaking into the microphone, induced currents produce continuous variations in the field strength of the electromagnet and coils, causing changes in the magnetism produced by the latter in the steel wire. This magnetism is permanent, and serves to register language. Reproductions are made by the steel wire bearing the electromagnetic record being drawn along before the poles of a similar electromagnet inserted into the circuit of a telephone, so that the process will be repeated in inverted order, acoustic vibrations analogous to the original vibrations being produced in the telephone membrane. Considerable loss in the language currents was found to result from the imperfect utilisation of the lines of force of the record in the process of reproduction. In order to obtain effects as satisfactory as possible, the pole of the iron core is entirely covered by the windings, as shown in

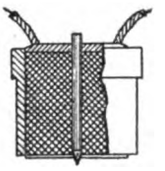

FIG. 1.

Fig. 1. The records may be reproduced more than 10,000 times without any diminution in the intensity being noted; though, on the other hand, they may be easily erased by a comparatively strong magnetisation of the whole record material. The record may be transmitted to another record material, yielding a somewhat weaker copy. About a year ago the inventor tried, with excellent results, a form of record material similar to that used in mechanical phonographs, but in the latest type of apparatus the steel cylinders are replaced by thin steel plates, the latter being cheaper and more convenient. These steel plates are susceptible of receiving records on both sides, and their dimensions permit of them being sent anywhere through the post, in order to be reproduced on a similar apparatus. Among other purposes, the telegraphone has been used to give and receive messages by telephone in the absence of one of the parties. This has been done between New York and Washington, the reproduction being quite distinct, notwithstanding the distance. Plate apparatus, with greater plates capable of stronger acoustic effects, are expected by the inventor to be of use for instruction in language, singing, and rhetoric, the voice being reproduced in natural tones instead of the peculiar accents noticed in the ordinary phonograph. The telegraphone has also been used to record wireless telegraphy dispatches, though the results so far obtained have not been very satisfactory. A special application of the telegraphone is known as the "telephone newspaper," being an apparatus by means of which a speech, song, etc., may be distributed to any number of people. An endless steel band is laid round two rotating

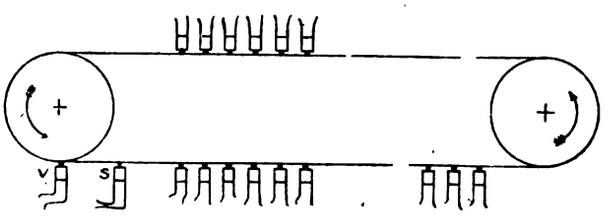

FIG. 2.

discs, as shown in Fig. 2, and these discs draw the band before an electromagnet that records the news. The discs are afterwards carried before a large number of "reading magnets," arranged in a long series, one behind the other, each being in connection with a different telephone line. The record band eventually passes in front of an obliterating magnet, V, whence it again passes before the recording magnet, and so on.

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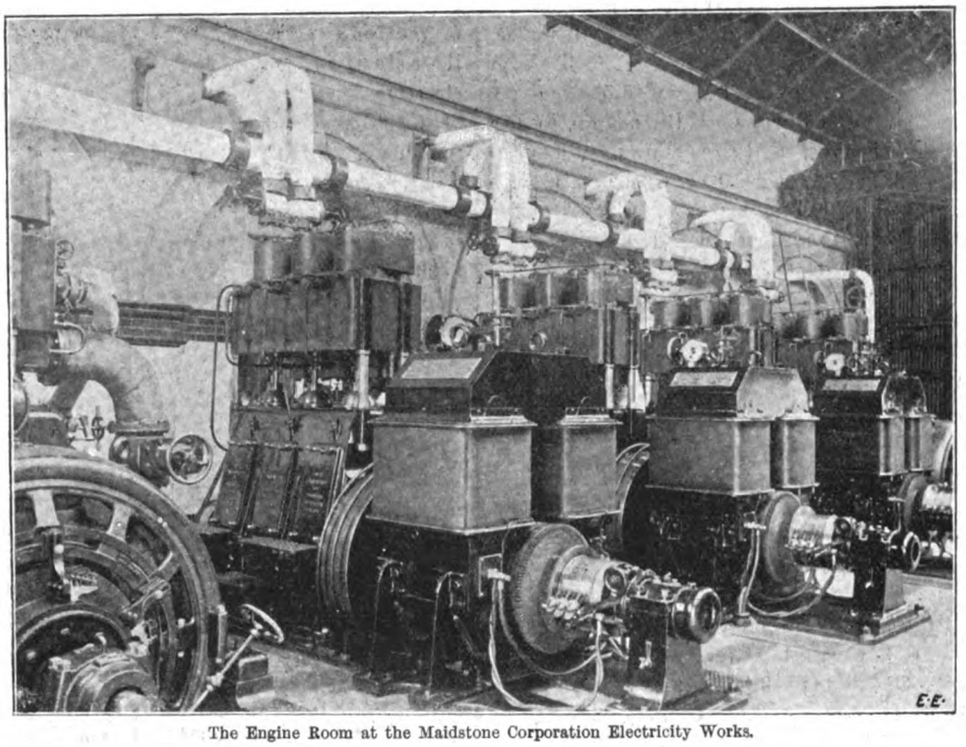
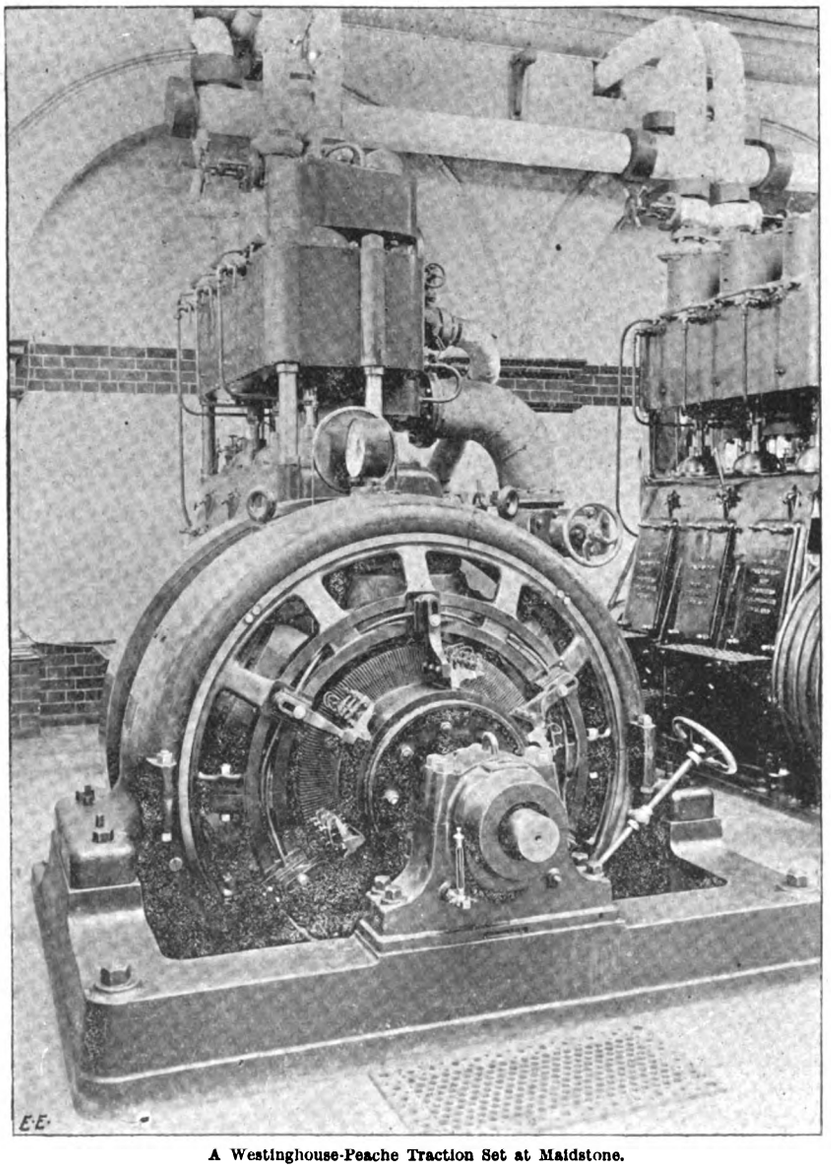
MAIDSTONE ELECTRIC TRAMWAYS.



The Engine Room at the Maidstone Corporation Electricity Works.



A Westinghouse-Peache Traction Set at Maidstone.

The chief town of Kent is noted for the keenness displayed by its inhabitants in things municipal and for the opposition with which any innovation is met. It speaks volumes, therefore, for the Committee, who are

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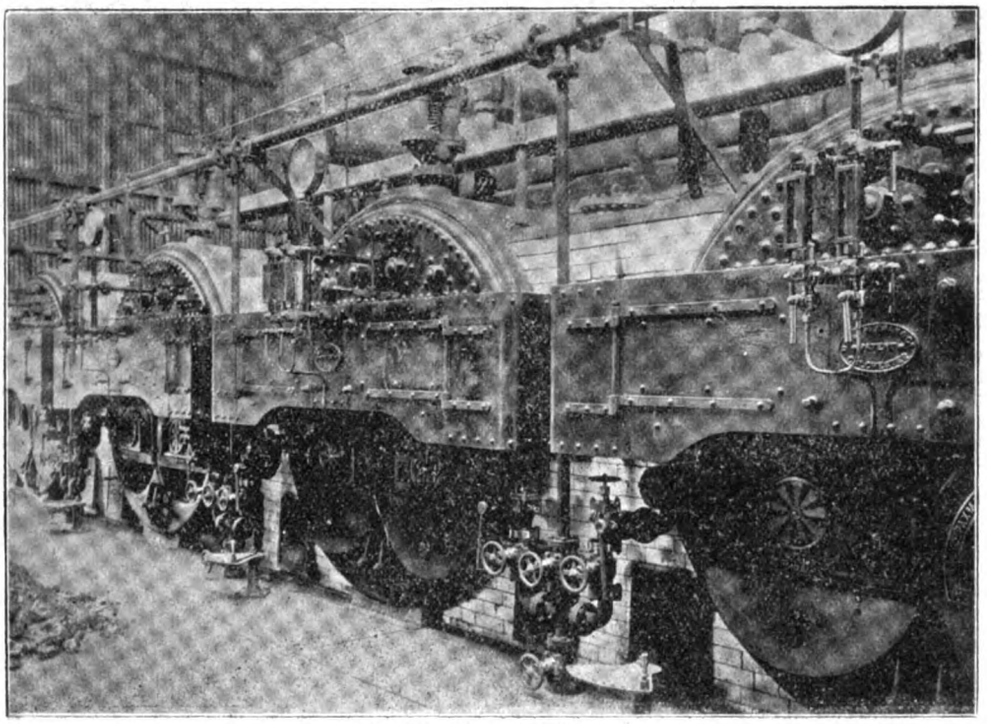
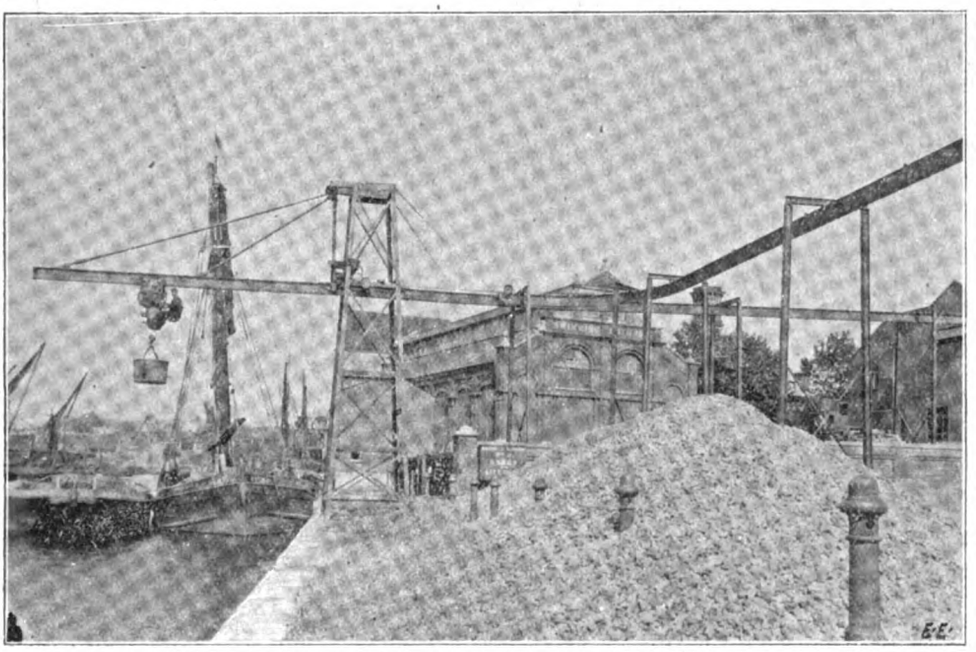
responsible for the introduction of electric traction in Maidstone, that they have succeeded in carrying through their scheme to a successful issue. The opponents of the scheme were unkind enough to say that the destinations of the three lines first to be constructed were emblematical of the policy of the Tramway Committee. As an explanation is needed to those of our readers not well acquainted with Maidstone, we may add that the workhouse is near the terminus of the one line, the second passes by a lunatic asylum, while the third goes to the cemetery. We may be quite sure, however, that the opponents of the tramway system will be amongst the first to support it when they find what a convenience it is, and they may perhaps remember that it was the opposition to the introduction of railways which caused the main lines to leave Maidstone on one side of their fast routes.



The Boiler House at Maidstone.

The power required for driving the tramways is supplied by the Corporation's electricity works in Fair Meadow, which were described in our issue of Jan. 3, 1902. These works were opened in December, 1901, the plant then installed being as follows; four Economic multitubular boilers made by Davey, Paxman, and Co., Limited, each capable of evaporating 6,000lb. of water per hour at a working pressure of 160lb. per square inch; four Peache three-crank compound single-acting engines of 250 h.p. each and one of 125 h.p., direct coupled to shunt-wound bipolar dynamos by Thos. Parker, Limited, and of a total capacity of 675 kw.; condenser by Cole, Marchant, and Morley, capacity 18,000lb. of steam per hour at 26in. vacuum—circulating water is obtained from the River Medway, about 50 yards distant; two Chloride batteries of 140 cells each, and of 400 ampere-hours capacity; switchboard by Messrs. Kelvin and James White.

Since 1901 several important extensions have been carried out—viz., an overhead electric conveyor has been erected, which is arranged to unload coal from barges on the river and deliver it direct into a new coal store which has been constructed at the side of the boiler-house. A branch track is also provided parallel to the river, and the conveyor can be used on this for unloading road metal for the highways department. One of Messrs. Paterson's patent grease separators has been installed for purifying the con-



Overhead Electric Coal Conveyor at the Maidstone Electricity Works.

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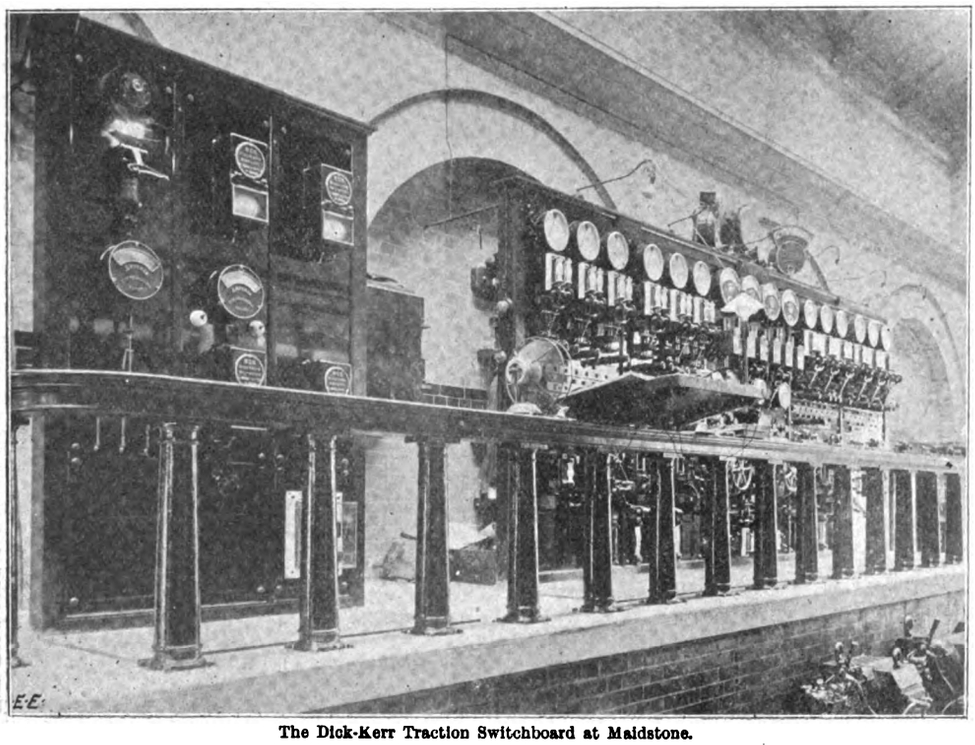
densed steam to enable it to be used for boiler feed, and any make-up water required is treated in a water softener made by the same firm.

In order to provide power for the tramways, the 75-kw. set was changed for one of 150 kw., consisting of a Peache engine direct coupled to a compound-wound dynamo of the British Westinghouse Company's manufacture. The existing dynamos being all shunt wound, and it being advisable to have a duplicate set available for traction purposes, another Westinghouse machine was substituted for the 150-kw. Parker dynamo on the No. 5 engine, and a heavier flywheel was fitted. Switches are provided on these machines for cutting out the series winding, and the leads from both dynamos are taken to the lighting switchboard, where by an arrangement of plugs they can be run on either the lighting or traction 'bus bars. Maximum and reverse current circuit breakers are fitted on the positive side of each machine, and 300-ampere knife switches on the negative poles.

The switchboard gallery has been extended, and a three-panel traction board by Messrs. Dick, Kerr, and Co. erected at a sufficient distance from the lighting board to allow for another feeder panel being added to the latter. At present there is only one feeder on the traction board for the line and one for return. The instruments on the line panel comprise a 300-ampere magnetic blow-out circuit breaker, one 300-ampere meter, one 300-ampere knife switch, and fuses for voltmeters and recording wattmeters. The Board of Trade panel contains a 5–0–5 recording ammeter, line leakage testing ammeter, and rail-drop recording voltmeter. On the negative panel are a recording voltmeter and a recording ammeter (N.C.S.), and a B.T.H. watt-hour meter. A subway has been constructed leading from the chamber under the switchboards to the street, and this will greatly facilitate the bringing in of any new cables.



The Dick-Kerr Traction Switchboard at Maidstone.

One of the Maidstone Tramcars.

For the tramway itself the main contract was placed with Messrs. Dick, Kerr, and Co., and include the permanent way, overhead equipment, cars, and car-shed, and an addition to the switchboard. The route length of the permanent way is just over two miles, and is of single track with

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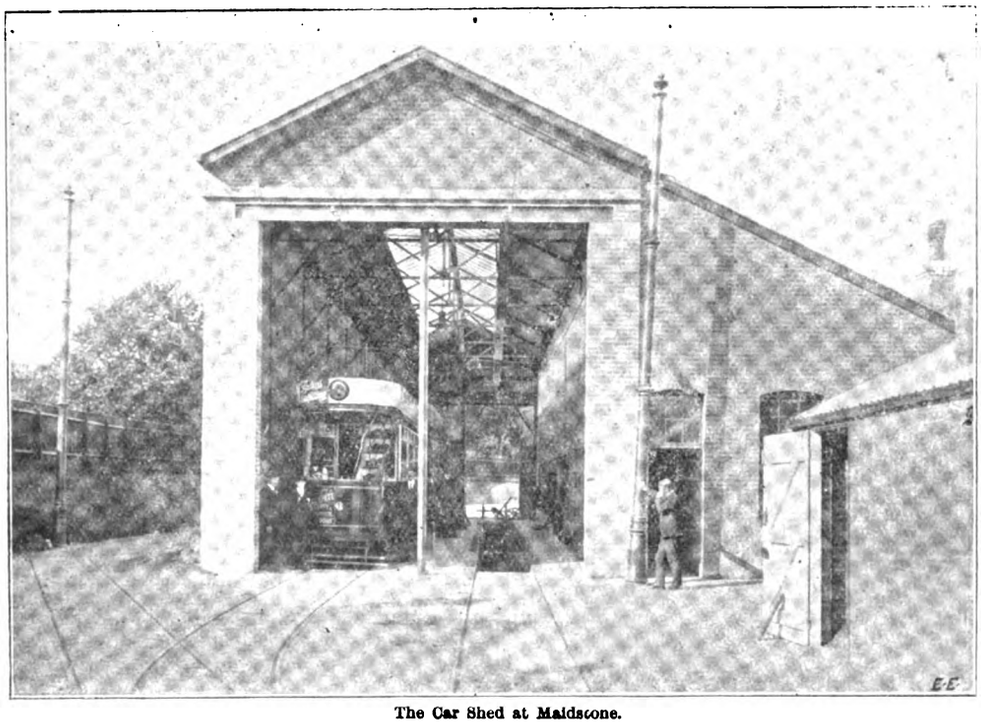
passing places throughout. The gauge of the line is 3ft. 6in. The form of construction adopted is as follows: The portion of track within the town proper is paved with 9in. by 3in. hardwood blocks, and for a part of the length where the gradient approaches 1 in 15 the track has been paved with 5in. by 4in. granite setts. The remainder of the track, amounting to about one mile, in the outlying portion of the town, where the traffic is slight, has been paved with a serration of granite on either side of the rails, with macadam filling in between, this form of construction lending itself particularly well to roads subjected to light traffic, and is, of course, particularly favourable upon grounds of economy. The points are in accordance with the latest practice, and are 13ft. long over all, of the extended leg type, the tongues, which are 8ft. 6in. in length, being specially spiralised in order to give the cars easy entrance to the loops. In connection with the granite serration and macadam paving, the concrete bed has been put in to the full width of the tramway formation to provide for paving the track throughout at a later date, should the Corporation decide to do so. The rails used are the British standard No. 2 section, weighing 95lb. per yard. The joints are of the "Dicker" type, fixed by 6in. bolts fitted with the Eureka lock. Tie-bars are spaced at 6ft. centres, and are of the patent rolled weldless type. The track has been bonded throughout with 4/0 Neptune bonds. In addition to the track work, widenings have to be carried out at three points along the route, amounting in all to 700 yards of route. The overhead equipment is on the span-wire system, and is of a particularly neat and rigid construction.

Overhead Work, Maidstone.

The cars, of which there are six, are double-deck, single-truck, and are built to run on a gauge of 3ft. 6in. They have all the very latest improvements, and are similar to the cars recently supplied to the Leicester Corporation, and were built for Dick, Kerr, and Co. by the Electric Railway and Tramways Carriage Works, Limited, of Preston. Each of the six cars has a seating capacity of 48 persons—22 inside and 26 outside—and is supplied with a complete electrical equipment. The motors are Dick-



The Car Shed at Maidstone.

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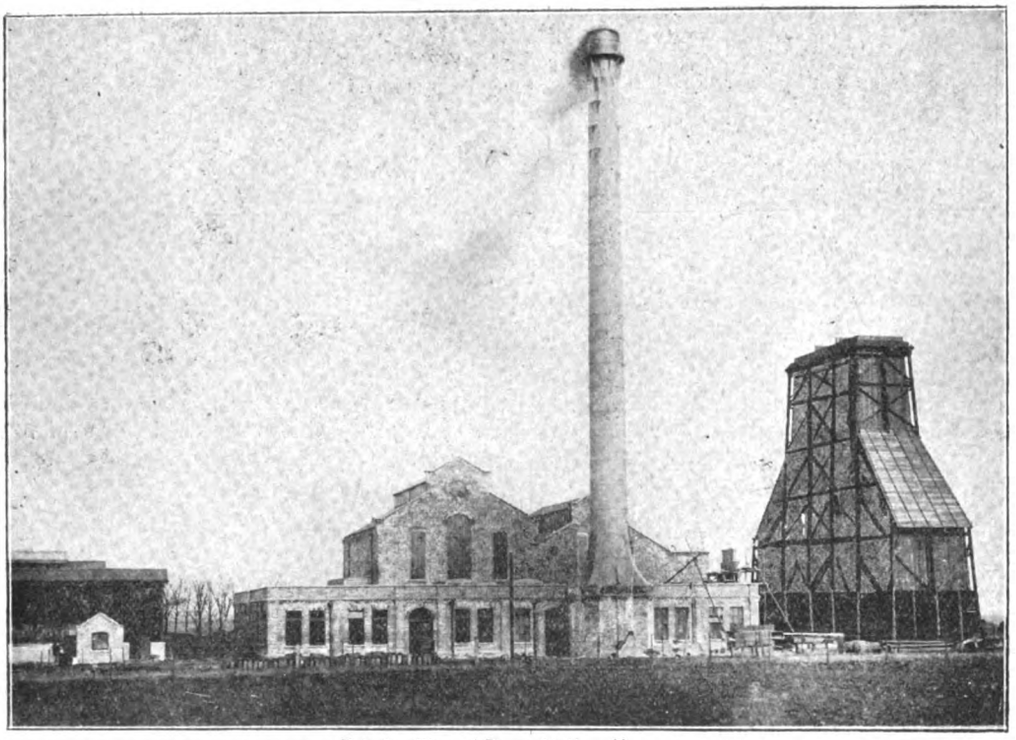
Kerr's standard 25 B type, 500 volts, and will deliver approximately 28 h.p. at the armature shaft, based upon the standard rating—*i.e.*, a rise in temperature of not more than 75deg. C. in its various parts after running at a full load for one hour. The equipments are mounted on Brill 21 E trucks. The controllers supplied with the electrical equipments are Dick-Kerr's standard D.B.I. form, C type, especially arranged with resistances for rheostatic braking, operated by the driving handle, which may be utilised either when the car is proceeding backwards or forwards.

The car-shed has been built to accommodate six double-deck cars, and has been constructed with a view to rapid and economical extension. The building is generally of brick, but the east wall, on which side the extension will probably be made, is panelled with 9in. brickwork between steel stanchions carrying the roof principals. The roof has been covered with 5in. pitch galvanised iron, provision being made for the substitution of slate should this be decided upon at a later date. The main shed proper contains pit accommodation for four cars. Provision has also been made for offices and stores, also paint and work shops for repairing the cars.

The whole of the work has been designed and carried out to the satisfaction of Mr. E. E. Hoadley, the borough electrical engineer of Maidstone. The engine foundations, steam and exhaust pipes, cables, and cablelaying within the station have all been carried out by the Corporation's own staff. The tramway load will be of great service to the undertaking, but we are pleased to know that by energetic management Mr. Hoadley has also obtained a good motor load which for a non-manufacturing town like Maidstone is exceptional.



Exterior View of Power Station, Sheerness.

THE ELECTRIC LIGHTING AND TRACTION UNDERTAKING AT SHEERNESS-ON-SEA.

The supply for lighting and traction purposes of the Sheerness and District Electric Power and Traction Company was started in April, 1903. The provisional order was obtained in 1900, and on October, 1902, building operations were commenced. Sheerness numbers about 18,000 inhabitants, mostly connected with the naval dockyard, where some 4,000 workmen find employment. The line starts at the dockyard railway station, runs along the dockyard entrance gates and the passenger station of the South-Eastern and Chatham Railway, through the principal business street of the borough, up to the Sheerness East Station of the Sheppey Light Railway, about one mile outside the town. There are possibilities of a remunerative traffic during the summer months from the trippers going to Leysdown, a small but growing seaside resort, and during the winter months from dockyard men coming from and going to the docks at noon and at five. Owing to the land in and around Sheerness nearly all belonging to the War Office, no suitable site was found available near the centre of the town, and it was resolved to build the power station and car sheds on some private land near the end of the line, where a supply of water from a well could be got from the owner of the land.

The power station buildings are of local yellow stocks, the chimney stack being of steel plates on a brick base. The design of the station was kept on the standard lines of the other stations of allied companies at Weston-super-Mare, Birkdale, Banbury, etc. The boiler-room, which is 39ft. in width, contains three Babcock-Wilcox boilers, two of which are in a battery, with a heating surface of 3,200 square feet each. The condenser, together with other apparatus, as feed pumps, feed heater, hot-well, grease separator, etc., has been put up in a separate room, and was supplied by Messrs. Allen and Sons, Bedford, and fitted with Edward's air-pumps. The feed pumps are made by Messrs. Weir and Co., and the grease separator by Holden and Brooke. In order to be quite safe from oil entering the water-tube boilers, a Rankine filter was also installed. The steam-piping, supplied by Messrs. Babcock and Wilcox, consists of one main header interconnecting the branches to the boilers and engines in such a way that each boiler supplies its own engine in a straight line. The engine-room is 32ft. 6in. wide and well lighted and ventilated. The engines are three high-speed Browett and Lindley enclosed type, coupled to three Brush 100-kw. continuous-current dynamos generating at from 420 to 550 volts. The generators are of the four-pole type for 450 revolutions, and have light aluminium brush-holders. They are provided with equalising switches mounted on the same base as the series field breaking switches, to enable the generators to run in parallel on the traction load. The switchboard is of black slate and of the usual B.T.H. pattern, with generator panels on the one side and feeder panels on the other. There are, further, a balancer-booster set and a storage battery for the lighting load, of ample capacity, while the roof of the battery-room is constructed strong enough to carry a traction battery later on, should this be desirable. The engine-room is spanned by a 10-ton overhead traveller. The feed and circulating water is supplied, as mentioned before, from a well some few hundred yards away by an air-driven plant on the well known American system.

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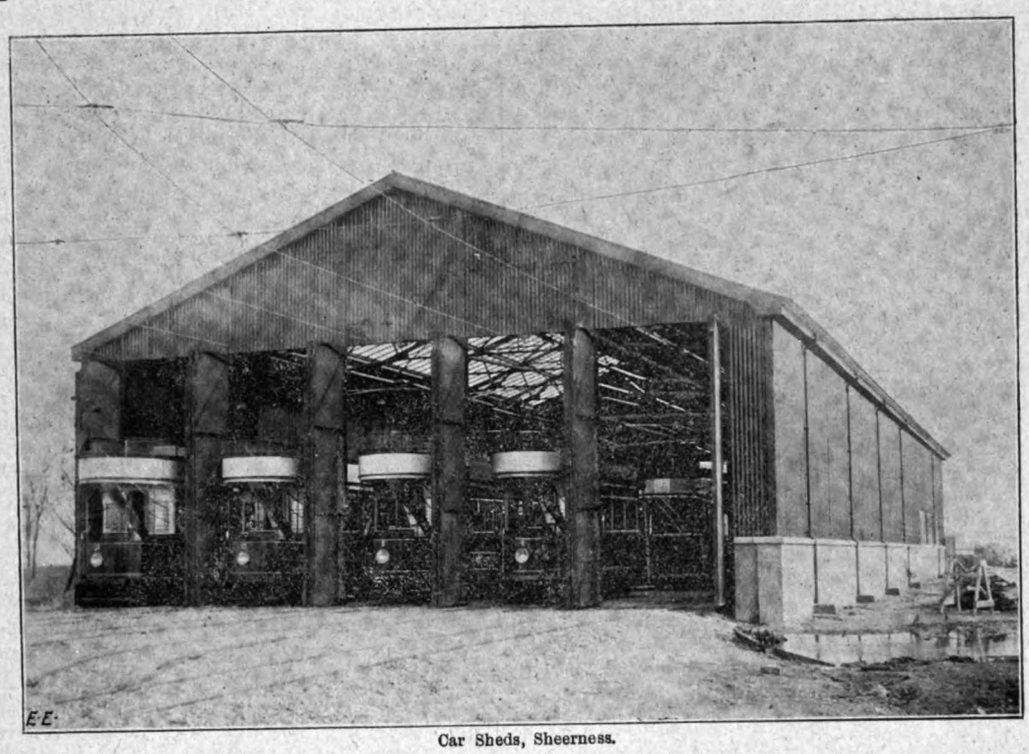
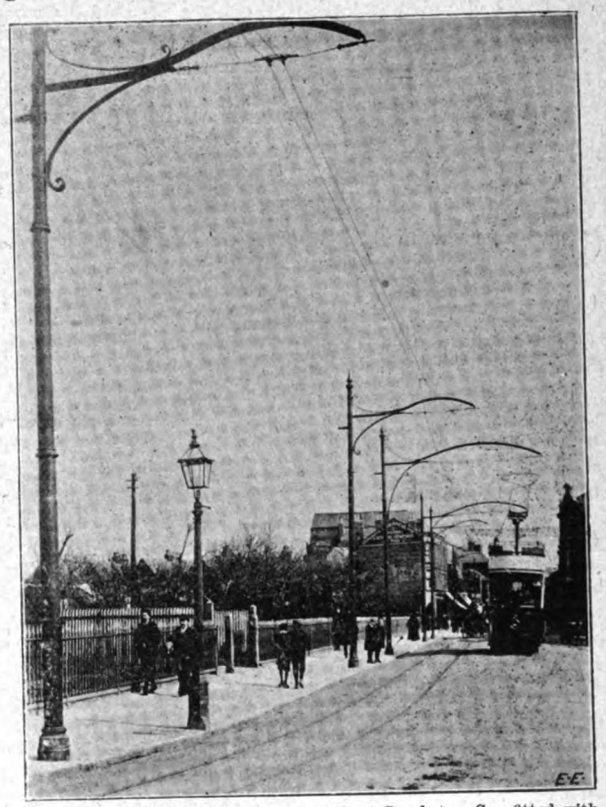
The 12 cars at present constituting the rolling-stock are all double-deckers, each carrying 26 outside and 22 inside, and were built, together with the electrical equipments, by the Brush Electrical Engineering Company at their Falcon Works. The brakes adopted are hand and electrical brakes, and the lifeguards are on the Tidswell pattern of a somewhat lighter construction. The cars are fitted with a sliding bow instead of the usual trolley, and this sliding bow together with the overhead equipment constitutes a decided novelty, as it is the first installation of this kind in England. The light and gracefully shaped bow is carried on a steel base which also carries the spring. In a later pattern, however, this spring is mounted inside the base like an ordinary trolley base.



Car Sheds, Sheerness.

Side Pole Construction, Sheerness.

The car-sheds have been built by Messrs. Johnes to the design of the architect, Mr. W. Gray, and are of galvanised iron on a concrete base. They have room for 18 cars on five tracks, two of which are built over pits 6ft. deep. Provision is made for effecting ordinary repairs, a shop for that purpose being fitted with lathes and drilling plant, etc. The sheds and shops are well lighted and ventilated. The shunting yard is conspicuous for the absence of switches and frogs in the overhead gear, and compares very favourably with a shunting yard for a trolley line. The tracks are laid on wooden sleepers and are well ballasted. The total length of the track is 2½ miles—2¼ miles of which is single and a quarter mile double track. The gauge is 3ft. 6in., on account of the narrow streets in Sheerness. The track is laid on a bed of concrete under the rails only, in order to keep down capital costs, and was constructed by Messrs. J. G. White and Co. The rails are 91lb. per yard and are in 42ft. lengths. The width of the groove is 1⅛in., although 1¼in. should have been permitted with regard to the traffic, which only consists of broad-tyred



Side Pole Construction with Long and Short Brackets. Car fitted with Sliding Bow in background.

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carts. The joints are made on the Anchor joint pattern, and double bonded. Cross-bonds occur every 40 yards, and all frogs and crossings have not less than two bonds. The points and crossings, supplied by Messrs. Askham Bros., are of crucible cast steel, with long tongues. The paving consists of granite setts at the turn-outs, and Constable's tar macadam on the single line, with a row of setts along the rails.

The whole of the overhead equipment has been carried out by Messrs. J. G. White and Co., side poles with long and short brackets being used, together with a little span-wire work at some points of the system. The poles are 30ft. long, and planted 6ft. in the earth surrounded by concrete. Mechanical ears are used, while the sliding bow requires special material of an exceedingly pleasing and practical design. It is much lighter and the points of support are less than with a trolley. The same applies to the number of poles used; also there are no frogs and crossings in the overhead equipment. The wire, with a section of 00 B. & S. gauge, is suspended on the bowstring principle, and divided into half-mile sections. Overhead guard and telephone wires, supported on insulators and brackets, are provided, the guard wires being bonded to the track. The cables have been supplied and laid by Callender's Cable and Construction Company on the solid system under the footway. One of the feeders is spliced at the feeder box somewhere near the Crescent, and feeds the half-mile sections on the Parade and West-street. There is only one return feeder, while at the end of the line, near the power station, the track is connected to the negative 'bus bars.

There are at present 1,700 8-c.p. lamps connected to the lighting mains, together with some motors. A feeder to Queenborough has been decided upon, and additional demand for power purposes may be expected from a factory building near the power station.

The entire undertaking has been designed by Mr. Gerald Hooghwinkel, M I.E.E., of the staff of the Electrical Power Distribution Company, Limited, while the buildings and car-sheds were erected to the design of Mr. W. Gray, of 11, Adam-street, London, W.C.

AN ENGINEERING DEGREE, AND HOW TO GET ONE.

BY A.M.

About two years ago the University of London issued regulations for a B.Sc. degree in engineering, and the scheme is now in full working order. How many men now at work in the engineering profession regret that they have no convincing evidence of their knowledge of engineering science. Some, perhaps, possess their college certificate, and find it quite unknown and unrecognised outside of a small district. Others, again, have passed the associateship examination of the Institution of Civil Engineers. But what of the young electrical engineer who aspires to higher posts, whose chief is not perhaps a member, and able to nominate him for membership of the Institution of Civil Engineers? To him and to many others the new degree offers the advantage of a hallmark of the very highest class, and yet one which may by hard work be won in the leisure time of the engineer engaged in his profession. Some of the provincial universities have granted their degrees in engineering for years past, but these have generally only been open to those fortunate enough to be able to take a fairly complete day course of instruction, the qualification being by attendance and examination; and many well-trained men from other institutions are left with no widely recognised diploma.

The older science degrees of London University are, in academic circles, held in estimation second to none, and the up-to-date syllabus of subjects and the ground covered by them ensures for the new engineering degree a similar high regard among technical engineers—and one which is almost certain to increase with years. The Institution of Civil Engineers accept holders of this degree for associateship without requiring them to pass the usual examination.

How can such a degree be obtained? In the first place, like almost everything else worth having, it means work. If the aspirant is residing in London, he had better consult the head of the engineering department of one of the many institutions comprising or affiliated to the London University. But to take a more general case. Suppose his work lies in the provinces. His first stage will, to an engineer, offer, perhaps, the greatest difficulty of any; he must, if he has not already done so, pass the matriculation examination. But even matriculation is not so dreadful now: Latin, the bugbear of so many students of science, is no longer a compulsory subject. The subjects which an engineer would probably choose are: (1) English; (2) elementary mathematics; (3) French; (4) elementary mechanics; (5) elementary physics, chemistry, or geometrical and mechanical drawing. Some assistance with most of these subjects could, if necessary, be obtained in evening classes in nearly any town in this country.

Having matriculated, the more serious work of the intermediate examination begins. The subjects most likely to be undertaken are: (1) mathematics; (2) mechanics; (3) engineering drawing; (4) electricity and magnetism; (5) heat and optics, or chemistry or geology. This examination is by no means a difficult one: the standard of the various subjects is about the same as that of the advanced stage of the Board of Education examinations; a candidate residing within range of an institution in which South Kensington science evening classes are held in these subjects, would be able to get a great amount of assistance from them.

Lastly, there is the B.Sc. or final examination. This examination is, of course, of a higher standard than the two preceding ones, but as the subjects are all those with which the candidates are presumably best acquainted, and in which they are most interested, it does not necessarily offer the greatest obstacle to the ultimate goal. The range of subjects being a large one, a considerable amount of choice is provided, so that the electrical engineer, the mechanical engineer, and the civil engineer can all find a suitable combination. The subjects are divided into two groups. In Group A three subjects have to be taken out of the following four: (1) theory of machines and machine design; (2) theory of structures and structural design; (3) strength and elasticity of materials; (4) electrical technology. In Group B two subjects for a pass, and three for honours, are necessary, selected from the following seven: (1) hydraulics; (2) surveying; (3) theory of heat engines; (4) design of electrical machinery and apparatus; (5) generation, transmission, and distribution of electrical energy; (6) higher mathematics; (7) advanced theory of machines and structures. It will be sufficient to indicate a choice for an all-round engineer, including, of course, electrical knowledge; the modifications for other branches will be obvious. In Group A the subjects of theory of machines, strength of materials, and electrical technology would be presented, and in Group B electrical design and electrical energy, with probably theory of heat engines, if the candidate aims at honours.

In, say, Manchester, where there is an exceptionally large number of technically educated young engineers, evening classes can be found covering the whole range of these subjects. In other large towns not quite so fortunate in the matter of technical education, a very great deal of assistance could be obtained from existing classes even if the entire ground is not covered, while to the man in the more remote country towns there is open correspondence tuition, and, above all, if he has learned how to *read and learn* for himself, there is the great opportunity of self-education.

Full regulations of the examinations with detailed particulars of the ground covered in each subject may be obtained free on application to the external registrar of London University, as may also those of the matriculation examination.

Lastly, there is one other class of persons to whom this subject is of importance—viz., parents, guardians, and advisers of youths who are destined for the engineering profession. The latter are often limited by circumstances to one or perhaps two years at college; to these a degree is still a possibility, for part of the work can be done at college, and the remainder, by an industrious youth, after leaving. There is one most important piece of advice to be urged if a degree is remotely contemplated: let a youth

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matriculate before leaving school, for his school learning is generally soon forgotten. Even if the degree work is not afterwards followed up, the matriculation certificate is accepted in lieu of the examination for admission as a student of the Institution of Civil Engineers and various other bodies.

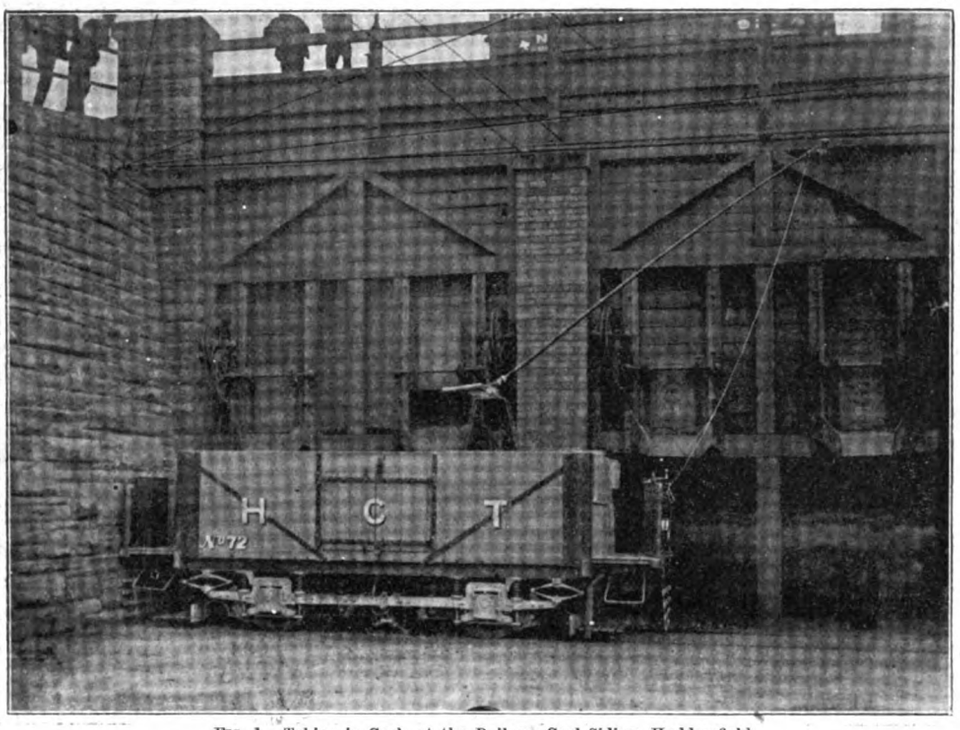

FIG. 1.—Taking in Coals at the Railway Coal Siding, Huddersfield.

ELECTRICAL COAL HAULAGE ON THE HUDDERSFIELD CORPORATION TRAMWAYS.

Through the courtesy of Mr. H. N. Thomas, the general manager and engineer of the tramway department, we are able to give in this week's issue some interesting photographs and particulars of the scheme of electrical coal haulage introduced by him. As our readers will know, Mr. Thomas is leaving the employ of the Huddersfield Corporation to undertake similar duties for the Durban Corporation. In consequence of his early departure for South Africa the trials of this coal delivery wagon have been expedited, and were successfully accomplished last week.

The scheme broadly consists in making the municipal tramways a link between the coal shoots on the railway and the coal bunkers of large manufacturers. In order that this might be done, permission had to be obtained from the railway companies to run a tramway line into their coal yards. The negotiations for this permission were successful, and we must congratulate both Mr. Thomas and his committee on the fact. The difficulty in the way of a settlement was that a tramway authority, which is an active competitor of the railways, was the applicant for the convenience. The Corporation had to approach the joint railway companies—*i.e.*, the London and North-Western and the Lancashire and Yorkshire. As it was a new departure, the matter had to be brought before the directorates of both companies, but it was eventually agreed that the Huddersfield Corporation

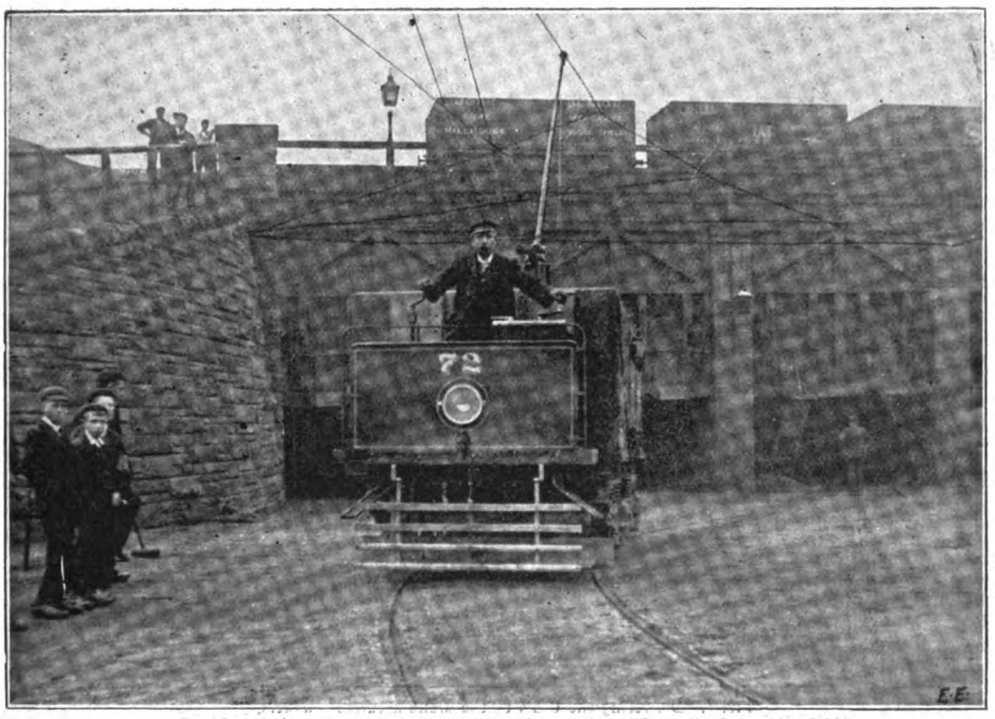

FIG. 2.—The 10-ton Electric Coal Wagon leaving the Railway Yard, Huddersfield.

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should lay tramlines in the coal-shoots yard at Hillhouse, so that wagons might be run into it and receive the coal from the delivery places at the shoot mouths. The ratification of the agreement was announced at a recent Council meeting. The completion of an agreement between the Corporation and Messrs. Martin, Sons, and Co., Limited, manufacturers, Wellington Mills, Lindley, which had been provisionally on foot for some time, was reported to the same meeting. The Corporation constructed a line running from Bradford-road along Whitestone-lane into the railway coal-shoots yard, a distance of about a quarter of a mile, and Messrs. Martin, Sons, and Co. have constructed a tramway line from the main road, on the way to Salendine Nook, into that portion of the premises where the coal has to be delivered. The overhead equipment for this short line has been put up by the Corporation workmen, under the superintendence of Mr. H. N. Thomas. The total length of the journey from the coal shoots at Hillhouse to the delivery place at Wellington Mills is about four miles.

Our photographs (which were taken by the chief engineering assistant, Mr. J. C. Whiteley) are most interesting, and due credit must be given to this gentleman for the assistance he has rendered to his chief in the carrying out of this pioneering work.

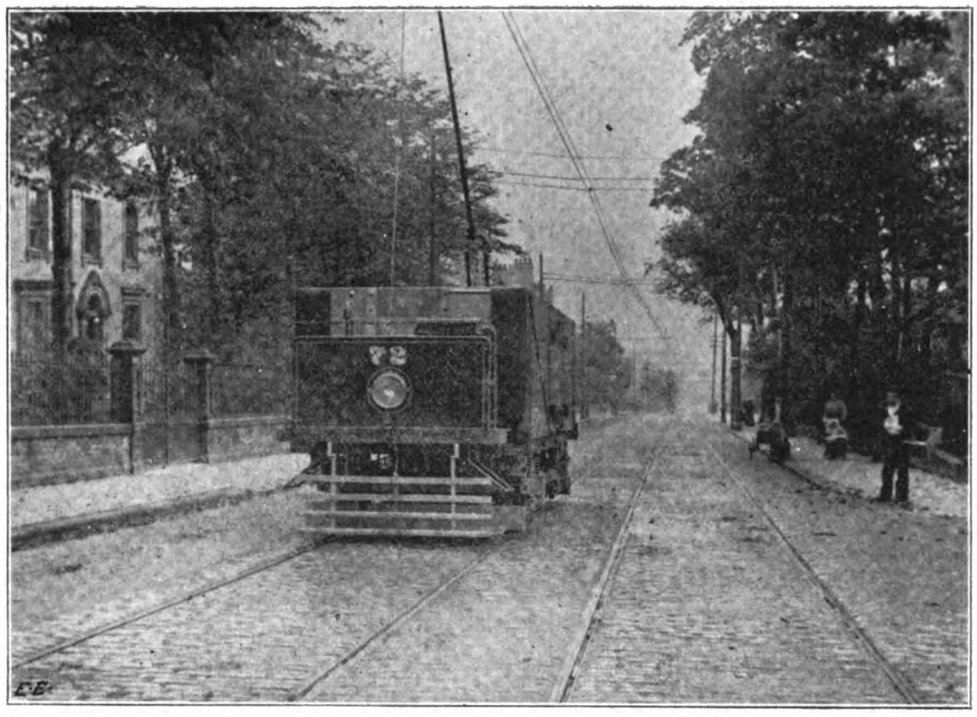

FIG. 3.—Electric Coal Haulage on the Huddersfield Corporation Tramways.

In these photographs Fig. 1 shows the wagon in position at Hillhouse coal sidings, Huddersfield, under the shoots. Fig. 2 is of a loaded coal wagon leaving the coal siding. Fig. 3 shows a coal wagon on the line of route through one of the residential districts; the grade the wagon is standing on is 1 in 18. Fig. 4 is the final stage, where the wagon is discharging coal in the bunkers at Martin's Mill.

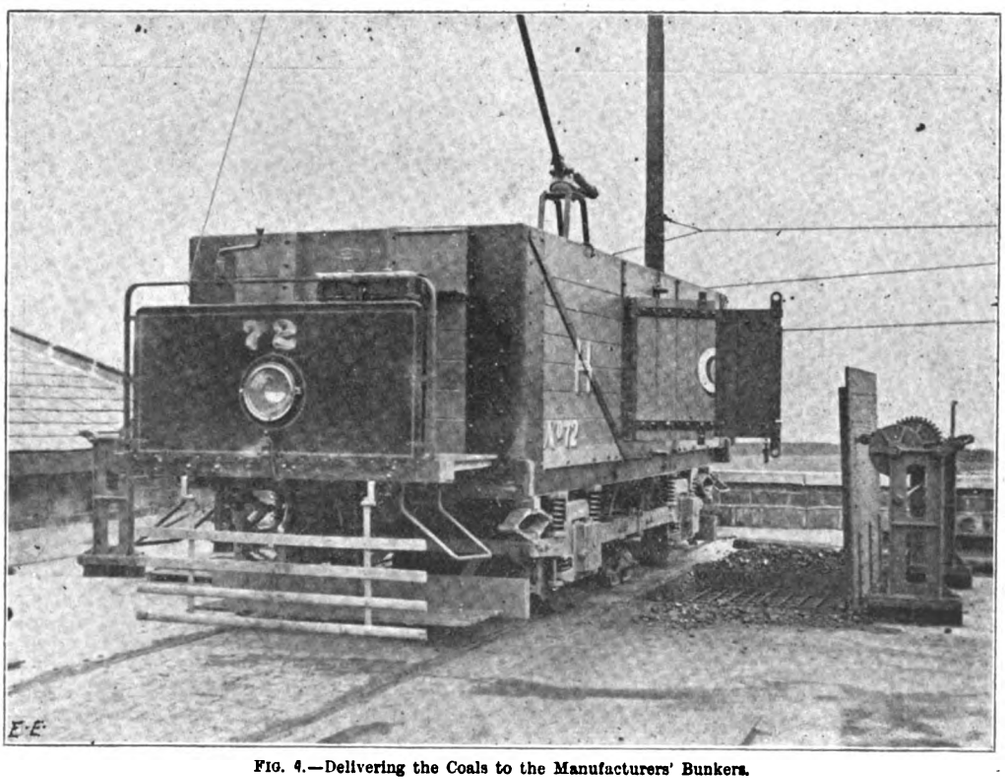

FIG. 4.—Delivering the Coals to the Manufacturers' Bunkers.

It will be seen from this that the wagon is not unlike an ordinary coal wagon. It is designed to hold 10 tons. The wagon is made so that the coal can be discharged from each

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side simultaneously. The body of the wagon was constructed by Messrs. Milnes, Voss, and Co., of Birkenhead, and it is mounted on a radial truck manufactured by the Brush Electrical Engineering Company. It is equipped with two Westinghouse 80 motors, each of approximately about 45 h.p., and it is also equipped with a Westinghouse-Newall magnetic brake and a powerful hand-brake. It is fitted with a special axle arrangement for enabling the wagons to pass easily round curves, an arrangement which has only been patented recently. The wagon is also supplied with the usual sanding apparatus, and is as complete as it can be for the purpose for which it is intended. The trolley pole has to be longer than those used on the ordinary cars, because of the height of the wagon being so much less. The car can be driven from either end, as is the case with the ordinary cars. The wagon had to be specially designed in order to cope with a difficulty which was at once seen at the coal shoots. The wagon body was too high to admit of coal being taken endways, as is the case with carts, under the delivery shoots. A line parallel with the face of the shoots had to be constructed in the shoots yard, so that the wagon may be taken alongside the delivery shoots, as is shown in the illustrations (Figs. 1 and 2).

Another point resulting from the use of old shoots was that a 3ft. 6in. platform could not be allowed on the wagon, but this had to be reduced to 2ft. 6in. For the same reason the headroom had to be cut down to 7ft. The inauguration ceremony of this new coal service was attended by a large number of interested parties, and we foresee that it will not be long before other manufacturers demand the same convenience from the Corporation. The feature of the case is that the roads in Huddersfield are exceedingly hilly, and the cost of haulage correspondingly great. In consequence, the cost per ton for delivery of coal into outlying works becomes a serious matter, and the introduction of a tramway siding will soon be repaid by the saving in cost. From the Corporation's point of view the service is a good thing, because it can be carried out during the slack periods of the day, or at night, when the tramway lines are not working to their maximum capacity.

We congratulate Mr. Thomas in that he has been able to witness the successful commencement of this service before his departure to Durban, and wish him again every success in his new work.

THE HUMMING OF ELECTRICAL MACHINES.*

Machines of modern design are liable to be more or less noisy, the sound varying from a whistle to a howl, according to circumstances. That it is not merely an air vibration which is in question may be safely admitted, from the fact that the noise usually stops as soon as the excitation is taken off. Also, the same results may be noticed on machines having wide open slots and those having very narrow or half-closed ones. Though this humming is in itself quite harmless, it is very disagreeable when the machine has to work near occupied houses, and cases have occurred in which an otherwise satisfactory machine has had to be replaced due to this cause alone. In stating above that modern machines are liable to this trouble, reference was intended more especially to those having laminated poles, small air-gaps (1·5mm. to 3mm.), and few slots. The difficulty is, in practice, found far less frequently in the older machines having air-gaps of 4mm. to 6mm., solid poles, and numerous slots. It may be mentioned at once that the pitch of the note, as would be expected, depends directly on the number of teeth, whilst the amplitude of the sound falls as the number of teeth increases. Already with 13 to 15 slots per polar arc practically no humming is noticeable, and it disappears entirely with higher numbers. In modern practice much smaller numbers of slots, such as six to nine slots per polar arc, are commonly met with. Experience has, however, shown that with even as low a number of slots per pole as five absolutely silent running is possible under certain conditions, as described below. It happened to be possible, by inserting sheet iron behind the poles, to vary the length of air-gap on certain machines of this sort experimented on, and it was found that, contrary to expectation, this did not appreciably increase the noise.

Whatever the cause of the humming, it is easy to prove that the latter is directly dependent on the number of slots. Of course, the actual seat of the noise is not necessarily the armature itself, but may be in the poles, which are set in vibration by the changes in magnetic field corresponding to the different positions of the armature. By means of the tuning fork the above statements may readily be confirmed. The usual tuning fork of commerce is set for the note la of the fourth octave, and consequently makes 440 vibrations per second. The number of vibrations corresponding to other notes may be seen from the following:

Fourth octave: do = 264 vibrations, re = 297, mi = 330, fa = 352, sol = 396, la = 440, si = 495 vibrations.

Fifth octave: do = 528 vibrations, re = 594, mi = 660, fa = 704, sol = 792, la = 880, si = 990 vibrations.

Sixth octave: do = 792 vibrations, re = 891, and so on.

It is, therefore, only necessary to determine the note by means of the tuning forks, which should offer no difficulty to a fairly musical ear, and at the same time take the speed of the machine. Dividing the number of vibrations corresponding to the note by the number of revolutions per second, the result is the number of vibrations per revolution, which, naturally, must vary directly with the mechanical or magnetic variations to which these vibrations are due.

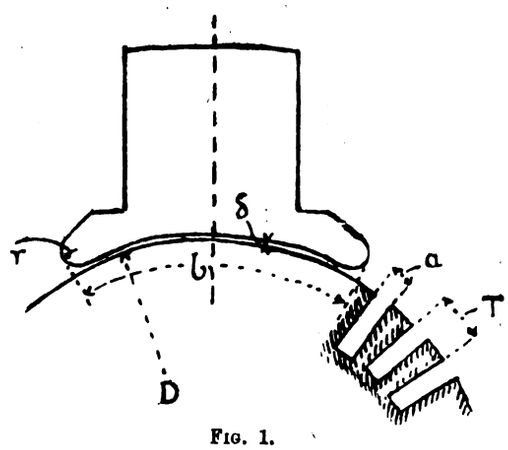

Fig. 1.

A few examples will make the matter clear. An 11-h.p. motor running at 1,070 revolutions per minute, or 17·8 per second, was found to give the note exactly midway between sol and la of the fifth octave, and corresponding to $\frac{792 + 880}{2} = 836$ vibrations per second, so that the vibrations per revolution are $\frac{836}{17·8} = 47$. As the number of slots in this motor was 47, there can be no doubt the initial cause of the humming lies in the armature slots.

The same experiment was made on a 4·5-kw. dynamo running at 1,400 revolutions per minute, or 23·46 per second. In this case the note was determined with great exactness, and was found to be midway between la and si in the fifth octave, and gives $\frac{880 + 990}{2} = 935$ vibrations per second, or $\frac{935}{23·4} = 40$ per second—*i.e.*, exactly as many as the number of armature slots.

The pole shoes of both machines were next reduced somewhat in span, and this almost entirely stopped the humming. When the pole span was still further reduced the humming commenced again. Other machines tested in the same way with various pole widths and different armature slots (see table) confirmed these results—*i.e.*, a distinct ratio of pole span to slot pitch could be found at which the humming was a minimum. The explanation for this is, as already mentioned, that the total flux passing through the pole varies according to the relative position of the armature and the poles, and, within certain limits, according to the ratio of slot pitch to polar span, and this causes the pole shoes to vibrate. In accordance with this

* Translation of an article by J. Fischer-Hinnen in the *Zeitschrift für Elektrotechnik*.

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view, the amplitude of the vibrations should be a minimum when the pole span is an exact multiple of the slot pitch. As a matter of fact, this rule in no way agrees with the test results, obviously owing to the effect of fringing of the lines at both sides of the pole-piece.

The writer has attempted to establish a rule, and, so far as his experiments go, the best results would seem to be obtained when the polar arc is made such that the slot pitch (reduced to the diameter of the bore) divides into it an exact number of times + ·5. There is, of course, difficulty in deciding what to call the polar arc when the pole tips are rounded, and in such cases the writer employs the extreme outer pole span less ·7 of the radius of the rounded tip. Stated algebraically, the rule for minimum humming is:

$$\frac{b - \cdot 7\, r}{(D + 2\,\delta)\,\pi} \cdot N_1 = \text{a whole number} + \cdot 5,$$

where N_1 is the number of slots, and the meanings of the other letters can be obtained from Fig. 1. The more closely this quotient approaches to a whole number the greater is the danger of humming, except when the number of slots is very great—*i.e.*, over 13 to 15 per pole span.

PARTICULARS OF MACHINES ACTUALLY CONSTRUCTED (see Fig. 1).

No.	Armature diameter, D.	Single air-gap, δ.	No. of slots, N_1.	Slot pitch, T.	Slot width, a.	Polar arc, b.	Radius of rounded tips, r.	K_1.
1	200	1·5	39	17·1	7	120·2	4·7	6·84
2	230	1·5	47	15·6	6	130·5	5	8·15
3	230	1·5	40	18·3	8·5	130·5	5	6·95
4	250	1·5	47	16·9	6·5	139·9	5	8·06
5	270	2	45	19·1	8·5	155	5	7 94
6	270	2	49	17·55	8·6	145	5·1	8·05
7	310	2	43	23	9	170	7	7·18
8	310	2·5	43	23	9	165	7	6·96
9	340	2	57	18·95	8	195·2	8·5	10
10	470	2·5	76	19·65	—	190	1	9·7
11	490	3	72	21·61	—	195	1	9·0
12	540	3	73	23·5	—	215	1·5	9·1
13	800	4	48	51·5	24	200	—	3·9
14	200	1·5	29	22	9	104·8	4·5	4·62
15	230	1·5	47	15·6	6	120·5	6	7·45
16	230	1·5	40	18·3	8·5	125·5	7	6·6
17	250	2	53	15	6·5	144·8	5	9·4
18	270	2	45	19·1	9	150	7	7·6
19	340	2	88	12·3	5·5	195·2	8·5	15·4
20	340	2	99	10·9	5·5	195·2	8 5	17 35
21	440	3	117	12	5·5	239·5	9·2	19·4
22	440	3	75	18·7	8	239·5	9·2	12·45
23	370	2	93	12·6	6	205	8·5	15·8
24	400	2·5	86	14·8	7·5	214	9	14
25	400	2	87	14·6	6·8	214	9	14·2

REMARKS.—Nos. 1 to 13, bad humming; Nos. 14 to 25, no humming. Nos. 4, 6, 8, and 18 had slanting poles.

This table shows that the rule given checks fairly well with the experimental results, except in the case of the three last machines, which, however, have a very large number of slots, and this alone may account for their behaviour. In spite of this agreement, however, the writer does not consider the rule to be absolutely reliable, as it takes no account of the slot width. If we consider the slot width reduced indefinitely, we arrive at a smooth-cored armature, which certainly does not hum, and yet the rule would show the contrary. In view of the importance of the matter, the writer hopes that others engaged in dynamo manufacture will test the accuracy of the above rule.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY AT GLASGOW.

SIR,—"The value of Sheriff Jameson's precious report may be gauged by the contempt with which it has been treated in Glasgow, the city with which it deals, and by the fact that the Government, which appointed him as commissioner, ignored it. With regard to Sheriff Jameson's Glasgow report, it is unfair and misleading to suggest that it questioned the accuracy of my estimate. The sheriff's doubts were understood (by whom?) to refer to the difficulty of repaying capital on the rates proposed, assuming, as he did, that the license would certainly terminate in 1911, and that the Corporation system would not then be bought by the Post Office. Under the new Act the license may be extended to 1925 at the wish of the municipality, and the Post Office will buy the system. My estimate was not so much an estimate as a statement of ascertained cost, since every item was covered by actual tenders from responsible firms, who were prepared to undertake the work at the figures given. The estimate was not shaken, although I was cross-examined on it for the best part of two days by the leading members of the Scottish Bar; and a reference to the Blue-book of the 1898 Select Committee will show that it has been accepted as correct by Mr. Hanbury. It is in effect correct, and as applicable to Dublin as to Glasgow."

These remarks are not my own, but occur in letters signed by A. R. Bennett and published in the *Freeman's Journal* in September, 1899. They show pretty clearly that Mr. Bennett at that time did not read into Sheriff Jameson's report the meaning which he and "W. O. T." now find in it. If "W. O. T." will take the trouble to read the whole paragraph on p. 17 of the report, he will find that the commissioner is speaking throughout of an estimate for a municipal telephone system for Glasgow. If he will refer to p. 4 of the report, he will find that the sheriff refused to enquire into the cost of the National Company's system. Even the part of the commissioner's report which "W. O. T." does quote makes no mention of the suggestion that the estimate was for the purpose of showing what the existing system ought to have cost. It is evident either that this suggestion made no impression upon the mind of the commissioner, or that he considered it a change of front not worthy of attention.

As for "W. O. T.," I am sorry for him. I have patiently borne with his obvious lack of knowledge of the technics of telephony, and with his even more trying impermeability to the meaning of plain English. By close argument and clear marshalling of facts I have driven him out of one ineffective position after another, and he finally takes refuge in a mere verbal quibble. He hoists the white flag, and at the same time tries to give one a furtive stab. I have tried to think better of "W. O. T.," to think that he really wanted the truth, as he has said. Let him read over, in the calm seclusion of his study, his contributions to the last three issues of the *Electrical Engineer*, and if, when he comes to his deplorable quibble on p. 308, he does not blush for himself, then there is no hope for him. Poor "W. O. T."!

I can quite appreciate that one who has such a remarkable record for accuracy and consistency as Mr. Bennett has must become extremely impatient at the stupidity of a poor dull chap like me, who cannot see any reason in describing an estimate for a metallic circuit underground telephone system as an appraisal of the cost of a single-wire overhead system containing fewer exchanges and a considerable smaller length of line. Mr. Bennett apparently argues on these lines: "I have described at various times the same thing in diametrically opposite terms. I choose now to adopt one set of descriptions, and that stupid fellow Webb chooses to adopt the other set. What is the good of Webb quoting one set when I now nail my faith to the other set?"

Mr. Bennett now quotes Colonel Slacke, and gives a partial account of the little tiff at the Hull enquiry, which was the occasion, I believe, of the first appearance since 1897 of the Glasgow estimate as a statement intended to show what the then existing system of the National Telephone Company ought to have cost. However, the whole point of Colonel Slacke's attitude is summed up in the last line which Mr. Bennett quotes, in which the inspector stated that he declined to hear any more of the matter. If Colonel Slacke had been willing to hear the matter out, Mr. Robb would no doubt have made it clear to him, as I think I have made is clear to any unprejudiced person, that it is impossible, in the face of Mr. Bennett's statements in 1898, 1899, and 1900, to accept his present statement that the estimate of 1897 was made for the special purpose of showing what the then existing system in Glasgow ought to have cost the National Telephone Company.

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In referring to the Hull incident, Mr. Bennett is not more accurate than usual. I made no reference in my evidence at Hull to the original Glasgow estimate. The only reference which occurs in the Hull report to my evidence at Glasgow is on the question of spare plant. There is no warrant for Mr. Bennett's statement that Colonel Slacke committed himself to any strong language as to my conduct. I think the reckless inaccuracy of Mr. Bennett's statements, both as to facts and to people, is a most unfortunate part of this discussion.

As regards Sheriff Jameson's report, to use an expressive phrase from the current slang of the day, Mr. Bennett cannot have it both ways. He has previously referred to the sheriff's report in the polite terms which he customarily applies to anyone who has the misfortune to differ from his views, and it is really hardly decent for him now to quote the report as upholding the entirely opposite view of the matter which he now adopts.

There is a strong resemblance in the history of this telephone estimate to another discussion which has occupied public attention of late. The parallels between Mr. Bennett's Glasgow estimate and the famous "Petersburg" are most striking. At the beginning the estimate is a Volunteer cruiser that knows its business—a man-of-war, bow, stern, and amidships; in other words, a full-fledged working estimate for a Glasgow municipal exchange equipped with all the latest devices. Challenged at the Dardanelles—the cross-examination at the enquiry is the Dardanelles—the fighting flag flutters to the deck and up goes the innocuous merchant bunting. "Merely a comparison; no working estimate about this, Mr. Sultan—that is, Commissioner." But once past the Dardanelles, the Glasgow enquiry over and blue water ahead, the man-of-war flag is broken out again, the ammunition hoists click fluently, and the guns bristle. "Estimate, indeed! No, Sir, no mere estimate; statement of ascertained cost. Fight anybody with this, anywhere. Sink any objections in short order." Poor merchantmen, editors, engineers, commissioners, and other small fry riddled and wrecked in most contemptuous manner. Later on, strong protests are made in light of ascertained facts. Fighting flag comes down with a run and merchant ensign covers the whole ship. "Working estimate? Never. Special commission expired long ago. Never was an estimate, never could be an estimate, nobody ever could take it for an estimate. Object merely to show what something entirely different ought to have cost." Unfortunately, it is not possible to make the instructions for the estimate to turn itself into a statement of what something else ought to have cost reach the right quarters, because between the azure covers of certain official records the estimate sails on serenely through the ages as a detailed working estimate for Glasgow municipal exchange. The parallel is not complete, but it is interesting as far as it goes.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.,
Aug. 29, 1904.

SIR,—Mr. Webb is delightful, but editors are grumpy, and I am told telephony at Glasgow "must not run the paper." Editors are human, but this telephone question *is* important. Mr. Webb is not nice to me; but I have heard somewhere that it is the custom of lawyers when they have no case to slang their opponents. On these grounds, I should say that Mr. Webb is fully conversant with the fact he has no case. Words were given to us to hide our real thoughts; he has enough words—what about his thoughts? Now let us come to grips, if we can, for Mr. Webb is more slippery than an eel, and boxes the compass admirably.

Aug. 5.—**Mr. Webb** leads off with the right, referring to 1897 estimate, which he *assumed* applied to work *to be* carried out. He leads to the inference that cost of installation should be proportionate to instruments or subscribers.

"**W. O. T.**" replies cost is *not* proportionate to instruments or subscribers, and that the estimate referred to was *not* an estimate for any work which Mr. Bennett proposed to carry out.

Aug. 12.—**Mr. Webb** is compelled to agree that "W. O. T." is, at any rate, partially correct, but will bring in other factors besides area as having influence on cost. [Inasmuch as Mr. Webb admitted the non-proportionality of cost with number of subscribers or instruments, my point was carried.] Mr. Webb now brought in a lot of questions, all based upon this assumed estimate.

"**W. O. T.**" replies, quoting Bennett, that this much-abused estimate was *not* for the purpose Mr. Webb *assumed* that it was. [Here we get: Webb says *yes*, Bennett says *no*—a direct negative. Bennett made the estimate, and surely he *must* know what he made it for. Query: which of the two is most likely right. I, as an outsider, say the man who knows, not the man who thinks he knows.]

Aug. 19.—**Mr. Webb** gives copious extracts from the minutes of evidence to support his "Yes." [He italicises some words, which he deems the most important. He is right; but again, to an impartial outsider these words seem to support Bennett's, not Webb's view (*vide* p. 271, column 2): "Not so much an estimate as a statement of ascertained cost." Webb says "'tis an estimate." Bennett says it isn't. Which is right—the man who prepared the statement, or the man who criticised it? Further, what did Bennett mean by "ascertained cost?" Cost of what—something to be done? If so, it was an estimate. Something done; if so, it was what Bennett says it is.]

"**W. O. T.**" merely states his interpretation of the evidence.

Mr. Bennett gives further extracts, showing most conclusively that the estimate or statement was not for what he wanted to do, as is Mr. Webb's contention, but for purposes of comparison. He also refers to Mr. Salveson's interpretation corroborative of his case.

Aug. 26.—**Mr. Webb** wobbles—he pretends he wants to settle a point, but judiciously goes to something else. He won't have Mr. Bennett's view, supported as it is by the evidence in chief, in re-examination, and in Mr. Salveson's interpretation, and he introduces the question of *metallic* circuits as a proof that Bennett, Salveson, and myself don't know what we are talking about. I cannot speak for two of these gentlemen, but Q. 5,040, 5,041, 5,043, 5,359 certainly bear out their views and my views, and in my opinion are quite consistent with the questions quoted by Webb. Then Mr. Webb goes on to be great on words. Mr. Bennett's reply (5,359) contained these words: "For the specific purpose of ascertaining the approximate cost of such a system as exists here." Webb's fencing with words is simply to draw a red herring over the scent, but it is too thin, Mr. Webb—too thin.

Mr. Bennett gives extracts corroborative of his view which came out at the Hull enquiry.

"**W. O. T.**" further corroborates Bennett by a quotation from the judge or commissioner's report, which is to all outsiders abolutely conclusive.

To-day we get another stage. I must not accept Jameson's view of a particular point because Bennett has ridiculed the report, and the Government did not act on it. Really, Mr. Webb, can you put that forward as aiding you. The point is *estimate*, not report. I do not know why Bennett or Glasgow or the Government put aside the report. I only know it corroborated the view that Bennett put forward about this estimate. The evidence that I can get from all the sources indicated serves the same purpose, and corroborates Bennett. Mr. Webb need not be sorry for me—let him first think of himself. I have read Jameson's report (p. 17), and what Mr. Webb says of the paragraph is distinctly wrong. The commissioner is *not* speaking of Bennett, as Webb would have me and others infer, and in this, and so far as I know, his writings for the first time, Webb descends to the use of contemptible weapons. The commissioner speaks of an estimate obtained from an unknown expert by Mr. Starke. There he says what I gave in the quotation (Aug. 26) about Bennett, then he goes on to Glasgow's indebtedness.—W. O. T.

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GLASGOW TRAMWAY ACCOUNTS.

The accounts of the Glasgow Corporation tramways department for the year ended May 31, 1904, are, of course, of supreme interest to the inhabitants of Glasgow. The information given in the publication is most complete, and is also of general interest, because it shows to other local authorities exactly what the Glasgow Corporation is doing. Without contradiction, we may say that the tramway department in this important Scotch town is a credit to the country, and that those responsible for the policy, financial and otherwise, are energetic and cautious business men. We are not surprised, however, to find that our contemporary, *Electrical Investments*, feels called upon to step in and warn the Glasgow people of their financial deficiencies, and of the consequent difficulties ahead. This publication—which one is led to suppose is intended for the "investor, director, councillor, engineer, manufacturer, contractor, etc."—is obviously shocked at the financial ruin hanging over the Glasgow tramway department. It manfully steps into the breach, and, to quote its own words complains of many things. For instance, our contemporary says:

"Many persons, of course, are satisfied with the general appearance of things, and do not trouble to look beneath the surface; and to all such it may appear that if the Glasgow tramways are well organised and efficiently operated, all is well, and nothing more need be said. But it must be remembered that this is a public undertaking on a very large scale, and involving very heavy capital expenditure; it is, further, the principal municipal tramway system in the kingdom, and is frequently cited as a conclusive argument in favour of municipalisation of the tramways in other communities; and for these reasons it is necessary to do more than enquire into the ability and efficiency of the staff. We must consider the financial policy of the Corporation or its responsible committee, and see whether the community has really benefited by municipalisation."

Our contemporary then gives the comparison between the revenue accounts for 1903 and 1904. It goes on to say: "It will be seen that the traffic receipts have increased in the year by £64,693. 6s., a very substantial and meritorious increase, indicating at once the popularity of the cars and the increasing demand for this means of locomotion; but what has it cost the Corporation to earn this increase in revenue? For a financial undertaking that is the important point. The working expenses for the year 1902-03 were £431,870. 2s. 11d., while those for 1903-04 are £496,266. 14s. 11d., an increase of £64,396. 12s. Thus the whole of the increase in traffic receipts has been swallowed up in working expenses, and if it were not for the increase in the item 'Other receipts,' the undertaking would have shown this year a balance to net revenue account almost identical with that for the previous year. Now, is this satisfactory? We do not think any company would find it so, nor would the town councillors of Glasgow if they were shareholders in a company showing these returns. The traffic revenue per car mile has decreased from 11·19d. to 10·58d.—that is, by 0·61d.—and the working expenses per car mile have increased from 5·21d. to 5·26d. The committee explains this increase as being 'altogether due to the increase in the amount of taxes and accident insurance,' while the decrease in revenue is 'chiefly due to the augmented service of cars which is now given on all routes.' But can either of these statements be accepted as satisfactory?"

Lastly, it attacks the Corporation for having devoted £62,000 out of the net revenue to special depreciation of various portions of their plant. It asks, "What is special depreciation?" and accuses the department of creating the

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term in order that a sum which is ordinary depreciation should swell the net revenue. Our contemporary concludes: "The revenue per car mile is declining year by year, and difficulties would appear to be ahead. The present policy tends to concealment of the true position, and may lead to great abuse when the difficulties arrive. Let the Council take warning in time."

We must say we are amused by the criticisms, which have not an atom of sense in them from beginning to end. It is hardly worth while troubling our readers with a few words exposing the special pleading in the article. As, however, the printing of mis-statements is supposed to render these unimpeachable, it may be well to mention one or two points. In the first place, it is quite true that the increase in traffic returns for the year has been equalised by a practically similar increase in the expenses. In other words, a more frequent service has been given at an increased cost, but the increased revenue has justified the improvement in the transport facilities. We presume that the advocates of company management will always fail to understand the argument which Mr. Garcke was the first to lay down—*i.e.*, that municipal undertakings should not make a profit. We then come to the question of the decrease in the revenue per car mile, which the Tramway Committee attribute to the augmented service of cars. We fail to see how any further reason is possible, in view of the fact that the total revenue is increased. Perhaps our contemporary thinks that with too many cars on the route people refuse to travel at all for fear they should get on to the wrong car. Lastly, we come to the depreciation question, which is the stock argument of the British Electric Traction Company and their numerous experts against corporation management. It is true that these arguments must not be applied to British Electric Traction undertakings, as otherwise their position would not bear investigation. After reminding our contemporary of the old proverb that "a rose with any other name would smell as sweet," we propose to contrast the Glasgow figures with one of the oldest companies under the British Electric Traction Company's *régime*. Thus, at Glasgow the capital account at the beginning of the last financial year stood at £2,129,512. As a result of the year's work the following large sums were applied to depreciation, or the repayment of capital, between which we see no difference. The items are: sinking fund, £45,552; depreciation, £78,619; special depreciation, £62,000. These amounts have a total of £186,171, or 8¾ per cent. on the capital above mentioned. Of course, the capital account has been added to during the year, but some £43,000 was also distributed between the "common good" and the reserve fund. These figures may show faults in the present policy and difficulties ahead, but the faults can only be in points of book-keeping and the difficulties in the minds of interested parties. We now turn to the accounts of the Potteries Electric Traction Company, and one would expect from the fact that Mr. Emile Garcke—the leading authority on depreciation—is a member of the Board, that this company would give Glasgow points on the depreciation question. The company for 1902 had an issued share capital of £490,000, and £220,000 of debenture stock. For that year, the last for which we have figures, the company had a net revenue, after paying debenture interest, of £23,299, or about 4¾ per cent. on its issued capital. Obviously, this should all have been put to depreciation, but the company voted the magnificent sum of £2,000 to depreciation—*i.e.*, 0·41 per cent.—and divided the rest as dividends. In our opinion the difficulties mentioned above are not far ahead in this case. These are the facts, but we are quite sure that our contemporary will ignore them, and that the argument of the insufficient depreciation of municipal undertakings will still be harped upon by the directors of the company above mentioned.

REVIEWS.

The Telephone Service: Its Past, Its Present, and Its Future. By HERBERT LAWS WEBB, M.I.E.E. Illustrated. Whittaker and Co. Price 1s.

Mr. Webb is an able, facile, and forcible writer; but in this book the writing is too much that of an advocate. It is largely controversial, not educational. He is always concerned for his verdict. The information he gives is interesting, but the grip of the advocate causes lapses in the narrative—which lapses in a court of law would be filled in by the opposing counsel. Thus in the brief historical chapter we read of Bell, Edison, and Hunning, but never a word of Hughes—a greater than either Edison or Hunning. Edison was a telephonic inventor by accident. He really had noticed—to the disadvantage of the experiments upon which he was engaged—the effects of loose contacts. Hughes, too, discovered these effects and worked out the discovery to practical purpose. Hunning merely constructed a good useful variant of the microphone. To class him with Bell, Hughes, and Edison is a mistake. He is not in the same hemisphere, much less upon the same pedestal. We merely ask that Hughes—one of the kindest, ablest, and most modest of men—should receive the recognition that is his due. As Mr. Webb says, we have had "20 years of continuous invention to produce a method fulfilling all requirements in a simple, reliable, and rapid manner." We agree, but would prefer to restrict the meaning of invention to such discoveries as those of Bell, Hughes, and Edison. All the rest has been comparatively simple—the mere adaptation of things well known to effect a desired object. Invention has not ceased, nor has adaptation of known inventions, so, although we have attained to an effective simple system, there is no doubt improvements will still continue.

Mr. Webb condemns the early telephone user as asking for and expecting too much, and grumbling because he did not get it (p. 14). Ought he not rather to put most of this blame upon the proper shoulders? The users did not know the capabilities of the then system. They asked solely for what was promised by promoters, exploiters, and speculators, who promised all and every, but did not keep their promises. Blame these men for much—we had nearly said all of the trouble telephonic. Mr. Webb himself, in his ardent desire to pose as an advocate, sails too close to the promise of the ideal in his remarks on the celerity of communication. The ideal state is vastly different from the real, as may be gathered from a comparison of the remarks (pp. 26 and 34). On the former page the author idealises; on the latter, and also on p. 43, he refers to the actual. We may repeat that throughout this little book whenever the author is not touching upon questions of policy—that is, whenever he is not *the* advocate, but is describing systems and apparatus—he is excellent both in matter and manner. Upon questions of policy the advocate is paramount, and, we are bound to say, inconclusive. Most of our remarks must be devoted to policy, but that must not be permitted to hide the high opinion formed as to capability to treat clearly and correctly the technical questions. Thus the functions of a telephone exchange (p. 30), the apparatus and organisation used to satisfy these functions (pp. 30-53), are admirably described. Even when advocacy is the controlling factor the case is clearly and temperately put, only it is not the whole case—only that part tending to prove the premeditated conclusions. In other words, these conclusions are not derived naturally from the premises, but the premises are constructed to fit the conclusions required. A prominent part of the controversial portion of the book deals with the question of tariffs, and this is the only part where the author is not clear. He touches the question on pp. 27, 28, 47, 48, 55, devotes Chapter VIII. to it—and in this chapter p. 93 is most important, concluding with a

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suggestion in regard to it in his construction policy (p. 115). The usage of "message rate," "message mile rate," throughout the book is misleading. What is meant is not a message rate, nor a message mile rate, but a combination rate—a combination of a flat and a message rate somewhat on the lines of the Wright system of charging as used in electric lighting. A message rate is a misnomer; there is no such thing, there can be no such thing. It is unthinkable and absolutely unpractical. A combination rate is practical, and perhaps the best system hitherto devised, but there is something to be said against that part of the combination rate which takes into account messages. Mr. Webb is infatuated with the message rate; it is his ideal, and in the eagerness of the advocate he overlooks some points. Let us try to summarise our view of the case, premising that a summary is not a full and detailed account. Assume that Mr. Webb is invited to estimate for and prepare a telephone system for a town—any town. He cannot deal first with messages or message miles, which shows that messages occupy a secondary, not a fundamental place. He is bound in the first place—and he cannot depart one iota from such a course—to obtain an idea of number of subscribers—that is, of lines. Nothing comes before this. He objects to estimates founded upon lines, but in this he is wrong. The position of subscribers gives him the area, also density factor. The classification of subscribers gives him message rates and times of demand, for each class of subscriber has its own message rates and time of maximum demand. These are known from statistics obtained from practical working, and neither genius nor ability will enable an expert to fortell them. Thus he gradually builds up sufficient information to enable him to design and estimate. You can no more determine message rates or message mile rates *ab initio* than you can fly; the message rate is statistical, and not predetermined. Pioneers in telephony had no statistics to guide them; they were in the dark, they knew not how many messages an attendant could handle; they had to meet subscribers who said, "How much?" and would not listen about a flexible rate, so that a flat rate was in those days almost the only one possible. It was soon seen, however, that telephony was a little out of the ordinary run of businesses, and approximated to that of electric lighting. Two branches of expenditure—roughly speaking—had to be satisfied out of revenue, that involved in construction—call this constructional—and that involved in the daily working. The demand of constructional cost upon revenue can be fairly easily determined, and this should form a flat rate in the combination rate which ultimately forms the tariff.

Mr. Webb, as we say, is strong upon a message rate, or a message mile rate. The latter is not worth consideration, and the former is "not correct in theory" (p. 94), as can easily be shown. Working costs are not proportionate to number of messages, but to message groups, or, better still, to message time-groups. An attendant can handle a given number—call this a group—of messages in a given time, hence the suggestion, time-groups. The time-group may—the figures are purely abstract—as a maximum be placed at 20 per minute. No group, then, between one per minute and 20 per minute affects attendants' wages, which form one portion of working costs. Similarly, there will be a time-group for junction lines, and so on. Thus between certain limits working costs are not affected, and these limits are in no case individual messages. Hence a message rate is not idealistic, nor "correct in theory"; it may be held by Mr. Webb to be intensely practical—which is another thing. But even then the rate would form but one part of the combination tariff, which consists, as we say, of a demand upon revenue to satisfy constructional and working expenses. We take it that Mr. Webb really means this combination rate for his tariffs as described on p. 93. But we must pass on.

Unfortunately, telephonic writers have got into the habit—and we know use is second nature—of seeing something abnormal in every telephonic detail, where, as a matter of fact, no such abnormal condition exists. There is nothing unique, though Mr. Webb claims it (p. 62) when he says, "One great difficulty with telephone traffic is that it comes in such uneven volumes at different times of the day, etc." . . . or "causes the service to be much more expensive to conduct" (p. 63), or "plant . . . staff must be organised to deal with the traffic without delay at the busiest hour of the day" (p. 63); or "at night the whole plant is practically idle" (pp. 64-5). These conditions hold in half the businesses carried on in this world, and are understood as part of the disabilities to be encountered. Why telephonists should arrogate to themselves something uncommon in these conditions would be laughable if they were not so evidently in earnest. Surely constant iteration has made them believe, but a moment's thought would show the futility of such claims. Every shop has its busy and slack times, its plant idle, etc., its night as well as its day. Nor can we admit the claim of unique, Chapter VI., pp. 66-75: "In every telephone connection there are two subscribers concerned, and unless the two perform their respective shares of the transaction satisfactorily, the general result will not be satisfactory." The statement is true, but not unique. It is used to emphasise the correct suggestion that the supplier of apparatus and system should hand to his subscribers the most simple, the most perfect apparatus. Let that subscriber do as little thinking as possible, and do as little work as possible in order to ensure satisfaction all round. The same moral can be applied to almost every business transaction, be it the posting of a letter, the sending of a telegram, or the buying of a piece of cheese.

The last three chapters are solely devoted to advocacy. The statements are *ex parte*, almost all controvertible and untenable. There is only one, however, which we shall trouble to deal with. It is like to the character of the previously mentioned unique and abnormal—that is, a statement so often made as to be taken for true without examination, yet, when examined, it contains hardly a shred of truth. Here it is: "The principal of these (things tending to restrict the systematic development of British telephony) is that the telephone companies have never had powers to run wires" (p. 104). We say, and say it deliberately, that the statement made in the sentence quoted is absolutely untrue from the first to the last word. It is the pretensions of the companies that are unique and abnormal. Why should they, purely money-making concerns, ask for powers to be given them which other individuals do not possess—nay, ask for them as something which is their right, and which powers are to be practically gratuitous? They ask for rights in and over public streets and private property—powers that shall minimise their capital and increase their revenue-earning capacity. They (private adventurers) get all the benefit to the detriment of the general public. Surely they can, if they choose, buy land or buy rights to use land, and so run their wires over or under the ground as they like. It is not they cannot buy land and run wire. They won't; they want something for nothing, and a more selfish, grasping, one-sided, sordid policy was never before promulgated. Because a careless Legislature has permitted gas, electric light, water, and other companies to use the public streets for private benefit, a right for everybody to do so is not constituted. Let the telephone companies buy the land or the right to use the land they require, neither individual, nor the public, nor the Legislature will say them nay. Of course, someone will say, But how about crossing the streets? Does any sane individual believe that this would constitute a real difficulty either with council or Legislature? The difficulty arises because the companies ask, not what is just, but too much. The most effective argument against companies is given to the municipalities because of this outrageous claim. We have a good deal of criticism and comparison of Government and commercial working. The Post Office is not a commercial undertaking, never was, and never will be. It is run by the State, not for profit-making, but something very different, better, and nobler.

It is clear that Mr. Webb does not quite understand the telegraphic accounts of the Post Office—nor for the matter of that does one man in a million. Were these accounts presented in commercial fashion they would startle many a talented but ill-informed writer, but at any rate we should not get such statements as "the loss on the telephone and telegraph business will before long wipe out the present handsome profit on the postal and money order

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business." Will Mr. Webb kindly tell us the capital value of the telegraphs of this country, and how that value appears in the accounts he so casually condemns? Before talking of losses he will find he has a good deal to consider when he really commences to investigate. We shall never agree with Mr. Webb while he retains this style of the pure advocate, yet we should probably agree with many of his conclusions with regard to municipal and Government businesses, though from different premises Mr. Webb is a gentleman destined in the future to take a foremost position if he will broaden his views and consider both sides of the question, with the object of ascertaining what is best and right, and not with a view of proving a particular or preconceived case. Let us have more of the judge, less of the advocate. He possesses qualities of the highest calibre. His method of stating his case is excellent. Even when his materials will not bear strict examination, he makes the best of them. With his technical descriptions we have no fault to find—here he is evidently quite at home; it is his politics that are faulty, yet his work is well worth consideration, for he puts his case in the simplest way, and is evidently in earnest. The only lapses—and for an advocate these are of the mildest—are p. 105, where he speaks of "much unjust and superficial criticism," and in his preface, when he speaks of "these discussions are usually marred by a lack of knowledge on the part of many participants" "We are not all infallible, not even the youngest of us," said a politician; hence the honest man admits ignorance and desires enlightenment. May we all get it according to our needs! How exceedingly difficult it is to review a book of this kind may be seen from two quotations. *First*: "It is sad to contemplate the manner in which the electrical industries in this country have been strangled by over-legislation and State interference." This we deny. *Second*: "The State monopoly has stamped out invention and manufacturing enterprise in telegraph work in Britain." With this we agree, but to give the reasons for denial or agreement would be wearisome.

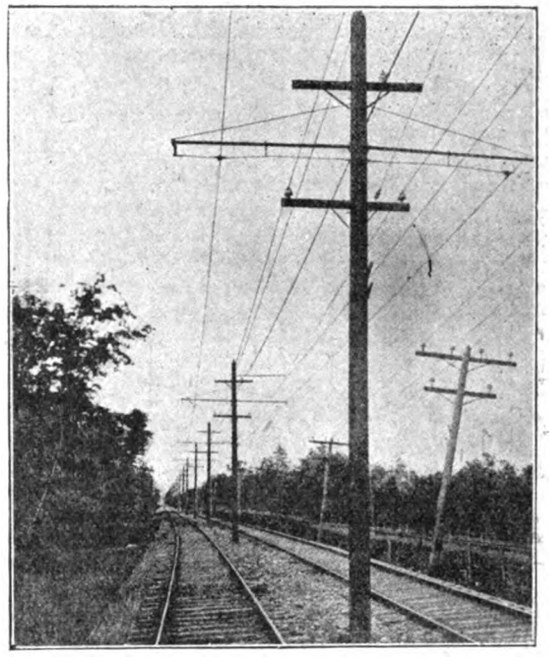
THE SINGLE-PHASE COMPENSATED MOTOR

The General Electric Company, of Schenectady, N.Y., has just developed a new single-phase motor of the compensated type, of which an interesting description is given in the *Electrical Review* of New York. A trial was made on the 19th ult. over the Ballston section of the Schenectady Railway Company, a distance of about 16 miles. This line has been operated with the standard direct-current apparatus, and for the purpose of testing the new alternating-current motor a second trolley wire was erected over each track, from which the alternating current is taken. We reproduce a view of this line, showing both direct and alternating current trolley lines The compensated motors and control are adapted for operation on the 2,000-volt alternating-current trolley between cities and the standard 600-volt direct-current trolley in Schenectady. This ability of the compensated motor equipments to run over tracks equipped with either alternating-current or direct-current trolley makes their field of application very broad, as the cars can secure all the benefit of running over existing city tracks without in any way sacrificing their running qualities upon suburban sections equipped with alternating-current trolley.

Centre-pole bracket construction is used, there being two brackets supporting the two 600-volt direct-current trolley wires and a cross-arm supporting the two 2,200-volt alternating-current trolley wires. The Ballston extension has been operated for several months with direct-current equipments, and their operation being continued in part necessitated an additional set of trolley wires for the alternating-current equipments which would not interfere with the direct-current trolleys. The centre poles are 34ft. long, and are spaced 100ft. apart, the alternating-current and direct-current trolley wires being No. 000 grooved section, with no feeders for the alternating-current trolley, and with a 500,000 circular mils feeder reinforcing the direct-current trolley. The direct-current trolley conforms to standard bracket construction, and presents no unusual features, while the alternating-current trolley wire is suspended from a $\frac{3}{8}$in. steel catenary. The alternating-current trolley is clipped to the catenary midway between poles, and the catenary in turn is hung over porcelain insulators on wooden cross-arms, the whole forming a construction of great flexibility, with the further advantage of providing excellent insulation with standard porcelain insulators and eliminating the span wires adjacent to the trolley wire, thereby preventing the pole catching should the trolley wheel leave the wire.

With the alternating-current system using a trolley and track return there is an inductive drop in the trolley and rails with an additional loss in the latter case due to eddy currents and hysteresis. Measurements made upon the Ballston line indicate an apparent trolley resistance of 1·3 times the ohmic resistance, and a rail resistance 6 55 times the ohmic resistance.

The resistance of the alternating-current trolley wire is somewhat reduced by the steel catenary in parallel with it. The alternating-current trolley wires are 5ft. apart and 16·5ft. above track, while the four 75lb. track rails are tied together every 1,500ft. The increased resistance with alternating current is a serious factor in low-voltage alternating-current city systems, but since the compensated motor operates perfectly with the direct current of city systems, no general necessity exists for a low-voltage alternating-current trolley.



When it is desired to make use of or instal a three-phase generator to take care of the operation of rotary converters, induction motors, etc, the preferred arrangement to balance the load at each sub-station is to instal three-phase, two-phase transformers connected two-phase on the secondary side and feeding separate trolley sections from the two phases.

The compensated motor consists of an annular laminated iron field with a distributed winding similar to that of an induction motor, and an armature provided with a commutator similar in general mechanical construction to a direct-current railway motor armature. These motors are wound for 200 volts, are permanently connected two in series, and are fed from the 400-volt secondary of an 80-kw. air-blast step-down transformer carried on the car. The distributed character of the field winding compensates for the armature reaction, so that power factors are relatively high throughout the range of operation. This type of motor is so designed that at the free-running speed of the car, which is the condition most frequently met with in suburban work, the power factor and efficiency are nearly at their maximum values.

A set of motor characteristics is shown in the accompanying diagrams for both alternating-current and direct-current running. It will be noted that the speed torque charac-

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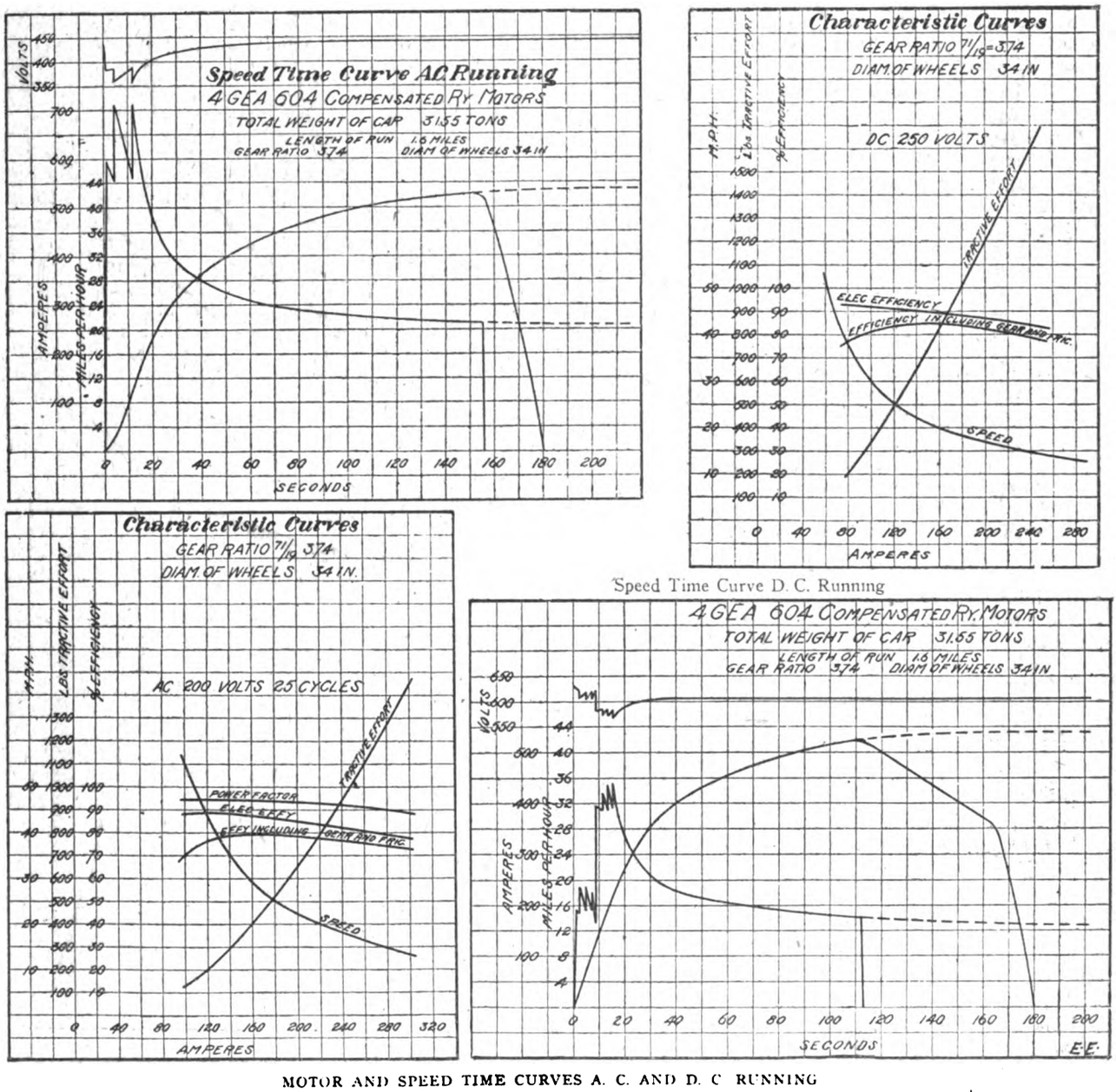
teristics for alternating-current running are equal to direct-current running in meeting the requirements of railway work. Unlike the multiphase induction motor with its practically constant-speed characteristic, the compensated motor varies its speed with the load, and is thus better adapted to operate trains over an irregular profile. The commutation of the compensated motor is equally satisfactory when running alternating current or direct current, and this good commutation is secured by careful electrical and mechanical design without using high-resistance leads.

There is a comparatively small additional expense required to adapt alternating-current equipment to run either alternating current or direct current, and in the case of the Ballston line this is accomplished with the use of a standard K 28, direct-current, series-parallel controller used in connection with a commutating switch to change field connections, cut-out step-down transformer, change line fuses, etc. The time required to operate the commutating switch is but a few seconds.

It is instructive to compare the performance of the compensated motor equipment when operated with alternating current and direct current. The accompanying speed-time curves were taken over the same stretch of track with alternating current and repeated with direct current. The direct-current speed-time and ampere-time curves are typical, and require no particular comment. The alternating-current run, taken under exactly similar conditions, over the same track, illustrates what can be expected from series-parallel control with compensated motors. The rate of acceleration is somewhat lower in the alternating-current run, hence requiring the application of power up to the moment of braking. The shape of the speed-time curve also is characteristic of alternating-current motor work—that is, a comparatively short time on the controller with a large amount of motor curve acceleration. The short period of fractional voltage running of alternating-current motors makes the method of their control of secondary importance,



Speed Time Curve D. C. Running

MOTOR AND SPEED TIME CURVES A. C. AND D. C RUNNING

The following constants apply to both sets of runs:

COMPARATIVE ALTERNATING-CURRENT AND DIRECT-CURRENT RUNS.

	Direct current.	Alternating current.
Length of runs	1·6 miles	1·6 miles
Weight of car	31·55 tons	31·55 tons
Time	180 seconds	180 seconds
Average current power on	229 amperes	346 amperes
Average voltage	606	425
Volt-amperes full speed on level	98	110
Volt-ampere hours per ton-mile of given run	86·3	125·5
Average speed	32 m.p.h.	32 m.p.h.
Schedule speed, including 15 seconds' stop	29·5	29·5

The low volt-ampere hours per ton-mile of the direct-current run is partly due to the better efficiency and power factor of the compensated motor when run direct current, and partly due to the somewhat higher rate of acceleration, permitting some coasting and resulting in a more efficient speed-time curve. The difference in volt-amperes alternating current and direct current depends upon the length of a given run, and the values approach each other more nearly with a run of greater length. It will be noted that the compensated motors run the car at practically the and largely minimises the economy of potential control over series-parallel control.

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same speed with 200 volts per motor, alternating current, and 300 volts, direct current. This uniform speed is obtained by series-parallelling the fields.

SOUTHWARK ELECTRICITY ACCOUNTS.

The following are abstracts of the revenue account and balance-sheet of the Southwark electricity department, together with statement of electricity generated, sold, etc., for the year ended March 31, 1904.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	4,907	18	9
Distribution of electricity	303	6	7
Public lamps	536	18	5
Rents, rates, and taxes	628	5	5
Management	826	18	3
Special charges	76	0	0
Balance carried to net revenue account	4,951	17	2
	£12,231	4	8

Cr. Income.	£	s.	d.
Sale of current	11,982	2	1
Rental of meters	151	4	3
Sale of lamps	57	1	3
Repairs to apparatus, etc.	10	17	11
Supervision on private works	29	19	2
	£12,231	4	8

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans outstanding	78,555	0	0
Sundry creditors	982	16	10
Cash due to borough treasurer, etc.	7,235	10	5
Net revenue account—amount at credit of	224	6	1
	£86,997	13	4

Cr. Assets.	£	s.	d.
Property, permanent works, etc.	81,899	8	11
Stock of cable, coal, etc., in hand	387	7	1
Sundry debtors and insurance	4,710	17	4
	£86,997	13	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		833,208
Quantity sold { Public lamps	254,586	793,418
Quantity sold { Private consumers	538,832	
Quantity used on works		29,810
Total quantity accounted for		823,228
Quantity not accounted for		9,980
Total maximum supply demanded (kilowatts)		57

Number of public lamps: arcs, 98; incandescent, 180; Nernst, 304

PERSONAL.

The Darlington Council have increased the salary of the borough electrical engineer, Mr. Lunn, by £100, making it £350 per annum.

On Tuesday night Mr. Thomas, the retiring manager of Huddersfield tramways, was presented at the athletic rooms of the tramways department with a breakfast tureen and a silver cigar case. The presentation was made on behalf of the employés by Mr. Whiteley, chief assistant engineer. Mr. Hartley (traffic assistant) occupied the chair. Mr. Thomas shortly proceeds to Durban to take up his new duties there, and from the congratulatory addresses by Messrs. Whiteley, Hollingworth, Booth, and Stringer it was evident that Mr. Thomas takes the heartiest good wishes of his former staff with him.

The Ilkeston Tramways Committee have appointed Mr. A. C. Gilbert as permanent manager of the tramways at a salary of £175 per annum.

Mr. William Drysdale, A.M.I.E.E., chief assistant engineer, Corporation electricity works, Falkirk, has been appointed chief assistant electrical engineer for the borough of Weymouth and Melcombe Regis at a commencing salary of £120. There were 130 applicants. Mr. Drysdale has been about two years in his Falkirk position.

Mr. Kirton, manager of the Lancaster Corporation tramways, has been appointed manager of the new Keighley tramways. The salary of the post is £104 per annum, and there were 140 applicants.

The salary of Mr. Samuel Gordon, cashier of the Aberdeen tramway department, has been increased from £200 to £225.

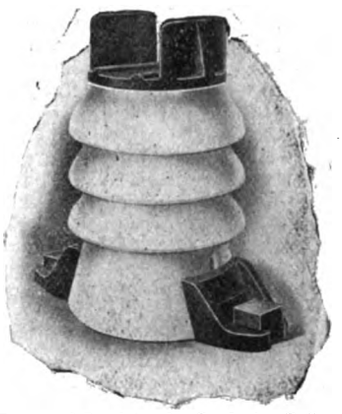
Mr. Andrew Nance, manager of the Belfast Street Tramways Company, has been appointed general manager of the Belfast Corporation tramways. We understand that the salary is to date from Jan. 1, 1905, at £1,250 for the first year, rising by annual increments of £50 to a maximum of £1,500 a year.

On Friday evening a well attended gathering took place at the Mother Red Cap, High-street, Camden Town, the occasion being the presentation of a massive oak spirit cabinet to Mr. William Anderson Brown, the distributing engineer of the electrical department of St. Pancras, on his marriage. The chair was taken by Mr. S. W. Baynes, the chief electrician, and the vice-chair by Mr. Bruce.

TRADE NOTICES AND NOVELTIES.

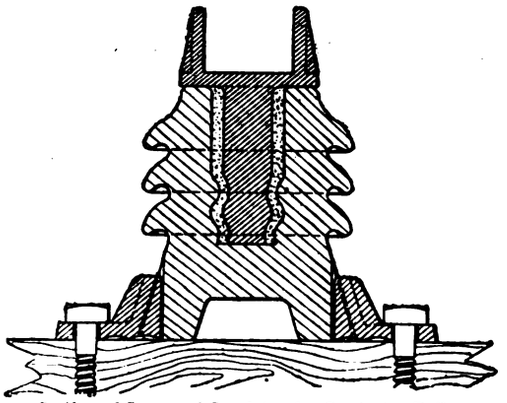
An Improved Insulator for Conductor Rails.

Among the many problems attending the substitution of electric power for steam locomotives in railway working, of no small importance is the attainment of a thoroughly satisfactory means of supporting and insulating the conductor rails. It is essential that the rail supports, while providing permanent insulation under the difficult conditions prevailing on railway tracks, should be substantial enough to withstand rough usage and sufficiently strong mechanically to resist considerable vibration and shock. With a view to meeting these requirements,



Improved Insulator for Conductor Rails.

Messrs. Doulton and Co., Limited, of Lambeth, London, who have had considerable experience in the manufacture of insulators of this class, have patented a new rail support. It consists of a pedestal of porcelain of substantial proportions, with a large base resting direct upon the rail-tie and secured thereto by external malleable iron fastenings. In this respect it differs considerably from earlier types of rail insulators, in which the



Section of Improved Insulator for Conductor Rails.

porcelain is supported on a central stud after the manner of telegraph insulators. The conductor rail is held in position by a chair of malleable iron, provided with a depending stud which is cemented into a recess in the insulator. The insulator shown in the accompanying illustrations is fitted with a chair for a conductor rail of rectangular section. The same type is supplied with chairs adapted for other sections of rail—*e.g.*, flanged or channel sections. The insulator is of high-grade vitreous porcelain of a form well adapted for manufacture, and it will be seen from the illustrations that it occupies the whole of the vertical space below the rail, thus presenting a maximum length of path to resist surface leakage of current.

Ediswan Catalogues.

We have received from the Edison and Swan United Electric Light Company, Limited, three new catalogue sections—namely: Section I., "Royal Ediswan" lamps; Section IV., measuring instruments; and Section V., wires and cables. Section I. contains all the latest forms of "Ediswan" lamps, and embraces low and high voltage standard lamps, high candle-power lamps, "Queen" reflector lamps, obscured, tubular, crinkled, and olive lamps, "Royal Ediswan" traction and ship lamps, and a large variety of special small-bulb patterns, as well as focus, cell-viewing, and radiator lamps. A good deal of useful information is also set forth at the commencement. Section IV. deals with measuring instruments of all sorts. A large number of pages are devoted to the "Ediswan" gravity and moving-coil instruments, and these are listed in a large number of sizes and varieties in order to meet all requirements. Tables of dimensions and diagrams for mounting are also provided. Amongst moving-coil instruments we notice the "Sector"

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and "Edgewise" patterns. The former can be provided either to mount direct on the switchboard or on brackets when required to revolve, or for fixing at end of slate. The "Edgewise" pattern is provided with the usual bracket for moving in a vertical plane, but can also be fitted on the top of the switchboard. Special attention is drawn to the "Ediswan" separate shunts for ammeters, which are claimed to be the best of their kind, being made without any soldered joints, and thus avoiding all thermo-electric and contact E.M.F. effects. Milliampere and millivolt meters also find a place; these are built on the moving-coil principle. Cardew voltmeters—which we understand were originally made by the company—are listed in many varieties; and there is a large selection of "Ediswan" cell testing instruments for small readings, and portable instruments for large readings, lamp testing ammeters, detectors, galvanometers, etc. The remainder of the catalogue is devoted to a selection of recording instruments, meters, and testing sets. Section V. is devoted entirely to wires and cables (which are listed in large variety), in vulcanised and pure rubber, lead covered, armoured, concentric, and many other patterns. Flexible cords receive special attention, including flexibles for dynamos and switchboards, motorcars, ships, bells, telephones, etc.; and some very useful pages are added for fuse, binding, and resistance wires. The introduction comprises some useful information on joint-making, a table for calculating fall of potential, and a wiring table for "Royal Ediswan" lamps, showing how many lamps of various candle-power, voltages, and wattages can be fed by different standard cables, both on the basis of 1,000 amperes per square inch and on the basis of the I.E.E. rules.

APPOINTMENTS VACANT.

Demonstrator in Engineering, London County Council Paddington technical institute, Saltram-crescent, W. Salary, £150 per annum. Applications by Sept. 14. See advertisement in last issue.

Shift Engineer, Ipswich Corporation electric supply and tramways departments. Salary, £90 per annum. See advertisement in last issue.

Electrical Engineer with central-station experience. Capital required, about £5,000. See advertisement.

Electrical Engineer to take charge of the driving and lighting plant of printing works. See advertisement.

Sub-station Attendants. See advertisement.

Junior Assistant, to take charge of light shift and assist during evening on switchboard. Wages, 25s. per week. See advertisement.

Electrical Fires in the States.—The electrical bureau of the National Board of Fire Underwriters of the United States has issued its quarterly report on electrical fires, from which we extract the following points in regard to causes. Twenty crosses of telephone, telegraph, and other signalling circuits with lighting and power circuits have been reported. Twelve fires have been caused by dynamos and motors, in eight cases due to burning out of armature or field coils. Twenty-seven cases of the grounding of circuits are reported, of which 12 were on awnings and metal work of buildings. Five fires have been caused by short-circuit in flexible cord, due principally to the use of defective "commercial" cord with thin rubber insulation, and to the wrapping of the cord around pipes, nails, etc., which injure the insulation. Six fires are reported due to short-circuit of wires in fixtures. Four fires were occasioned by short-circuit in wattmeters, one of the devices being an old-style chemical meter. Four fires were due to the use of open-link fuses, principally in the defective porcelain cut-out blocks. Five fires were caused by the heat from incandescent lamps located near inflammable material. Twelve reports of damage by lightning have been received. In at least four of these fires the lightning entered the building over the lighting or signal wires, which were not protected with reliable protective devices. Six fires have occurred in electric cars. Reports of 145 electrical fires, losses aggregating over £34,400, have been received during the last quarter. Reports have been received of 107 fires, losses aggregating some £2,800,000, supposed to have been due to electricity, but they are not included in this report, as the causes could not be definitely proven as electrical, principally because the fires destroyed the conclusive evidences of their origins. One of these fires occasioned a loss estimated at about £2,400,000. Twenty-nine fires, losses aggregating over £50,000, reported as due to electricity, have, upon further and more reliable investigation, been found to have been due to other causes.

DESCRIPTION OF REFUSE DESTRUCTOR AND ELECTRICAL POWER GENERATING STATION IN COURSE OF ERECTION AT SALTLEY.*

BY D. J. ROBERTS.

This combined scheme has for its object the cremation of all kinds of ordinary house and shop refuse, and the utilisation of the otherwise waste heat from the refuse furnaces for the purpose of raising steam for generating electricity for traction and lighting purposes.

Owing to the rapid growth of our large towns, the question of sites for buildings of this class has become an important item. Few designers are now sufficiently fortunate to have to deal with what they would term an ideal site; however, the author is of opinion that the site of these buildings, especially for a destructor, may be truly termed ideal, with a canal forming one boundary and two approach roads communicating with two of the other boundaries. It is also conveniently situated within the collecting area. In connection with the destructor, it is intended to use one of the above roads as an entrance and the other as an exit to and from the inclined roadway. Owing to the scheme being a joint one, it was necessary to arrange the buildings on the site in such a manner that the destructor house, chimney, and everything in connection with the furnaces should be erected on land belonging to the Corporation of Birmingham (which had an area of about two acres) and the boiler-house and electric power station on land belonging to the Drainage Board. The inclined roadway is arranged to commence adjoining the south-west boundary of the site, and will run in a north-easterly direction and join up to the destructor house in the centre of the front of this building facing the roadway.

Next to the destructor house comes the boiler-house and then the electric power station, all adjoining one to the other. The entrance to the inclined roadway will be from the Drainage Board's private approach road, and adjoining this will be a weigh office, measuring 14ft. by 12ft., with a weighbridge having a table 12ft. by 8ft. and capable of weighing up to 10 tons. In plan the inclined roadway resembles the letter T, this form of plan being due to the site not being of sufficient length to introduce a straight roadway with a sufficiently easy gradient. The cross portion at the lower end will be 150ft. long and 32ft. wide between the parapet walls, and will form an entrance at the one end and an exit at the other to and from the tipping floor. There will be one track only on this portion, which will be 28ft. wide, laid on hard dry filling, supported by retaining walls, and inclined at a gradient of 1 in 18. The remaining portion of the roadway up to the tipping floor will be carried on semicircular arches, 14ft. span, each consisting of three half-brick rings in cement, the haunches being filled in with lime concrete. The total length of this will be 242ft. and 20ft. 2in. wide between the parapet walls and the gradient 1 in 19. There will be two tracks on this section, each 6ft. 4in. wide between the kerb; this width of track will be sufficient to allow of motor vehicles being used should the Health Committee at some future time decide to adopt the use of this form of vehicle.

Leaving the inclined roadway, we come to the destructor house. This building will be two storeys in height, measuring internally 104ft. long and 43ft. wide. The ground floor will be divided longitudinally into three sections, of practically equal dimensions, the height from floor to ceiling being 15ft. The first section on the right of the inclined roadway will contain a side entrance passage to the clinkering area, a workshop, storeroom, and a staircase from the clinkering floor up to the tipping floor. The workshop and storeroom will be heated by means of steam on the low-pressure system, the heating pipes being 3in. diameter cast-iron pipes suspended from the ceilings. At the one end of the line of piping will be a steam-trap to run off condensation, and at the other end next the main steam-pipe will be a 1in. reducing valve to reduce the pressure from 160lb. to 10lb. per square inch, and also a stop-valve for the purpose of shutting off the system when

* Abstract of paper read before the Association of Municipal and County Engineers.

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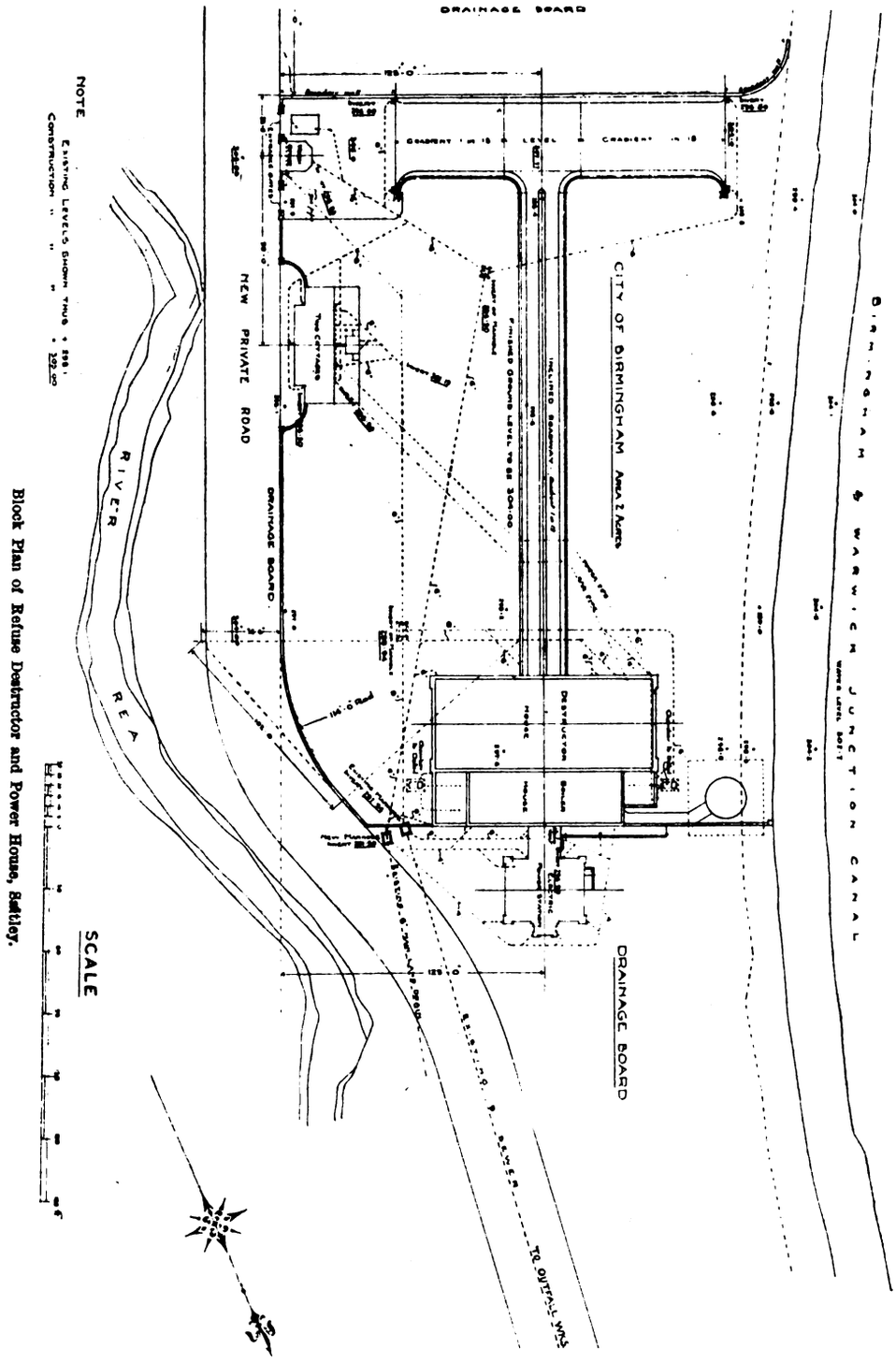
not required. Immediately opposite the inclined roadway will be a pump-room, in which will be placed at present two boiler feed pumps and one hydraulic pump for working the rams of the feed doors to the cells, and space will be reserved for a small electric lighting set, which is intended to be put in at a later date. The size of this room will be 20ft. 2in. by 18ft. 6in. Owing to this room being immediately opposite the inclined roadway, the difficulty of securing light has been overcome by placing the end abutment to the arches of the inclined roadway about 6ft. from the front of the building, to allow of two large windows being fixed one on either side of the room under the roadway. The two boiler feed pumps will be "Mumford's" vertical pumps, with 6in. diameter steam-cylinders and 4in. diameter water-cylinders with 6in stroke, each capable of delivering 2,400 gallons per hour against a pressure of 160lb. per square inch. The hydraulic pump will be "Heenan's three-throw," capable of maintaining a pressure of 10cwt. to the square inch, directly coupled to an entirely enclosed steam-engine of about 12 b.h.p.

The cells to be erected are those known as the "Heenan patent top feed," the makers being Messrs. Heenan and Froude, Manchester. Each cell will have a grate area of 25 square feet. There will be eight of these cells arranged in two distinct sets, each set consisting of four cells, one air heater and fan, and one settling chamber 24ft. by 4ft. by 10ft, connected to one boiler and forming one unit of plant. The cells and settling chambers internally will be entirely lined with 9in. of fire brickwork, and externally with common hard brickwork 14in. thick, and between this outer and inner lining of brickwork there will be a 1½in. cavity filled up with wired silicate of cotton. The whole of the brickwork to the cells and the settling chamber will be braced together by means of 6in. by 2½in. double channels placed vertically at intervals of about 6ft. 9in. These will in turn be secured to horizontal 10in. by 3in. channels let in flush with the brickwork, and fixed in such a position as to take the thrust of the arched covers of the cells. The vertical double channels will be of sufficient length to extend about 9in. above the brick-work for the purpose of receiving the ends of the 1½in.



Block Plan of Refuse Destructor and Power House, Saltley.

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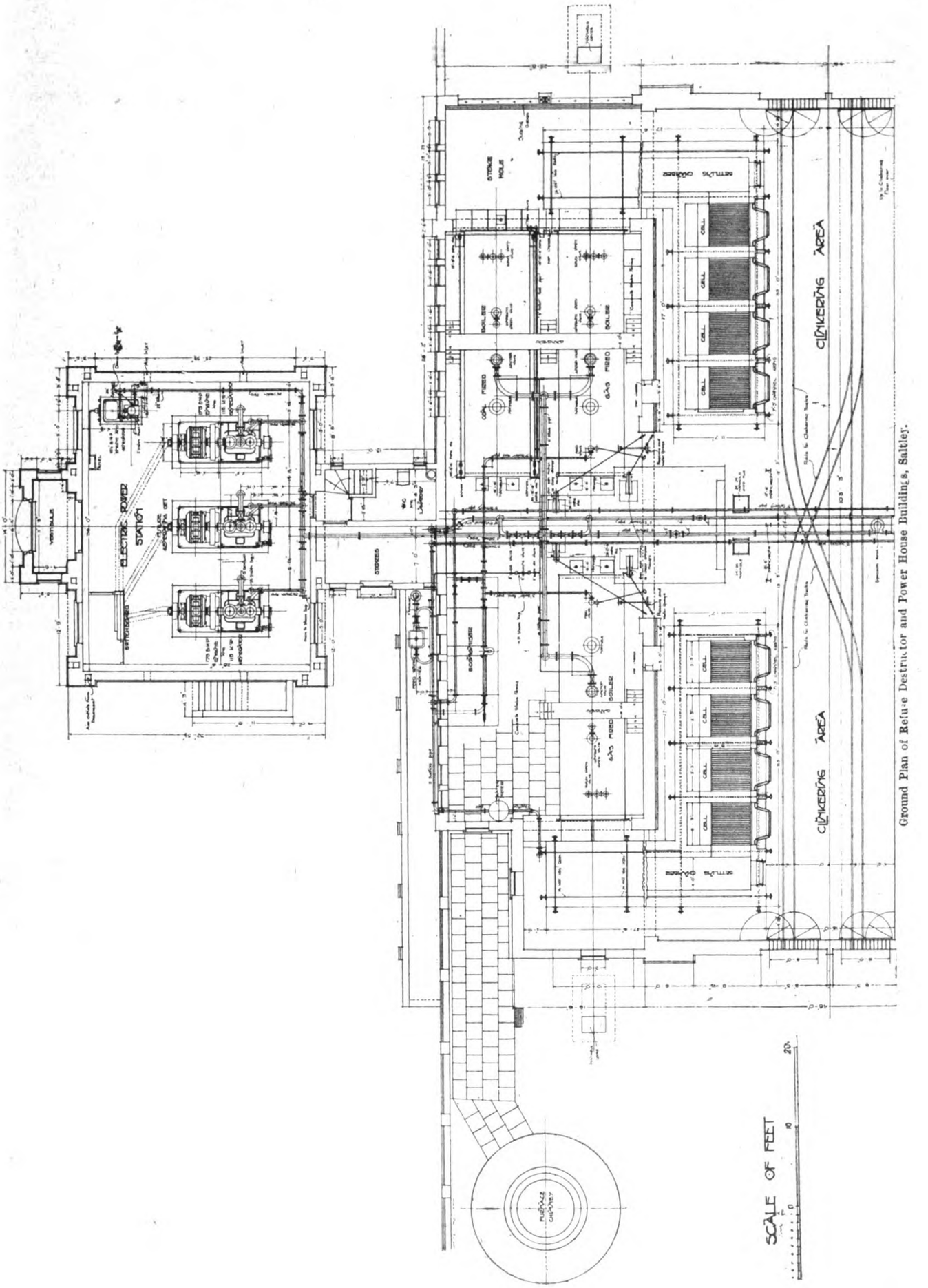
diameter tierods, which are to bind together one side with the other. The fronts of the cells will be of very heavy construction, each weighing something like 45cwt. Each front will be fitted with regulating valves to adjust the admission of heated air from the heaters both above and below the grates. The hot air will be conveyed from the heaters to the cells below floor, in brick ducts 30in. wide and 24in. deep, running under the entire length of each set of cells, immediately under the fire-grates. The clinkering doors will be lined internally with firebrick, and arranged to slide upwards and balance by means of balance weights. Such portions of the fronts to the cells that are not covered



Ground Plan of Refuse Destructor and Power House Buildings, Salford.

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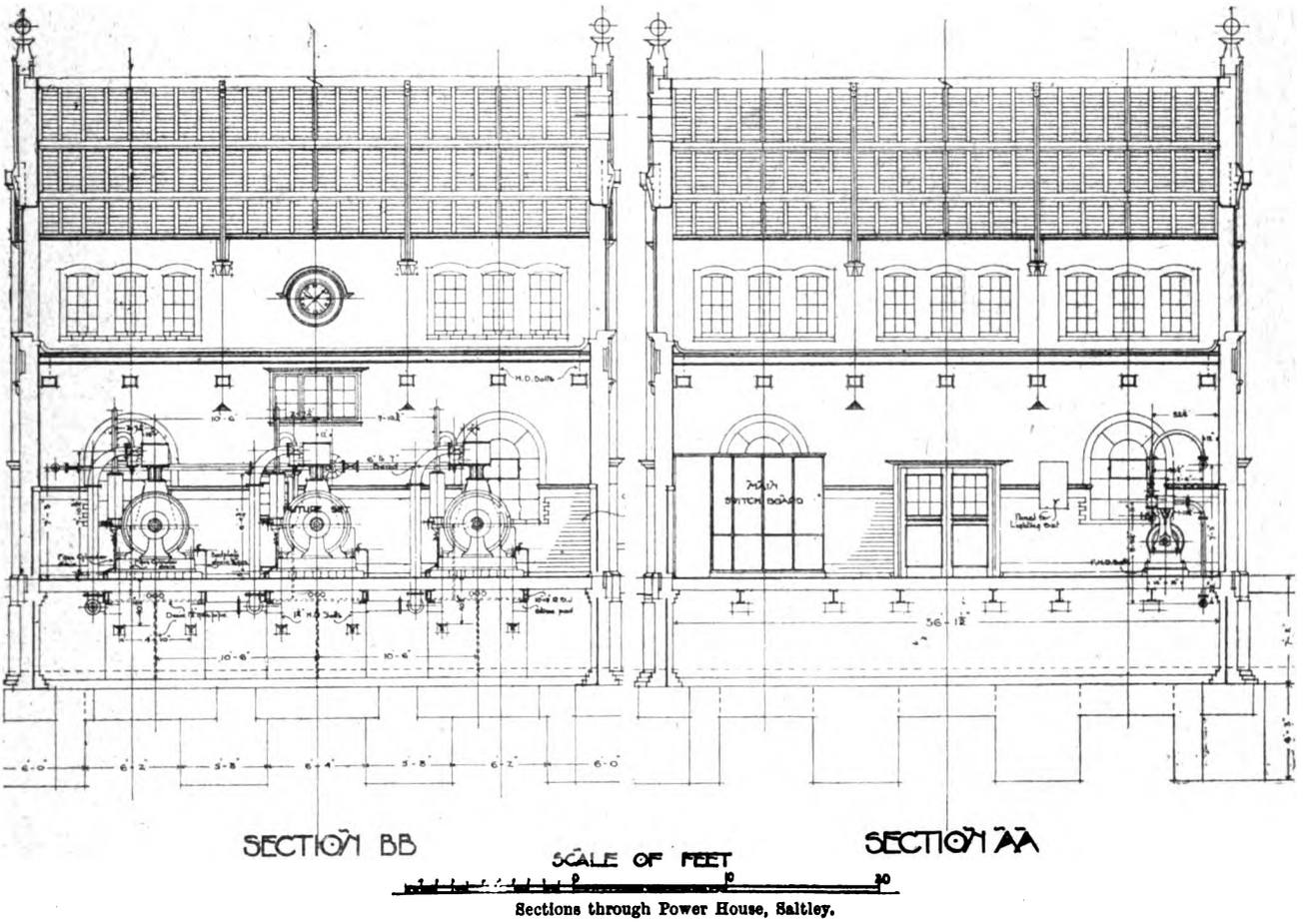
by ironwork will be finished with glazed brickwork, so that they can be easily kept clean. There will be two refuse hoppers, one over each set of cells, each measuring 32ft. long, 13ft. wide, and 6ft. deep, below the tipping beam. The floors of these hoppers will be constructed of rolled-steel joists and concrete, floated smooth and so placed that no portion of the same shall be in contact with the upper part of the cells, so as to avoid as far as possible the heating of refuse that may be stored in the hoppers previous to charging. The feed doors to the cells will be made to slide and rendered fireproof by means of curved firebrick tiles. Each door will be provided with a water-trough to ensure an inch water seal to prevent the blowing out of sulphurous fumes when the doors are closed. These doors will be worked by means of small hydraulic rams, each working at a pressure of 500lb. per square inch, and operated by levers from the tipping floor. Each ram will be connected up to the three-throw hydraulic pump in the pump-room.

The air heaters will each provide about 1,500 square feet of heating surface. They will consist of 3in. diameter boiler tubes fixed in a vertical position, and secured at their upper and lower extremities to horizontal plates, and entirely surrounded with brickwork braced together in a similar manner to the cells. The hot gases, after leaving the boilers, will be made to pass through these tubes on their way to the economiser and chimney, thereby heating the forced air, which will be made to circulate around the outer surface of the tubes on its way from the fans to the cells. It is claimed by the makers that the introduction of hot forced air into the cells gives an initial temperature of from 300deg. to 350deg. In addition to this, heated air has a greater avidity to absorb moisture; consequently, with the use of hot air the usual drying hearth in the cell is dispensed with. Then, again, with the use of forced air it is easier to regulate the supply of air to the cells to that of the theoretical supply required. With the aid of forced heated air it has been contended for years by those who have closely studied the matter that it is possible to so regulate the forced heated air and the pull of the chimney that a perfect balance of gases can be secured. With this condition existent in the cells cold air cannot enter even with the doors wide open. The fans for forcing the air to the cells will be placed on the tipping floor, immediately over the heaters, and in close proximity to the hoppers. It is hoped that by placing the fans on this floor that they will greatly assist the circulation and the removal of foul air in this part of the buildings. The fans will be connected down to the heaters by means of square steel tubes. Each fan will be 66in. diameter, in order that they may be run at a comparatively low speed, and so that differences in volume can be obtained without much fluctuation in wind speed. The fans will be coupled up to and driven by entirely enclosed self-oiling Belliss engines of 12 b.h.p. each. These fans will be of sufficient capacity to enable 60 tons of ordinary house and shop refuse to be burned in 24 hours on one set of four cells, which is equal to 56lb. per square foot of grate per hour. The makers guarantee that when eight cells and two boilers are in use under ordinary conditions, that the plant will evaporate not less than 9,000lb. of water when the furnaces are fed at the rate of 8,000lb. of refuse per hour.

The first floor of the destructor house will contain the refuse hoppers, the air-fans and engines, the tipping area, and a staircase down to the clinkering area. The tipping area will measure 104ft. long and 27ft. wide, and in addition to this, between the two hoppers there will be an enclosed area 26ft. long and 16ft. wide where it is intended to place the fan and engines.



Sections through Power House, Saltley.

Leaving the destructor house, we next come to the boiler-house. This building measures internally 73ft. 6in long and 24ft. 6in. wide, and is 13ft. high from the top of the flues to tierod. Accommodation is here provided for three boilers, one economiser (with provision for adding another 64 tubes), and the necessary flues. The flues inside the house are to be of large dimensions so as to secure easy access for cleaning purposes. In the centre of the building will be the main flue running across at a low level from the heater in the destructor house to the economiser. On one side of this flue will be placed two boilers side by side, and on the opposite side will be placed one boiler and the economiser with a by-pass flue between. Openings covered with portable firebrick slabs in chases will be provided between the lower boiler flues and the above main low-level flue from the heater for the purpose of sweeping the soot or dust from the boiler flues into the main flue,

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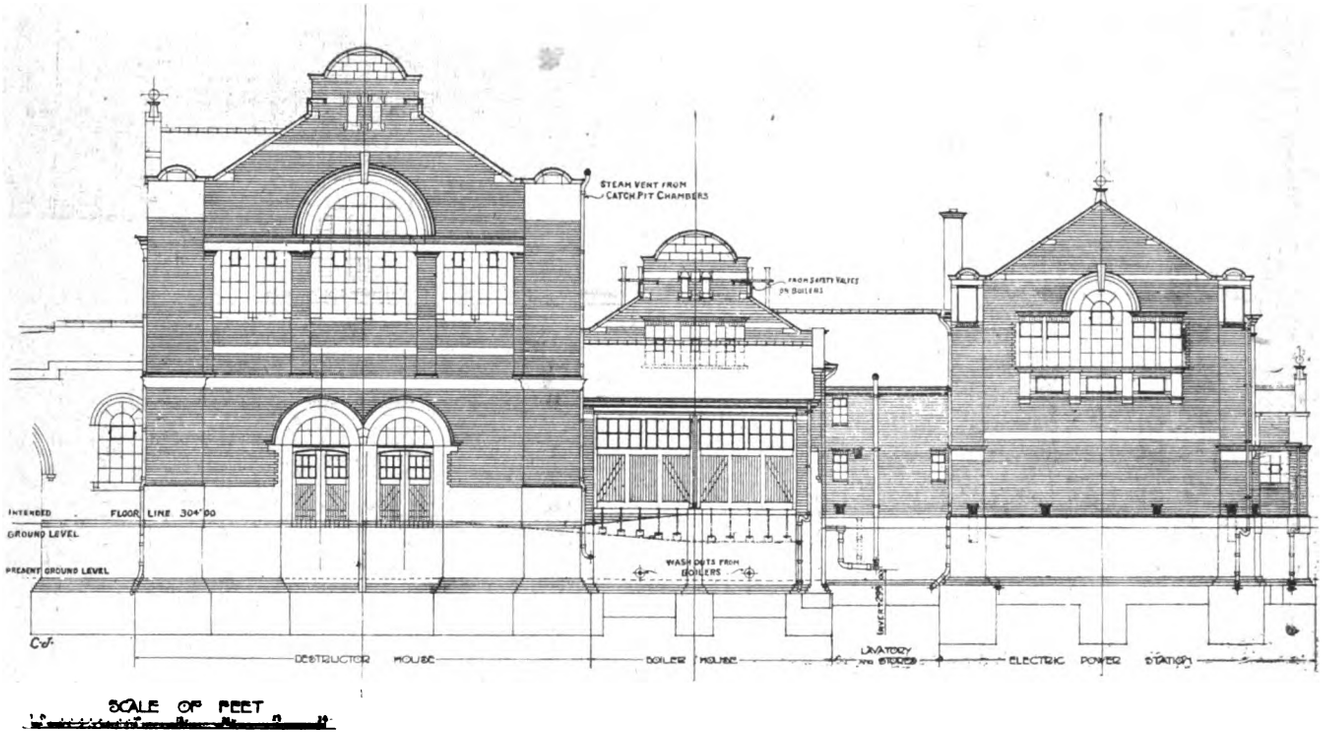
and thence to a point in this flue under the destructor-house floor, where it can be hoisted up by means of a small permanent winch and deposited into the clinkering trucks close at hand.

The three boilers, which are to be supplied by Messrs. Taylor and Sons, of Marsden, Yorkshire, will be of the type known as Lancashire boilers, each measuring internally 30ft. long and 8ft. diameter, constructed for a working pressure of 160lb. per square inch. Two of these boilers will be gas fired—that is, they will be connected with the furnaces—while the other will be adapted for coal firing, and will be a stand-by. The gas-fired boilers will be connected to the settling chambers by means of steel rings lined internally with firebricks. Each boiler will be fitted with one Hopkinson's patent "Duad" safety valve for high steam and low water, one Hopkinson's patent "Duplex" safety valve for high steam only, one Hopkinson's patent parallel side blow-off valve, and one Hopkinson's isolation valve. The pressure and water gauges on the gas-fired boilers will be fixed on the sides on Hopkinson's columns C type with guards near the back ends of the boilers facing the destructor house, so they they can be seen from the clinkering area. The gauges on the coal-fired boiler will be placed in the usual position on the firing end in connection with the coal-fired boiler, and at the opposite end there will be a cast-iron storage water tank at a high level to hold 5,000 gallons, which will be supplied from the city main.

The furnace chimney, which will stand on a cement concrete base 36ft. square and 8ft. thick, will be at the end of the boiler-house next the canal. A portion of the main flue from the boiler-house to the chimney for a distance of 28ft. will be increased from 3ft. 6in. by 7ft. 3in. to 6ft. by 7ft. 3in., so as to decrease the velocity, thereby facilitating the settlement of any dust before reaching the chimney. The total height of the chimney above the intended finished ground level will be 165ft., and the internal diameter at the top will be 7ft. Above the foundations the chimney for its entire height will be circular in plan, and the batter on the outside face will be 1 in 40—the bond being three rows of stretchers to one row of headers. The top will be finished with a strong cast-iron casing, bolted together in sections, and filled in on the inner side with brickwork; below this there will be a terra-cotta cornice, and some buff plain brick bands, which should form a pleasing contrast with the brindle bricks which it is intended to use for the facing generally. Internally, there will be a fire-brick lining 130ft. high, 9in. thick for the first 75ft. of its



South-East Elevation of Buildings, Saltley.

together with the feed inlet valve. The feed inlets to the gas-fired boilers will be at the top near the back ends. The valves in these cases will be Hopkinson's patent "accessible feed valves," worked from the clinkering area by means of rods and hand-wheels, the hand-wheel being arranged to be worked adjoining the pressure and water gauges. From this position it will also be arranged to work the flue dampers in connection with the gas-fired boilers. It is intended to set the boilers on Pearson's patent seating blocks with asbestos cushion and to cover them with Pearson's patent firebrick covering blocks laid on a layer of asbestos. The emptying pipes from the boilers will discharge outside the building into catch-pit chambers, constructed for the purpose of arresting any deposit from the boilers which would otherwise be discharged into the drains.

The economiser will be supplied by the Clay Cross Company, Chesterfield, and will consist of 128 tubes 9ft. long, $4\frac{9}{16}$in. diameter, fixed vertically and forced into longitudinal top and bottom boxes in sections forming metal to metal joint. The tubes will be arranged in two groups of 64 each, and connected together with cast iron expansion elbows. Each tube will be fitted with triple scrapers, worked by a small continuous-current electric motor. At the south-east end of the boiler-house will be a stokehole

height, and $4\frac{1}{2}$in. thick for the remaining 55ft. At the top this lining will be finished with a keyed firebrick coping, laid loose on the top of the lining to protect the cavity between the lining and the main wall of chimney. The conductor tape will be $1\frac{1}{4}$in. by $1\frac{1}{8}$in., copper connected at the bottom end to a 3ft. square copper earth-plate No. 16 B.W.G., and finished at the top with a solid $\frac{3}{4}$in. diameter copper air terminal, with $\frac{1}{2}$in. diameter inclined points. The terminal will be fixed to a wrought-iron bracket bolted to the cast-iron casing before referred to.

Having described the boiler-house and appurtenances, we now come to the power station. The front portion of this block of buildings will be taken up entirely by the engine-room on the ground floor, with a basement under of similar area. Between the engine-room and the boiler-house will be a small wing, containing on the ground floor a storeroom and lavatory, with a basement under, and on the first floor a small messroom for the attendant containing a window overlooking the engine-room. The engine-room will be 36ft. long, 28ft. 6in. wide, and 22ft. high from the floor to the tierod. The main front will face north-east, and in the centre of this front will be a small entrance porch or vestibule, to serve as the main entrance to this portion of the scheme, approached from the Board's private road. There will be no communication internally

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between the power station and the boiler-house, the arrangement between the Drainage Board and the Health Committee being that the production of steam shall be entirely governed by the Health Committee, for which the Drainage Board pay an annual fixed sum.

The generating plant in the engine-room will consist of two three-phase generators, direct driven by Belliss engines, and provision will be made for a third set. The engines will be compound two-crank engines, each capable of developing 175 b.h.p. at a steam pressure of 130lb. per square inch, and the generators will be B.T.H. standard 115-kw., 2,000-volt, 50-cycle, revolving-field, three-phase generators, each equipped with shaft, half coupling, out-board bearing, and direct-coupled exciters. Each of these will be capable of standing an overload of 10 per cent. continuously, 25 per cent. for one hour, and 50 per cent. momentarily. The engine-room will also contain the switchboard. This will consist of four panels of polished marble. Two of these panels will control the generators, and the remaining two panels will be for the high-tension and low-tension feeders. The panels for the generators and the high-tension panel will each be 90in. high and 24in. wide, built up in two sections; the low-tension panel will be 90in. high and 16in. wide. The whole of the electrical work will be carried out by the British Thomson-Houston Company, Rugby. A small lighting set will also be placed in the engine-room for the purpose of lighting the power station and the precipitation tanks at Saltley. This will consist of a single vertical engine by Messrs. Bryan Donkin and Clinch, capable of developing 15½ b.h.p. at a speed of 550 revolutions per minute, when supplied with steam at 100lb. pressure, connected direct to one 10-kw., 220-volt, compound-wound generator, with one field rheostat and multi-contact switch.

The exhaust steam from the engines will be taken down into the basement, and thence to a feed-water heater to be fixed outside between the engine-room and the boiler-house. The class of heater it is intended to adopt will be Webster's vacuum feed-water heater and purifier, with oil separator attached, capable of raising the temperature of about 8,000lb. of feed water per hour from 50deg. to about 206deg. F. and over, when fed continuously with exhaust steam at the rate of not less than 1,400lb. per hour.

The travelling crane in the engine-room will be supplied by Messrs. Higginbottom and Mannock, Manchester. This crane will be capable of safely lifting six tons with all motions worked by hand chains from below. In construction it will consist of two 14in. by 6in. cross steel girders, supporting the necessary travelling and lifting gearing, resting at each end on steel carriages, made up of plates and angles, each carriage being fitted with two cast-iron travelling wheels, 21in. diameter. The usual arches internally for carrying the gantry beams have here been placed outside, in which case the beams and rails will rest on the main walls, which will be carried above the gantry beam by the external arches. This form of construction will greatly add to the appearance of the building, and dispenses with a number of objectionable angles in the engine-room. The engine-room will be ventilated by means of a 16in. diameter electric fan, with motor for 220-volt continuous current, capable of circulating 1,260 cubic feet of air per minute. There will be a glazed brick dado in the engine-room and porch, 6ft. high, and above this the walls will be plastered and colour-washed. The floors will be tiled with encaustic tiles.

It must not be omitted to mention that Messrs. W. Lee and Son, of Aston, Birmingham, are the contractors for the whole of the building work in connection with this joint scheme.

The estimated cost of the whole scheme is made up as follows:

CORPORATION OF BIRMINGHAM.

Destructor house	£4,214	0	0
Inclined roadway and boundary walling	3,767	0	0
Drainage, manholes, etc.	100	0	0
Chimney foundation	650	0	0
Chimney above new formation level	1,149	0	0
Outside flue	147	0	0
Refuse furnaces, air fans and engines, and air heaters	4,244	10	0
Hydraulic rams, pump, and engine in connection with furnaces	355	0	0
Gas and water services and fittings	137	10	0
Heating, calorifier, steam-kettle, oven, etc.	100	0	0
Six clinkering trucks and special design	90	0	0
Tramlines inside buildings for ditto	50	0	0
Steam lay out	120	0	0
Fixing only storage tank, providing inlet and outlet pipes, overflow, etc., and gas and water department work	105	0	0
Two cottages, weigh office, and foundations for weigh-bridge	950	0	0
Weighbidge	57	0	0
Land	800	0	0
Total for Corporation carried to summary	£17,046	0	0

DRAINAGE BOARD.

Boiler-house	£1,190	0	0
Economiser	185	0	0
Three boilers	1,412	12	0
Boiler covering	56	0	0
Steam lay out	1,250	0	0
Power station	1,287	0	0
Two feed pumps	100	0	0
One feed heater	58	0	0
Two generating sets	2,400	0	0
Main switchboard complete, including cable connections	356	0	0
Lighting set	180	0	0
Boundary fencing and entrance gates	60	0	0
Travelling overhead hand crane	128	0	0
Total for Drainage Board carried to summary	£8,662	12	0

SUMMARY.

Corporation of Birmingham	£17,046	0	0
Drainage Board	8,662	12	0
Total cost of scheme	£25,708	12	0

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

The profits of this Company for the year ending June 30, after paying debenture interest and charging £4,299 for depreciation, were £5,546, and £4,827 was brought forward. A dividend of 5 per cent. is proposed, carrying forward £2,873. The directors attribute the decrease of profits to severe competition and general slackness of trade. The prospects for the ensuing year are, however, more favourable. Mr. Barningham and Mr. Kerr (directors) and Messrs. Chiene and Tait (auditors) offer themselves for re-election.

ABERDEEN SUBURBAN TRAMWAYS.

The half-yearly meeting of this Company was held on Wednesday at Aberdeen, Mr. George J. Walker, chairman, presiding.

The report stated that a net profit of £449. 5s. 3d. had been made on the Company's working for the short period that the lines were opened, and the directors proposed that the balance standing at the credit of the profit and loss account should be carried forward to next account.

The **Chairman**, in moving the adoption of the report, commented upon the harmonious working with the Corporation tramways, to which, he remarked, the Company's service undoubtedly acted as a great feeder. As the Company was only in its infancy, the directors thought it prudent to carry the profit forward. He hoped that before long the Company would be able to run additional cars.

The report was unanimously adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Marcinelle (Belgium).—The Episcopal College require tenders for voltmeters. Tenders by Sept 15.

Tynemouth.—The Corporation invite tenders for a 600-kw. steam dynamo by Sept. 30. See advertisement.

Oviedo (Spain).—The Municipality require tenders for the public lighting of the town for 20 years. Tenders by Sept. 20.

Madrid.—Tenders are required by the Municipality for a number of lamp-posts for one, three, and five lamps. Tenders by Sept. 21.

Arenas de San Pedro (Spain).—The Municipality require tenders for the electric lighting of the town for eight years. Tenders by Sept. 25.

Pretoria.—The Commanding Royal Engineer at Army Head-quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

The Hague (Holland).—The Council of the Hague require tenders for the supply of from 8,000 to 9,000 tons of steel rails, including appurtenances, for electric tramways. Tenders by Sept. 22.

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Edmonton.—The Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. Tenders by Sept. 27. See advertisement.

Brussels.—The Government Railways require tenders for galvanised-iron wire, telectric cables, copper wire, insulators, etc. Specification No. 32. Tenders by Sept. 14, 11 a.m. Public adjudication at the Bourse, Brussels.

The Hague.—The Municipality require tenders for 8,000 to 9,000 steel rails and accessories for electric tramways. Particulars, etc., may be obtained at the Gemeentewerf Groenewegje, at the Hague. Tenders by Sept. 22.

Belmez (Spain).—The Municipality require tenders for electric lighting of Belmez Pueblo Nuevo del Terrible, and Pennarroya for seven years by Sept. 17. Particulars from the Alcadia Constitutional, Belmez, Cordoba, Spain.

Aberdeen.—The Tramways Committee invite tenders for the supply and delivery of 20 top-deck car-covers. Drawings and specifications may be had from Mr. J. Alex. Bell, city electrical engineer, Aberdeen. Tenders by Sept. 27. See advertisement.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Sofia.—The District Finance Commissioners require tenders for 50,000 km. 4mm. iron wire, 1 000 km. 2mm. iron wire, 15,000 Parphor insulators (No. 2), and 1,000 iron hooks (No. 2). Five per cent. guarantee required. Estimate. £1,175. Tenders by Sept. 23.

Wallasey.—The Urban District Council invite tenders for the supply and erection of high-tension switchgear (which must be of British manufacture) for a sub-station. Tenders to Mr. N. W. Cook, clerk and solicitor, Public Offices, Egremont, Cheshire, by Sept. 14.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Wrexham.—The Corporation require tenders for erection of overhead line wires to connect electric fire calls with the firemen's houses. Further particulars can be obtained from Mr. W. Sillery, borough electrical engineer. Endorsed tenders to be sent to Mr. Thomas Bury, town clerk, Guildhall, Wrexham, by 12th inst.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Edinburgh.—Tenders will be received for the supply of 600 tons (more or less) of cable ropes, for the Edinburgh and District Tramways Company, Limited. Specification may be obtained of Mr. John E. Pitcairn, general manager, 1, South Charlotte-street, Edinburgh, and tenders must be lodged with him in accordance with specification by Sept. 19.

Tschatschak (Servia).—The Electricity Company Owtschar und Kablar in this town require two turbines of 750 h.p. each, two generators for three-phase currents, and other plant for the erection of a hydro-electric central station, and equipment of lines of distribution within 40 miles, by Oct. 2. Specifications, etc., may be obtained from the Manager of the Company.

India Office, S.W.—The Secretary of State for India in Council is prepared to receive tenders to supply (1) compressed paper blocks; (2) carriage and wagon wheels and axles; (3) electrical plant. The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office by 2 p.m. on 13th inst. for Nos. 1 and 2, and on 20th inst. for No. 3.

Leeds.—The Guardians invite tenders for the wiring installation and subway and underground concentric mains for the electric lighting to the several proposed new hospital blocks and other extensive existing buildings at the workhouse, Beckett-street, Leeds. Send names to Messrs. Thomas Winn and Sons on or before Sept. 12 when specifications and full particulars will be forwarded. Each application must be accompanied by a deposit of £3. 3s.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

West Ham.—The Town Council invite tenders for the supply, delivery, and erection of all poles, fittings, wires, and pillars required for the electrical equipment of approximately 3 miles 3 furlongs of tramway track in the county borough of West Ham. Specification, etc., may be obtained from the Borough Electrical Engineer, Electrical Works, Canning Town, E., on deposit of a £5 Bank of England note. Tenders to Mr. Fred. E. Hilleary, town clerk, Town Hall, Stratford, E., by 4 p.m. on Sept. 13.

London, N.—The Edmonton Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. They are prepared to consider offers based upon certain alternative arrangements, particulars of which are set out in the form of tender. Particulars and form of tender may be obtained at the office of Mr. William Francis Payne, clerk, Town Hall, Edmonton. Tenders must be addressed to the Clerk, and delivered by 12 noon on Sept. 27.

Ilford.—The District Council invite tenders for extensions to buildings at their electric lighting station, Ley-street, Ilford. Plans, specification, and form of tender may be obtained on application to Mr. H. Shaw, A.M.I.C.E., surveyor, Town Hall, Ilford, during the usual office hours, on payment of a deposit of £2. 2s. Sealed tenders, endorsed "Tender for Electricity Station Buildings," must be delivered to Mr. John W. Benton, clerk, Town Hall, Ilford, by 12th inst.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Barking (Essex).—The Urban District Council invite tenders for the construction of light railways as follows: (Contract No. 1 and 1A) rails, fishplates, and bolts; (2 and 2A) permanent way construction); (3 and 3A) overhead line equipment; (4 and 4A) underground feeder cables, etc. Specification may be obtained of Mr. H. Hargreaves, clerk, Public Offices, Barking, Essex, on depositing a cheque for £5 5s. Applicants to state the contract for which they propose tendering. Tenders to Chairman of the Electricity and Tramways Committee, Council Offices, Barking Town, by 12 noon on Sept. 20.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania), until noon on Sept 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

London, S.W.—The London County Council require tenders for the manufacture, delivery, and erection at the Council's tramways electricity generating station at Greenwich of two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Persons desiring to submit tenders may inspect the drawings and obtain the specifications, bills of quantities, form of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the Cashier to the Council of £2 deposit. Tenders to be addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Pumping Plant." No tender will be received after 10 a.m. on Oct. 4.

Madrid.—The call for tenders for the service of the electric lighting of Pueblo Nueva del Terrible and Penarroya was without result. The conditions of tender have therefore been modified in certain respects, and a new adjudication is announced to take place on Sept. 18. Tenders are also required for the supply of 25,000 porcelain telegraph insulators, No. 1 of the Spanish type. Tenders, which must be accompanied by a proof that 5 per cent. of the amount has been deposited, will be received at the office of the Direction General of Posts and Telegraphs, No. 10, Carretas, 2° Madrid, up to Sept. 16. The *Gacetas* containing the above notices may be seen by persons interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

RESULTS OF TENDERS.

Portsmouth.—The tender of W. Cory and Sons, Limited, Mark-lane, London, has been accepted for the supply to the electricity works of Lusdale nuts at 13s. per ton.

Plymouth.—The Education Authority have accepted the tender of W. G. Heath and Co., Frankfort-street, Plymouth, at £550 for electric light installation at the Municipal Technical School.

Baltic House, E.C.—The tender of the Private Wire and Telephone Installation Company, 5, Palmer-street, S.W., for installing electric light, telephones, and electric bells in Baltic House, Leadenhall-street, has been accepted.

Plymouth.—The Council have accepted tenders from the British Westinghouse Company for the construction of steam alternators at a cost of £4,141, and from Messrs. Hewitt and Kellet for boilers and piping to cost £3,228.

Lincoln.—The City Council have accepted Messrs E. Nuttall and Co.'s tender for the construction of the permanent way for the tramways in the High-street; also of Messrs. W. Griffiths and Co., Limited, for the construction of the electric tramways.

Sunderland.—The Council have accepted the tender of Messrs. Stothert and Pitt, Limited, for the supply of electric cranes, capstans, and motors required in connection with proposed new traffic quays in front of the warehouses at the Hudson Dock North.

Wellington (Somerset).—The following tenders have been accepted for electric lighting, wiring, and fittings at Nynehead Court, Wellington, for Mr. G. S. Lysaght:—Stansell and Sons, Taunton, £754; Petter and Sons, Yeovil and Bristol, oil-engine, £257.

Colwyn Bay.—The whole of the contract for the construction of a permanent way, cables, and electrical fittings in connection with a tramway and light railway between Colwyn Bay and Llandudno has been secured by Messrs. F. W. Smith and Co., Limited, electrical contractors, Southport. Nearly £80,000 is involved.

Dartford.—The tender of the Western Electric Company, North Woolwich, at £850. 6s. 10½d., has been accepted by the Dartford

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Urban District Council for carrying out an extension of underground and pilot cables drawn into existing spareways, and for the laying of private and public lighting cables, together with all necessary roadwork, junction boxes, etc.

War Office.—The Army Council have placed a contract with Geipel and Lange, Vulcan Works, 72A, St. Thomas's-street, Southwark, S.E., for 38 Geipel's patent steam traps, to be fitted at the Royal Gunpowder Factory, Quinton-hill, Waltham Abbey. This is the seventh repeat order which they have received for this factory, which will make a total of 210 Geipel traps fitted there.

South Africa.—Orders are about being placed by the Johannesburg Municipality for switchboards, transformers, and switchgear for the new lighting and tramway schemes. A Westinghouse three-phase induction motor is to be installed at the Knights Deep gold mine. A small alternator, with a direct-coupled exciter, has been ordered through the Crown Agents for the Colonies from Messrs. Mather and Platt, Limited, for shipment to Lagos.—*British South Africa Export Gazette.*

South Africa.—The *British South African Export Gazette* announce the following contracts: "Messrs. W. T. Glover and Co. have, we understand, secured the contract for supplying and laying the cables for the Johannesburg electric lighting and tramway schemes. The value of the contract is considerably over £100,000. A storage battery of 250 central-station type cells has been ordered from the Hart Accumulator Company by the Aliwal North Town Council. Orders have recently been placed in England by the Natal Government for the supply of a quantity of dynamos, wire, lamps, and accessories for train-lighting. The contracts placed with Messrs. John Musgrave and Sons, Bolton, for engine equipment for the extension of the Durban power station are on the point of shipment, while that section entrusted to the Brush Electrical Engineering Company is on the water."

BUSINESS NOTES.

TRACTION.

Huddersfield.—In another column we refer to the Corporation's new enterprise.

Darwen.—The Town Council are considering the question of introducing the regenerative-control principle.

Birmingham.—The site of the old general hospital in Summer-lane is being utilised for the new power station.

Kirkcaldy.—A line of tramway in Dysart, connecting with the Kirkcaldy Corporation system, is reported to be in contemplation.

Sunderland.—The Corporation have decided to introduce covers on their double-decked cars. On one or two routes it will be necessary to lower the road.

Torquay.—The Dolter Electric Traction Company have written to the town clerk as to the probable date when the Corporation will be in a position to supply current for the tramways.

Devonport.—The Board of Trade has approved a set of by-laws for the regulation of the tramways, the chief relating to the limitation of the number of passengers to the accommodation of the cars.

Leicester.—The Aylestone-road section of the Corporation tramways was opened on Monday evening. Substantial headway is being made with the Evington-road, Great Central-street, and Groby-road lines.

Campbeltown-Machrihanish.—A petition is being organised in favour of a light railway between these places, situate in the county of Argyle. An application to the Light Railway Commissioners for powers is pending.

Belfast.—The Corporation have confirmed the Tramway's Committee's recommendation that the overhead system be adopted. We refer in our personal column to the appointment of Mr. Nance as tramways manager.

South Shields.—The question whether the tramway system shall be constructed and worked municipally, or leased to private undertakers, was again before the Corporation on Wednesday. Nothing definite was done, it being stated that the committee appointed to deal with the question expected to present their report in November.

Llanelly.—At a meeting of the Urban District Council last week, it was reported that the British Insulated and Helsby's Cables, Limited, had written stating that they could not see the deputation appointed by the Council pending an appeal which they proposed to make against the judgment of the High Court in the recent action with the tramways company. The remainder of the Council's proceedings were held privately.

Swindon.—Several trials have been made on the newly-constructed system, everything passing off satisfactorily. The Board of Trade inspection is expected to be held on Wednesday or Thursday next, in which case the formal opening will take place on the latter day, but as the drivers are to undergo a short course of training, the service will probably not be opened to the public till a week or two later.

Leeds.—Approval has been given by the Corporation Tramways Committee to a proposal for a special evening class on electricity for tramway employés at the Leeds Institute. The committee offer as an inducement to pay the sessional fee of 5s. for all their men who enter and put in a reasonable number of attendances, the idea of the committee being to technically educate the men a little more in the uses of electricity.

York.—Mr. J. Kincaid, chairman of the York Tramways Company, has written to the Corporation with reference to the present condition of the rolling-stock and property of the company. It has been decided to call a special meeting of the Streets and Buildings Committee to consider the letter, and Mr. Kincaid will be asked to state approximately the sum for which the company would be prepared to transfer their undertaking to the Corporation.

Darlington.—The electric tram system is not yet complete, and the Tramways Committee recommend that a sub-committee be appointed to consider and report upon the delay which has occurred in connection with the contracts entered into with the British Westinghouse Electric and Manufacturing Company and the British Electric Equipment Company. Some time ago the Council authorised the enforcement of the penalties in regard to the contracts.

Accrington.—A report was presented to the Corporation on Monday with regard to the reconstruction of the tramways for electrical traction, provision being also made for certain extensions. The system is at present worked by a company under lease, which expires shortly; and the Corporation contemplate applying for powers to carry on the undertaking themselves. The report advises that the construction of additional double lines should be avoided as far as possible, so as to keep the capital costs as low as possible.

London County Council.—Residents of Brixton have been provided with additional means of access to the City, the London County Council having commenced a through service of electric cars from Water-lane to the foot of Southwark Bridge. For the present the service will be confined to between 7 a.m. and five minutes to 10 a.m., and between 3.30 p.m. and four minutes to 8 p.m. Another route has also been opened up between Asylum-road, Peckham, St. George's Church, and Southwark Bridge. This is continued throughout the day.

Rochdale.—The Board of Trade inspector examined the short length of new tramway along Oldham-road from the High Level-road to King's-road at the end of last week. After traversing the route in one of the new double-decker, single-truck cars, he expressed himself satisfied and sanctioned immediate running. The length, which is laid with double track the whole distance, with interlacing lines over Lock Bridge, covers 5 furlong 2·3 chains. A maximum speed of 12 miles an hour was fixed, and later in the day the line was opened to the public.

Southport-Blackpool.—It is reported that the financial difficulties connected with the tramways track which is to cross the Ribble estuary near Lytham, and thus connect Southport, Lytham, St. Anne, Blackpool, and Fleetwood by tram, have been satisfactorily arranged. Sir Hiram Maxim is the chief supporter of the scheme, and the firm of Vickers, Maxim, and Co. are to construct the transporter bridge over the trained channel to the land on each side of the Ribble. Tenders have been invited, and there is every prospect of an early start being made on the work.

Liverpool.—A conference is to be held between the Tramways, the Estate, and the Health Committees in relation to the proposed tramway along Edge-lane. The point at issue is whether a large sum shall be spent upon road widenings to permit of a double line. At Wednesday's meeting of the Corporation a councillor enquired whether the Tramways Committee had considered the advisability of extending the tramway to the Calderstones estate. The Chairman replied that the committee had various extension schemes under consideration, which would be brought before the Council at the earliest possible date.

Manchester.—A meeting of the Corporation is to be held during the first week in October to deal with the question of the provision of electric tramways in the Bucklow and the Cheadle and Gatley rural and urban districts. It is proposed to pass resolutions giving notice to the Manchester Southern Tramways Company that the Manchester Corporation intend to exercise the powers and assume the obligations conferred or imposed on the company by the Southern Tramways Act of 1903 in relation to the construction, maintenance, and user of so much of the tramways authorised by that Act as are situate in those districts.

Worcester.—At its meeting on Tuesday the Town Council adopted revised by-laws to meet the altered conditions of the conversion from horse to electric traffic. Considerable discussion took place as to the efficiency of the tram service in the city, and the company were urged to carry out their undertaking to provide a 10-minute service throughout the whole of their city system. The chairman of the Electricity Committee pointed out that at present the demand for current was only half what was expected, and the committee were bound to take steps to utilise the surplus power in other directions. A proposal to prohibit the running of trams on Sundays was lost.

Blackpool.—At Tuesday's meeting of the Council it was reported that the receipts for the last two months had increased by £3,554 over the corresponding period of last year. A comparison of the expenditure during the same periods showed that in 1903 the wages were £2,112, and the electricity £1,850, a total of £3,962; while this year the wages during the two months were 2,153, an increase of £41, and electricity £1,821 a decrease of £228, despite the fact that the Corporation has run 17,696 more miles and carried 536,675 more passengers. The engineer attributed the decrease in the cost of the electricity to smaller leakage consequent upon the new lines of tramways and the drier summer. There was still the interest and sinking fund charges on the new tramways to take into consideration, however. The system of tram contracts came under review, and the opinion was expressed that the system should be thoroughly revised.

Derby.—The Board of Trade inspector, Major Pringle, visited Derby on Wednesday afternoon and inspected the reconstructed routes. A couple of special cars were chartered, and upon them travelled the Mayor (Councillor C. Boam), the chairman and vice-chairman of the Tramways Committee (Alderman F. Duesbury, J.P., and Alderman P. W. Spriggs), the town clerk (Mr. G. Trevelyan Lee), the borough surveyor (Mr. John Ward), the electrical engineer (Mr. T. P. Wilmshurst), the tramways manager (Mr. F. Harding), and other members of the committee and officials. The lines run over were Bateman-

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street, Douglas-street, and Dairyhouse-road; Babington-lane, Normanton-road, and Dale-road; and Burton-road. The inspection proved quite satisfactory, and it was anticipated by last evening the system would be in full working order. The Mayor has invited the whole of the drivers, conductors, and general staff, who number close upon 200, to dinner, in commemoration of the opening of the new system.

Petrol-Electric Cars.—We are informed that, in spite of very severe competition from manufacturers in America and other countries, the Wolseley Tool and Motorcar Company, Limited, of Adderley Park, Birmingham, have secured an order for a large six-cylinder petrol engine to develop at normal revolutions 140 b.h.p. The order has been placed by the General Electric Company, of Schenectady, New York, for the first of their new petrol-electric railway coaches. Very considerable interest has been manifested in America, as elsewhere, in the extensive experiments of the North-Eastern Railway Company with their petrol-electric automotor railway coaches. These first two coaches have now passed through all their extensive series of tests, and are running in public service between Scarborough and Filey with every satisfaction. It will be remembered that the "Wolseley" Company supplied two special 90-h p. petrol engines for these coaches after experiments had been made with several other types of motors. The North-Eastern engines have four cylinders 8½in. bore by 10in. stroke. The new ones for America are to be 9in. bore by 10in. stroke, six cylinders. It is especially satisfactory to the "Wolseley" Company to feel that as a result of their enterprise in supplying a special design for the North-Eastern Railway Company's experiments they have secured this order from America. It is understood that after the experimental run of this first engine orders for a further considerable number of engines will be placed with the Birmingham company.

Halifax.—The Tramways Committee ask authority to construct tramways from the present terminus at Jerry-lane, Sowerby Bridge, to Style-bank, Triangle, at an estimated cost of £4,200, "on condition that the Sowerby Urban District Council agree, as far as they legally can, to forego rating the tramway lines in their district for a period of five years." The question of recognising distinct departments in the Halifax tramways system, so that in the absence of the general manager responsibility can be fixed on the head of each department, has for some time past been engaging the attention of the committee. A report of a sub-committee has received the full committee's sanction, and will be brought before the Council at their October meeting. The Tramways Committee are to be duly represented in the new Bill which the Corporation is promoting, but the only fresh powers that they are seeking are for West Vale to Elland, and for three very short lengths. One of these latter refers to Thrum Hall-lane for football traffic, and the other two are to enable the committee to establish a connection with the navigation yards at Halifax and Sowerby Bridge. The committee also propose to vary the Wheatley route, and instead of going round by Shroggs Park, to turn up the Wheatley-lane. They will apply, too, for a revival of the powers which have lapsed down Salterhebble Hill. A start will be made in a day or two with the relaying of the whole line from Skircoat Green to the brewery. The reason is that the joints have given way in consequence of their being laid only on sole-plates instead of having anchor joints.

Bury.—At last Friday's meeting of the Tramway Committee the borough engineer reported that he expected the Tottington section would be completed in a fortnight's time, but that it depended upon the progress made with the reconstruction of the feeder bridge in Crostons-road as to when the section would be opened. He expected it would be in about three weeks' time. It was also reported that Tottington-road, from Walshaw-road to Whittle-street, would be closed from to-morrow to vehicular traffic, pending the reconstruction of the feeder bridge. A letter was read from the secretary of the St. John Ambulance Brigade, Bury Division, with reference to the provision of rubber gloves on the various sections, and suggesting that a pair of gloves should be placed in each of the brigade's wall boxes. About 20 pairs would be required, and the brigade offered to bear one-half the cost. The committee decided to accept the proposal, and expressed their thanks to the brigade for the suggestion. After prolonged negotiations, an agreement has been drawn up between the Bury and Salford Corporations for the interchange of tramway traffic, and this will be formally signed in the course of the next few days. The Salford Corporation under existing agreements has control of the tramways in Prestwich and Whitefield. The Whitefield tramways were opened 18 months ago, or rather that part of them lying between the Prestwich boundary and the Whitefield railway station. There has been considerable delay in the completion of the lines to the Bury boundary owing to trouble between the Whitefield Urban District Council and the company running the steam trams from Whitefield to Bury. The differences, however, have now been settled, and the Salford Corporation has prepared the track and erected the overhead equipment, and the route will be opened very shortly. The agreement between the Salford and Bury Corporations provides for interchange of traffic on much the same lines as that between the Salford and Manchester Corporations in respect to Bury New-road and Deansgate. The Salford Corporation, however, under the new agreement, will have the right to name the routes in Bury over which their cars are to run, and, further, they will decide upon which of their routes the Bury cars are to run. The Corporation have received a letter from the Salford authorities intimating that the section between Whitefield Station and Unsworth boundary is finished, and has been coupled up to the Bury system, and offering Bury the privilege of at once using the lines and running cars through to Whitefield Station. It appears, however, that the lines have not yet been officially inspected, and it was decided not to adopt the Salford suggestion until the line had been inspected. After that has been done there will be a conference between the Bury and Salford managers as to the running of the cars. It has been decided that the fare from Bury to Whitefield Station shall be 2½d., thus making the fare to Manchester 6d.

LIGHTING AND GENERAL.

Worksop.—The Council are raising £2,000 to complete the electric works loan.

Ilkley.—Mr. Warden Stevens is preparing a report on an electric lighting scheme.

Beaumaris (Wales).—The Council have resolved to apply for an electric lighting provisional order.

Andover.—The Town Council intend to apply to the Board of Trade for an electric lighting provisional order.

Weymouth.—An installation of 60 lights of various power has just been successfully opened at electric lighting station. Mr. W. D. Orchard was the contractor.

Batley.—The Council are reducing the price of electric current for the second and subsequent hours per day from 3d. to 2d. per unit, as from and after Oct. 1.

Redditch.—Contracts have been sealed amounting to £3,000 for boilers and feed-water heaters in connection with the electric light undertaking extension.

St. Helens.—The report of Mr. J. Brown, the borough treasurer, shows a considerable increase of £6,883 on the balance of assets in the electricity accounts.

Exmouth.—The question of the best and cheapest mode of lighting the esplanade is before the District Council. The Council have obtained a provisional order.

Buralem.—Sanction has just been received to a loan of £15,700 for the purpose of extending the workhouse, which includes the provision of the electric lighting plant.

Maryport.—The Urban District Council have asked for an extension of the time for carrying out the provisions of the provisional order for electric lighting which they obtained some time ago.

Londonderry.—A test and inspection of the Corporation electric light and power works and the switching on of the private supply took place last night at the electric station, Strand-road.

Felixstowe.—The Lighting Committee have asked the Suffolk Electric Supply Company to name a cash price at which they would sell to the Council the Felixstowe portion of their undertaking.

Bury.—The Electricity Committee have resolved that a supply of electricity to the new workhouse hospital be given upon payment of a flat rate of 3½d. per unit with a minimum annual payment of £200 for a period of 10 years.

Falkirk.—The new poorhouse, which is to be opened next month, has been fitted with 450 lights for an installation of electricity, which is to be taken from the Corporation. Messrs. Thomson and Co., electrical engineers, Falkirk, fitted up the premises.

South Metropolitan Electric Light and Power Co.—The debenture stock transfer register of the above company will be closed, as from the 17th to the 30th inst., for the purpose of preparing interest warrants for the above stock, payable Oct. 1, 1904.

Tuition by Correspondence.—We are asked to draw attention to the fact that electrical and mechanical engineering is taught by correspondence by Prof. A. Jamieson, M.I.C.E., Kelvinside, Glasgow, and students are prepared for examinations and situations.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the London Electric Supply Corporation's further issue of 10,000 6 per cent. preference shares of £5 each, fully paid.

Carron.—The Carron Company are engaged on an extension of the electric lighting of their works at Carron. This is part of a large scheme by which it is hoped to light the entire works. The sections to be lit are those in which it is necessary meantime to burn gas during the day.

Fareham.—The Electric Lighting Committee in their last report state that the new boiler has been built, tested, and found satisfactory. The question of extending the mains to Catisfield has been considered, but as the demand for electricity was not large the committee thought the Council would not be justified in proceeding with the work.

Sale of Plant.—The electric plant at Broomhill, Woodside-lane, North Finchley, N., will be sold on Sept. 13. A catalogue may be obtained from Messrs. Brackett and Sons. For particulars of this and other sales, including the sale of a business, see advertisement columns, also for details of an important sale of plant by tender by the Sunderland Corporation.

Hebden Bridge.—The minutes of the Electricity Committee, submitted at the last District Council meeting, stated that there are at present 2,150 electrical lamps connected. The consulting engineer (Mr. Emmott, Halifax) was empowered to prepare specifications and obtain estimates from the leading makers of suction gas plants suitable for generating electricity at the works. It was resolved to call for the £2,260 balance of the sum authorised to be borrowed by the electricity undertaking.

St. Annes.—In his report of work in the electricity department for the month ended Aug. 26, the electrical engineer states that the output from works was: units sold during July, 1903, 43,178; 1904, 49,876; total units sold to July 31, 1903, 104,489; 1904, 175,030; total number of consumers 1903, 194; 1904, 268. The work has progressed satisfactorily during the month, the traction load during August being very heavy. Messrs. Willans have completed the erection of the last new engine and dynamo. Mr. F. Wilson has completed the foundation tank for the cooling tower. The mechanical stoker fitted to No. 4 boiler has been at work some three weeks, and, on the whole, very satisfactorily. Apart from the question of smoke, he found the machine a decided improvement over hand-firing. Several cables are to be extended.

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Sowerby.—The Parish Council have decided to accept the tender of the Northern Counties Electric Supply Association for lighting the public lamps, the price to be 28s. 6d. per lamp for 1,385 hours, with an approximate 40 c.p.

Stourbridge.—At last week's meeting the Electric Powers Committee recommended that steps be taken to procure an electric lighting provisional order in regard to the parishes of Pedmore, Hagley, Clent, and Belbroughton. After discussion, the Council decided to delete the recommendation from the report.

Aberdeen.—The Gas and Electric Lighting Committee of the Town Council have decided to recommend that the charge for electric light be reduced by ½d. per unit. At present the charge for private lighting purposes is 6d. per unit for the first hour and 2d. per hour afterwards, and for public lighting 6d. and 1½d.

Norwich.—Elaborate changes are in progress just now in the Market-place, consequent upon the approaching migration of the telephone exchange from the Haymarket to the old *Chronicle* offices. It is said that as a final result Norwich will have one of the best equipped and most modernised exchanges in the kingdom.

Keele.—Sanction has been received to the Council's application to borrow £1,000 for the purchase of property in Edinburgh-street, Mason-terrace, and Government-street for the purposes of erecting an electric lighting and general stores depôt. The Board have given the fullest extent—a period of 60 years—for the repayment of principal and interest.

Removal.—The Tudor Accumulator Company, Limited, have removed their offices from 16 to 119, Victoria-street, Westminster, London, S.W. (telegraphic address, "Subconical, London"; telephone, 24, Victoria). We are informed, that to avoid all delay, all correspondence should be addressed as above, and not to the works, from where it has to be forwarded.

Redcar.—Mr. Eldridge has been consulted as to the estimated expenditure of the Council in laying down plant for electric supply. This estimate is £7,050 to £8,530, and before proceeding further the Council desire to find out the probable private consumption. This decision has been reported to the Board of Trade, as the limit of the order obtained has been reached.

Wrexham.—The electrical engineer's report shows that in July, 1904, 17,196 units were used for tramways and 11,705 for light and other purposes, the total consumption being 28,901, as compared with 29,143 in July, 1903. Three new consumers were connected. The committee's report on the proposed extension scheme was discussed at the last Council meeting, but was referred back.

Turton.—At the last meeting of the Urban District Council a letter was read from the Lancashire Electric Power Company, stating that they had decided that their provisional order for the supply of electricity to the Turton district, which would otherwise have come forward at the next session of Parliament, should be postponed for 12 months, in order that the Turton Council might consider the matter.

Pitlochry.—A private company proposes to introduce electric light to Pitlochry and district at a cost given as being equivalent to half the present cost of gas, which is 7s. 6d. per 1,000 cubic feet. They are now obtaining permission to utilise the water at the Falls of Tummell for generating the necessary power. Mr. A. E. Butter, C.M.G., of Faskally, has approved, and a petition to the trustees of Mr. G. F. Barbour, of Bonskeid, is being promoted asking for his consent.

Agency.—The Electrical Power Storage Company, Limited, have appointed Messrs. Saunders, Todd, and Co., of Maritime-buildings, King-street, Newcastle-on-Tyne, their agents for Northumberland, Durham, and the Tees district, and Mr. J. W. Barnard, sole agent for the company's Q and V type cells, has arranged to place the sale of these and small type cells in their hands for the above district, so that Messrs. Saunders, Todd, and Co. may be in a position to deal with all types of storage batteries.

Cardiff.—Tenders have been received for the erection of a sub-station at the docks, and the contract of Messrs. D. W. Davies and Co., Cardiff, has been accepted. The sum sanctioned by the Local Government Board being only £15,000, and the tender being for a larger sum, it has been decided to communicate again with the central authority. The application of Ely Paper Mills for a supply of electrical power will be considered next week. The works will probably consume 2,000,000 units per annum.

Windsor.—Last Friday the petrol in a new motorcar which had just been finished for a private company at the Windsor Electrical Installation Company's works in Peascod-street caught fire, which spread to the car-shed and the cable store adjoining. It was not possible to telephone to the waterworks for more pressure, as the wire had been destroyed by the flames. However, the firemen were on the spot almost immediately, and succeeded in subduing the fire before it could involve the whole of the shed in which the cable is stored.

Willenhall.—The clerk has been instructed to serve upon the Midland Electric Corporation for Power Distribution a requisition requiring them to lay down distributing mains for the purpose of a general supply throughout the whole of the streets in the area of the Willenhall Urban District Council, and, if necessary, to enter into an agreement with the corporation for the supply of electricity for general street-lighting for a term of three years. A notice is also to be served upon the gas company to determine the present agreement with the company as to public lighting. The erection of a destructor is suggested.

Plymouth.—The reduction in the price of current to private consumers came into operation in July, yet the return of the Corporation electricity undertaking for that month shows an increase of receipts over the corresponding period of last year. The total number of units sold in the month was 110,244. Of these the Corporation trams consumed 71,977 units, the Plymouth and Devonport trams 7,051, private consumers 23,197, motors 851, arc lighting 5,510, and miscellaneous 1,638. The estimated receipts for the month were £1,216. In the corresponding period of last year the consumption totalled 97,175, and the receipts were £1,095. The total lamp connections now number 44,359, against 32,554 last year, and the consumers 575, against 439.

Yardley.—At the last District Council meeting a letter was read from the secretary of the General Post Office, London, with regard to the establishment of telegraphic communication by means of electric bell circuits between the fire stations at Sparkhill and a number of fire-alarm posts. The Postmaster-General was prepared to sanction the continuance of the system on the Council entering into an agreement and paying a nominal royalty of 1s. It was explained by the surveyor that the communication was only used by the public to give alarms of outbreaks of fire. He had made enquiries in other parts of the country, and had found that other authorities questioned the right of the Post Office authorities to control the matter. It was decided to leave the subject in the hands of the clerk.

Wycombe.—At the last meeting of the Council, a report was agreed to in which the Electric Lighting Committee recommended a renewal for a term of seven years of the street-lighting contract with the Wycombe Borough Electric Light and Power Company, who have had this contract for the last six years. The number of arc lamps is to be increased from 11 to 12, the position of the additional arc lamp being selected by the authority, and the 279 small lamps will be fitted at the company's expense with new tops to carry ½-ampere Nernst burners giving 70 c.p. The company is to provide the Council at their own cost with a photometer for testing both the arc and Nernst lamps. The fine for an extinction or implied extinction is to be 3d. for a Nernst lamp, and 5s. for an arc lamp. The cost of lighting the lamps is to be as under: 12 arc lamps at £13, £156; 279 ½-ampere Nernst at £3, £837—total, £993.

Beaumaris.—At the last Council meeting Mr. Cownie, manager and secretary of the National Electric Construction Company, wrote proposing a free wiring scheme based upon a charge of 4½d. per lamp per quarter in addition to the charge for current, and stated, as they had now started on the actual construction of the works, the time had arrived to decide whether they could agree upon a scheme satisfactory to all parties concerned. When the Council determined the working agreement—that is, the agreement for the construction and maintenance of the works which had already been completed—they would have the option of purchasing all the installations at their cost price, which, for this purpose, would be fixed at the sum of 15s. per lamp, plus 10 per cent. and less 2½ per cent. per annum for depreciation. If the Council did not exercise their option of purchasing the installations, then they would pay to the company for all unpurchased installations a rental of 4½d. per lamp per quarter in respect of each installation for such period as may be required to complete 25 years from the date each installation was installed. The matter will shortly be discussed by the Council.

Penny-in-the-Slot Telephones.—According to the *Financial Times*, the Liverpool branch of the National Telephone Company states that the system of "penny-in-the-slot" telephones is to be abandoned. The reason assigned for this decision is twofold. The penny-in-the-slot system involves separate switchboards, additional staff, and a differential administration, for which, in the Liverpool head office, there is not physical space at command. Moreover, it does not pay. Penny-in-the-slot subscribers have been charged a subscription of £3. 10s. per annum, and there has been a condition that if the pennies placed in the instrument in the course of a year do not amount to 30s. the subscriber is to make up the difference. This has been found to involve a considerable amount of clerical work on the part of the Telephone Company's staff and some irritation on the part of the subscribers. The Telephone Company now offers in place of the penny-in-the-slot a system known as the X. and Y. Two separate subscribers may use the line in common at a charge of £6 per annum each. The disadvantage is that when one of them is using the line it is blocked to the other; but each, if curiously disposed, can hear the conversation carried on by the other.

Redruth.—The Urban Electric Supply Company are rapidly extending their operations under the management of Mr. F. S. Hanning. Since the official opening of the tramway in November, 1901, the number of consumers of electric light has steadily increased, there being now between 500 and 600, representing the equivalent of 28,444 8-c.p. lamps. The streets are lit with 172 incandescent and two arc lamps, some burning all night and some half the night. For power supply 220 h.p. has been installed, the machinery driven including 30 h.p. for air compressor, 25 h.p. for Roots blowers, power for fans for gorges, fans for cupolas, ore pulverisers, braiders for fuse-making, and engineering works, wood-working machinery, ironmongers' machines, chaffcutters, dough mixers, soda machines, brewery machinery, organ blowing, etc. The Tuckingmill Fuse Works are entirely driven by electricity, and East Pool ore is carried to the Tolvaddon stamps by use of the same power, in specially constructed tram wagons, probably not much under 1,000 tons weekly. The cheaper rate of carriage to East Pool mine will mean something like a saving of from £400 to £500 per annum. An arrangement is contemplated by this mine for the drivage of pulverisers by electricity. A special engine has been erected to drive the magnetic separator.

LIENS REGISTERED.

Edmundsons' Electricity Corporation, Limited.—An acknowledgment of indebtedness, dated Aug. 19, 1904 (supplemental to a trust deed, dated July 10, 1899, and four deeds of acknowledgment, dated respectively April 27, 1900, Aug. 1, 1901, Nov. 14, 1902, and Sept. 28, 1903, securing debenture stock to an amount not exceeding

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three-fifths of the paid-up capital for the time being), has been registered. Property charged: 130 first mortgage debentures of £100 each of the Winchester Electric Light and Power Company; 150 similar debentures of the High Wycombe (Borough) Electric Light and Power Company; 200 similar debentures of the Salisbury Electric Light and Supply Company; 150 similar debentures of the Ventnor Electric Light and Power Company; 100 similar debentures of the Bromley (Kent) Electric Light and Power Company; 40 similar debentures of the Woolwich District Electric Light Company; 50 similar debentures of the Chislehurst Electric Supply Company; 40 similar debentures of the Newmarket Electric Light Company; 50 similar debentures of the Alderley and Wilmslow Electric Supply Company; and the company's undertaking and general assets, present and future. Trustees: J. Bailey, 102, Eaton-square, S.W.; and the Anglo-American Debenture Corporation, Limited, 75, Lombard-street, E.C. Total amount of debenture stock previously issued, £300,000.

Metropolitan Electric Supply Company, Limited.—A mortgage by sub-demise, dated Aug. 5, 1904 (supplemental to a trust deed dated July 20, 1894, securing £250,000 first debenture stock), and a further mortgage by sub-demise of even date (supplemental to a trust deed dated July 4, 1899, securing £250 000 second debenture stock), have been registered. Property charged in both cases: Freehold hereditaments, 2, 3, 4, 5, and 6, Fisher-street and 63, 64, 65, and 66, Eagle-street, Holborn, comprised in registered title No. 82,208, and leasehold hereditaments in Tower-street, St. Giles-in-the-Fields, comprised in registered title No. 49,994. Trustees for first debenture stockholders: Sir Robert Herbert, G.C.B., 3, Whitehall-court, S.W.; and Sir James Pender, Bart., Donhead House, Salisbury. Trustees for second debenture stockholders: D. Meinertzhagen, 12, Tokenhouse-yard, E.C.; and Admiral Lord J. Hay, G.C.B., Fulmer Place, Fulmer, Bucks.

SOUTHAMPTON ELECTRIC LIGHTING ACCOUNTS.

Herewith are given abstracts of the revenue account and balance sheet of the Southampton Corporation electric lighting department for the year ended March 31, 1904. The capital expenditure to that date was £172,966.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	9,678	7	8
Distribution of electricity	2,044	8	4
Public lamps	279	6	10
Management	962	14	5
Rents, rates, and taxes	926	17	5
Insurance, printing, postage, etc.	460	4	7
	14,351	19	3
Balance carried to profit and loss account	13,287	2	1
	£227,639	1	4

Cr. Income.	£	s.	d.
Sale of current	27,201	10	7
Meter rents	326	19	9
Miscellaneous receipts	110	11	0
	£227,639	1	4

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Corporation stock	117,019	1	0
Sundry creditors, etc.	4,828	9	7
Capital and Counties Bank	39,083	17	11
Surplus account—sinking fund, etc.	26,333	4	3
	£187,264	12	9

Cr. Assets.	£	s.	d.
Land, buildings, machinery, etc.	172,966	8	0
Sundry debtors	5,332	2	7
Stock of stores in hand	1,293	6	0
Sinking fund investments	7,672	16	2
	£187,264	12	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			2 599,447
Quantity sold	Private consumers	654,034	
	Public lighting	137,353	
	Corporation tramways	1,298,392	2,089,779
Quantity used on works			96,332
Total quantity accounted for			2,186,111
Total maximum supply demanded (kilowatts)			1,335

Number of public lamps, 176.

PROVISIONAL PATENTS, 1904.

AUGUST 29.

18628. An improved electric lamp holder or socket. George Benjamin Stern and Albert Cecil Greene, 31, Silver-crescent, Gunnersbury, London.

18629. Movable step for tramcars. Andrew Sclanders Nelson, 65, Chancery-lane, London.

18635. A method of generating electricity. David Cook, 165, Queen Victoria-street, London.

18642. Improvements relating to means for the production and application of electrical resonance. Horace Manders, 48, Dover-street, Piccadilly, London.

18645. Improvements in and connected with movable arms for microphone carriers. Hermann Oppenheimer, 55, Red-cross-street, Barbican, London. (Akt.-Ges. Mix und Genest, Germany.)

18683. Improvements in and relating to the control of alternating-current electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

AUGUST 30.

18704. Improvements in or relating to electrical circuit breakers and automatic switches. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

18756. Improvements in or relating to street railway cars. Charles Goehring, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, May 21, 1904, being date of application in United States. (Complete specification.)

18764. Improvements in automatic car-couplers. Andrew Jackson Beard, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Sept. 2, 1903, being date of application in United States.) (Complete specification.)

18766. Improvements in megaphones. Harold Etherington Wilson, 37, Chancery-lane, London.

AUGUST 31.

18792. Improved means for controlling the flow of electricity into third or operative rails or similar appliances for vehicular or other traffic, the said means being also available for signalling purposes. James Graham and Ramsey Kendal, 6, Finkle-street, Stockton-on-Tees.

18801. A mechanical electric governor. Reginald Falshaw, Albert-chambers, Albert-street, Harrogate.

18813. Improvements in or relating to electrical switches and the like. John Taylor, 48, St. Stephen's-avenue, Shepherd's Bush, London.

18819. Improvements in pneumatic brake apparatus for railway and like vehicles. John Wills Cloud, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

18823. Apparatus for enabling telegraphic and telephonic messages to be received simultaneously over the same line wire. Charles Mark Jacobs, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

18826. Improvements in and relating to fenders for tramway cars. Carl Gabesam, 81, High Holborn, London.

18827. Thermostatic electric circuit controller. Christian Klopfenstein and Godfried Klopfenstein, 81, High Holborn, London. (Complete specification.)

18831. Improvements in and relating to telegraphic and like electric circuits. William Kent Kise, Fife House, Kingston-on-Thames.

18840. Improvements in and relating to processes of electro-deposition. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18841. Improvements relating to electric transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18842. Improvements in polarity indicators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

SEPT. 1.

18855. Improvements in or relating to wires or conductors for electrically propelled tramcars and other vehicles. Richard Green, 36, Temple-street, Birmingham.

18882. Light regulator for electric railway cars. Ettore Arturs Kerbaker, 4, Adelphi-terrace, London.

18908. Improvements in and relating to electric time-recording mechanism and apparatus. Marshall Kelly, 60, Queen Victoria-street, London. (Complete specification.)

18910. Improvements in electrical heaters. Lovel Bearse Pemberton, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 4, 1904, being date of application in United States.) (Complete specification.)

18919. An improved terminal or coupling for electric cables. William Middleton and John Yule Middleton, 18, Buckingham-street, Strand, London.

18920. Improvements in and relating to the manufacture of electrical insulating and non-heat conducting compositions. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Société Anonyme Matthey et Cie., Switzerland.)

SEPT. 2.

18926. Terminal connections. Herbert Ernest James McDermott, 168, Plumstead Common-road, Plumstead, Kent.

18937. Improved means and appliances for operating electrolytic cells. James Hargreaves, May Villa, Peel House-lane, Farnworth Within, Widnes, Lancashire.

18942. Improved means for advertising on electric tramcars. Richard Thomas Simcock, 128, Colmore-row, Birmingham.

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18949. A safety guard for conductor or live rails on electric railways. George Digby Sale, 154, St. Vincent-street, Glasgow. (Complete specification.)

18959. Improvements in electric lamps. Owen David Lucas, 39, Victoria-street, London.

18971. A new magnetic mechanical movement. Henry Stewart Anderson, 6, Bream's-buildings, Chancery-lane, London.

18979. Improvements in or relating to electric traction. Robert Stewart Clouston, 111, Hatton-garden, London.

18987. Improvements in systems of electrical distribution. Percy Holbrook Thomas, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 4, 1903, being date of application in United States.) (Complete specification.)

18988. Improvements in safety apparatus for tramcars and other like vehicles. Ethelbert Adolphus Stanley and John Edward Anger, 6, Lord-street, Liverpool.

18991. Improvements in systems of electrical distribution. Percy Holbrook Thomas, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 4, 1903 being date of application in United States. (Complete specification.)

SEPT. 3.

19009. Improved means of rectifying alternating current, named "aluminium rectifier." Frank Stewart Porah and Sydney George Livett, 62, Theobald's-road, Bedford-row, London.

19034. Improvements in wall plugs for attachment of electric fittings and the like. John Bramwell Haynes and John Hincheliffé, 8, Quality-court, Chancery-lane, London.

19061. Improvements in instruments for calculating electric conductors and problems generally where all but any specific one of the members of a simple algebraic formula are known, as, for instance, Ohm's formula $C = \frac{V}{R}$. Harold Thornthwaite Hincks, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED

To be published Sept. 22, 1904.

1903.

18581. System for electric lighting of railway trains. Leitner and Lucas.

18745. Excess indicators for use with an electric current. Atkinson.

19172. Apparatus for controlling the working of electrically driven cars. Siemens Bros. and Co., Limited, and Lydall.

19454. Operating vapour electric lamps from an alternating-current source. Weintraub. (Date applied for under International Convention, Oct. 18, 1902.)

20634. Lamp casings and reflectors principally for incandescent electric lamps. O'Brien and Rottanzi.

22968. Multipolar electric generators and motors. Boyden.

22997. Controlling devices for electrically propelled vehicles. Carolan. (General Electric Company.)

23170. Car and line indicators for street railways. Haggerty.

23443. Electrometers. Crompton and Co., Limited, and Price.

25199. Switches for use in connection with the electrical ignition systems of motor cycles and for analogous purposes. Sangster.

1904.

7980. Electric fuses or cut-outs. Mercadier. (Date applied for under Interntional Convention, April 7, 1903.)

12755. Coin-freed apparatus for supplying a current of electricity to persons using it after the insertion of a predetermined coin, and for indicating the strength of the current supplied. Carter and Leheup.

14221. Galvanic batteries. Dreibholz.

14366. Starting resistances for electric motor commutators. Latour. (Date applied for under International Convention, June 27, 1903.)

15467. Vapour electric conductors. Kruh. (Date applied for under International Convention, July 11, 1903.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅜-½
Avon Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5⅜-5¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	99-101 xd
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅜-3¼
—— 4 per cent. Mortgage Debenture Stock	100	–	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,751 ..	2	–	¼-⅜
—— Non. Cum., 5 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	94-97 xd
—— 4½ per cent. 2nd Debenture Stock	100	–	70-75
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9¼-10¼
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	5	–	14-2
—— 5 per cent. Debentures	100	–	90-95
Edison and Swan United, "A" Shares, 1-98,261	5	–	⅜-½
—— "A" Shares, 01-017,139	5	..	1-2
—— 5 per cent. Debentures	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼
—— 7 per cent. Cumulative Pref.	2	..	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	..	11-12
—— 4½ per cent. Preference	5	–	5-5¼ xd
—— 4½ per cent. Debentures	100	–	107-111 xd
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-19¼
—— 4 per cent. Debentures	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	34-37
—— 5 per cent. Bonds	100	–	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock. Red.	100	–	103-105
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-6
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary	5	–	10¾-11¼
—— 7 per cent. Preference	5	–	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 ..	5	–	7¼-7⅜
—— Nos. 20,001-30,000	5	–	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12½-13¼
Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock	100	–	105-109
Charing Cross and Strand, Nos. 1-70,000	5	–	7⅜-8¼
—— 70,001-80,000	5	..	7-7¼
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 40,001-80,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	105-109
City of London, Ordinary	10	–	10¼-10⅜
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	102-105
County of London Electric Supply, Ordinary	10	–	7¼-8¼
—— 6 per cent. Cum. Pref.	10	–	11¼-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	101-104
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	105-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6 6¼
—— 6 per cent. Cum. Pref.	5	–	6-6¼
—— 4½ per cent. First Mort. Deb.	100	–	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	14-2¼
—— 5 per cent. Debenture Stock, Red.	100	..	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	99-102
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited, Ord.. 1-13,000	5	–	7¼-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	101-103
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	⅜-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	3	–	1¼-2
—— 6 per cent. Pref.	5	–	5-5½ xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	96-99
Metropolitan Ordinary	10	–	15½-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	109-113
—— 4½ per cent. Cum. Pref.	5	–	5¾-5⅞
—— 3½ per cent. Mortgage Debenture, Red.	100	–	96-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb..	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14-15
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) ..	100	–	100-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310.....	5	–	5¾-6¼
—— 4 per cent. Debenture Stock	100	–	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2¾-3¼
—— 4 per cent. Debenture Stock	100	–	83-88
South London, Ordinary	–	–	3¾-4¼
South Metropolitan Electric Light and Power Co., Ord..	1	..	¾-1
— 7 per cent. Cum. Pref.	1	..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	..	104-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	14½-15¼
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¾-5¼
Westminster, Ordinary	5	–	12¾-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6-6¼
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	6¼-6⅜
—— Ord.	5	..	6¼-6⅜
—— Permanent 6 per cent. Debenture Stock, 1888 ..	100	–	137-141
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	98-101
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	96 99
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..	1	..	11/16-13/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	¾-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11 xd
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1 75,000.....	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.....	100	–	97-100
—— Ord Pref.	100	..	99-102
—— Non. Cum. 5 per cent. Pref.	10	–	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	–	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-300,000 & 50,001-90,000	10	–	8¾-9¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10¾-11
—— 5 per cent. Perpetual Debenture Stock	100	–	116-119
—— 4½ per cent. 2nd Deb. Stock	100	–	94-97

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Name.	Amount paid.	Last price.
	£	£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 –	3-3½
—— "A" 5 per cent. Cm. Pf., 1-40,000	5 –	5½-5⅝
—— "B" 5 per cent. Cm. Pf., 1-27,500	5 –	5-5½
—— 5 per cent. Deb. Stock, Red.	100 –	106-108
—— Prov. Certs., all paid	100 –	101-104
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100 ..	94-99
Calcutta Tramways, Limited, 1-102,268	5 ..	7¼-7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	104-107
Cape Electric Tramways, Nos. 1-480,000	1 –	1⅛-1¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 –	4¾-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 –	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 –	100-103
Cork Electric Tramways and Lighting Co. Ordinary	10 –	9½-10
—— 5 per cent. Cum. Pref.	10 –	11-12
—— 4 per cent. Debentures	100 –	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 –	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 –	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 –	94-97
Imperial Tramways Ordinary	all –	18 19
—— 6 per cent. Cum. Pref.	all –	14-14½
—— 4½ per cent. Deb Stock	100 –	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 –	3¼ 4 xd
—— 4 per cent. Debenture Stock	100 –	88-91
Kidderminster and District Lighting and Traction, Pref.	5 –	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 –	10¼ 11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 –	104-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100 ..	100 103
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1 ..	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	¾-1
—— 4½ per cent. Deb. Stock, Red.	100 ..	98-100
Milwaukee Electric Rail and Light. 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000 ..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	100-103 xd
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	103-105
New General Traction, Ordinary	5 –	½
—— 6 per cent. Cum. Pref.	5 –	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100 –	88-93

Name.	Amount paid.	Last price
	£	£
Oldham, Aston, and Hyde Tramway, Ordinary	10 –	12-12½
—— 5 per cent. Cum. Pref.	10 –	9¾-9⅞
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100 –	100-103
Potteries Electric Traction, Ordinary 20,001-40,000	10 –	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10 –	8¼-9¼
—— 4½ per cent. Debenture Stock	100 –	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 –	1
—— £101,138 5 per cent. Preference	1 –	1
—— £528,093 4½ per cent. Debenture Stock	100 p. c. –	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 –	86-88
—— 4 per cent. Pref.	100 –	100-102
—— " " deferred	100 –	80-82
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 –	106-109
City and South London, Consolidated Ordinary	100 –	41-43
—— 4 per cent. Debenture Stock	100 –	105-108
—— 5 per cent. Pref. Stock '91	100 –	121-124
—— " " " '96	100 –	117-120
—— " " " '01	100 –	115-118
Liverpool Overhead, 5 per cent. Pref.	10 –	10-10½
—— Ordinary, 1-50,000	10 –	3¼-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	– –	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	– ..	97-98
Waterloo and City, Ordinary	100 –	86-89
Telephones.—		
National Telephone, Preferred	100 –	04-106
—— Deferred Stock	100 –	90 93
—— 5 per cent. Cum. First Pref.	10 –	12-14
—— 5 per cent. Cum. Second Pref.	10 –	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 –	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100 –	97-99
—— 4 per cent. Deb. Stock, Red.	100 –	104-106
—— 4 per cent. Prov. Cert.	– ..	65-67
Original Telephone and Electric Company	1	1 /16-1 1/16
—— 6 per cent. Cum. Pref.	1 ..	1-1⅛

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 3	1,665	1,311	+ 353	+ 4,457*h*	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Sep. 3	43	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	" 3	1,093	1,133	+ 31	+ 145	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	" 3	5,179	5,201	- 22	—	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	" 2	1,035	788	+ 238	+ 2,335	21	21	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	" 1	2,231	1,618	+ 613	+ 4,013	17½	17½	" 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	" 5	1,463	1,368	+ 95	- 40	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	" 4	1,842	1,913	- 71	+ 271	38	38	March 31*g*	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	Aug. 31	1,455	1,429	+ 26	—	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	" 27	4,458	3,855	+ 6 2	+17 623	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	Sep. 4	1,280	1,107	+ 173	+ 2,473*h*	7½	6½	" 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	" 2	5,494	5,199	+ 295	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	" 3	1,117	841	+ 276	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	" 4	383	394	— 11	—	8½	—	—	—	—	—	—	—	—	—
Cardiff Corporation	Aug. 20	2,189	2,088	+ 101	+ 1,375	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	Sep. 3	228	222	+ 6	+ 275	—	—	" 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	" 3	5,602	5,493	+ 109	— 1,957*h*	6	6	" 31	357,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City & South London Railway	" 4	2 439	2,415	+ 24	— 1,067*h*	6⅜	6⅜	" 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	" 7	567	633	— 65	— 2,125	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	" 2	251	230	+ 21	—	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	" 3	285	310	— 25	— 217	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	" 2	158	165	— 8	— 244	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	" 2	4,498	4,344	+ 154	—	46	46	March 31	125,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	" 2	1,293	1,160	+ 133	—										
Dundee City Tramways	Aug. 31	867	976	+ 89	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Sep. 3	746	759	- 13	+ 1,371	10·75	10·75	March 31*g*	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	" 3	15,026	13,625	+2,601	+12,509*h*	124	124	May 31*g*	556,572	177,179,549	14,008,750	0·88	11·25	5,489*b*	7·40*d*
Gloucester Corporation	Aug. 31	371	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	" 24	3,258	3,084	+ 174	+ 2 460	30½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	Sep. 3	1,469	1,201	+ 268	—	34	34	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·32
Hull Corporation, E. S.	" 3	2,300	1,847	+ 453	+ 6,653	25	19	" 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	July 9	528	552	- 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Aug. 31	170	192	- 22	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	" 30	256	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Sep. 3	6,290	5,329	+ 961	+ 8,783	77	77	March 25*g*	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	" 3	1,506	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Aug. 27	10,411	10,400	+ 11	+11,785	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Sep. 4	1,594	1,714	— 120	— 271*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	July 2	13 329	11 405	+1,824	+26,151	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Sep. 3	391	382	+ 9	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	" 3	12 937	11,840	+1,097	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	" 2	2 223	1,490	+ 733	+ 3,642*h*	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	" 3	145	111	+ 34	+ 991	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corpn.	" 3	3,694	3,394	+ 260	—	38½	38½	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	" 3	538	489	+ 49	+ 16	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,026	+ 466	+ 3,951	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	" 11	179	165	+ 14	—	4½	4½	March 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Sep. 1	503	504	— 1	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	Sep. 3	469	—	—	—	7½	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 5	4.809	4,703	+ 106	+ 2,674*h*	53½	53½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	" 4	1,115	1,179	- 64	—	11	11	" 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Aug. 31	590	531	+ 59	+ 1,138	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	Sep. 2	640	374	+ 266	+ 5 883	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	" 4	1,388	1,375	+ 13	+ 726	18·48	18·48	" 31*g*	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	" 3	859	772	+ 87	+ 1,133	10·5	10·5	" 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	" 1	1,212	—	—	—	1¾	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	Aug. 24	748	465	+ 283	+ 9,503	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures

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NOTES.

Faraday House.—On Monday next Mr. W. R. Cooper, M.A., B.Sc., M.I.E.E., will commence a course of lectures to the senior students upon "Secondary Cells."

Institution Journal.—We have received a copy of the Institution *Journal*, dated August, which contains Mr. Siemens's paper on "High-Speed Electric Railway Experiments on the Marienfelde-Zossen Line," with the discussion; "A Theoretical Consideration of the Currents induced in Cable Sheaths, and the Losses occasioned thereby," by M. B. Field, with discussion; "The Equipment of an Engine Test-House," by R. K. Morcom (Birmingham Section), with discussion; "Mersey Railway Multiple Control," by H. L. Kirker (Manchester Section); "Description of the Electrical Equipment of an Engine Works and Shipyard, with notes thereon," by H. O. Wraith (Leeds Section), with discussion; and "Some Uses of the Oscillograph," by D. K. Morris (Birmingham Section.)

Electricity and Agriculture.—A paper on this subject was recently presented by M. Emile Guarini to the Belgian Society of Engineers and Manufacturers. The author considered that the application of electricity in this connection would extend more when electrical energy was produced at coalfields and distributed to farms by wire, but in the meantime electricity can be generated on the farm by water power, steam, gasoline, gas, wind, and sun motors. A continuous current is best for farms, and if the current is sent a long way to the farm as an alternating current, it should be transformed into a continuous one. The electric motors used ought to be portable, so as to be placed alongside the plough, thresher, straw-cutter, pump, chopper, shearer, churn, etc. Electric is more economical than hand churning. The author added that electricity can be used for lighting fields to permit of night work, for heating incubators, for hot-air fans, for carbonising peat into fuel, and other purposes.

Influence of Pressure on the E.M.F. of Gas Electrodes.—Mr. Theodor Wulf contributes some notes on this subject to the *Zeitschrift Physikal Chemie.* The decomposition point observed galvanometrically is the point at which the discharged gas ions dissolve appreciably in metal and electrolyte. The point at which bubbles are visibly formed is reached when the gas is evolved from a saturated solution. The latter point is dependent, the former point is not dependent, on the pressure, as might be expected from the fact that the evolution of gaseous bubbles means a large increase of volume, whilst the process of solution in metal or electrolyte does not involve any such great volume change. The two points nearly coincide when the gas in question is but slightly soluble, as, for instance, hydrogen and oxygen at the ordinary pressure. They are quite distinct, however, in the case of a soluble gas, such as chlorine. Helmholtz's formula for the variation of the E.M.F. of the hydrogen electrode with pressure has been verified for the range 1 to 1,000 atmospheres.

The Influence of Frequency on the Electrolytic Action of Alternating Currents.—Some experiments recently described in *L'Electrochimie* would seem to contradict the accepted views on this subject. De la Rive, who made the first researches on alternate-current electrolysis, and all the investigators who followed him found that the weight of the deposit formed at the electrodes diminished rapidly with increasing frequency. The new experiments, however, show that, whilst this is the case with many combinations of metals and electrolytes, there are exceptions to the rule. Thus, iron electrodes in cyanide of potassium show a maximum rate of dissolution at a definite frequency. Platinum, which is practically insoluble in cyanide of potassium, is readily dissolved under the action of alternating currents, and the rate of dissolution was found to rise steadily with the frequency within the limits of the experiment (7 ⁓ to 100 ⁓). Nickel and cobalt, again, have a maximum rate of dissolution at a definite frequency, whilst lead in sulphuric acid is practically unaffected by the frequency.

The Regulation of Induction Motors.—In order to reduce the sudden large rush of current on starting up induction motors, Zani-Mailand suggested the winding of the rotor with two independent circuits—one having a high ohmic resistance, but little or no self-induction, and the other having a negligible ohmic resistance, but considerable self-induction. On starting up a motor of this type most of the rotor current will, owing to its high frequency, flow through the path of high resistance and low inductance. As the speed increases the frequency of the rotor currents falls, and more and more current will flow through the path of low resistance and high inductance, until at full speed practically all the current will flow through this circuit. An improvement has lately been suggested by Zani, says the *Elektrotechnische Rundschau*, by means of which it is only necessary to have a single rotor winding. Three coils are mounted on iron cores and fixed on the rotor: the ends of these coils are connected in series with the three phases of the rotor winding. In principle these coils act as the primaries of transformers, of which the secondary currents are represented by the eddy currents in the solid iron cores. It is found quite satisfactory to omit any separate secondary winding and to merely use solid instead of laminated cores in this way. When the motor has attained full speed, a centrifugal arrangement is made to open the magnetic circuits of the three transformers.

South-Western Polytechnic.—The syllabus for the ensuing session (evening classes) justifies the institution's title of polytechnic, and there can be but few walks in life for which instruction is not afforded. The electrical division, for which the institution is provided with admirable equipment, comprises courses in elementary, intermediate, and advanced electrical engineering, alternating and polyphase currents, electrical design, electrical instruments and lamps, electrical wiring and fitting, and the arithmetic of electric lighting. The instruction combines practical work with lectures, and is designed to, among other purposes, prepare students for the examinations of the City and Guilds of London Institute and of the London County Council. The prospectus of the day college for men and women also exhibits a comprehensive course of training for students above the age of 16. The day school for boys and girls provides admirable tuition in technical and commercial subjects, with a classical side for those who desire to enter the "professions," while girls receive practical instruction in domestic economy. The excellent gymnasium attached to the school shows that the old maxim, *mens sana in corpore sano*, is observed at Chelsea. We just learn, by the way, that Mr. A. J. Makower, of the alternating-current designing department of the British Thomson-Houston Company, Limited, has been appointed head of the electrical engineering department of the institution.

The Past Session.—A review of the electrical measures before Parliament during the late session shows that 58 private Bills for traction, lighting, or power were passed. Of these four were substituted measures and two were abandonment Bills, whilst several of the others were for additional powers. The promoters were pretty equally divided between local authorities and companies,

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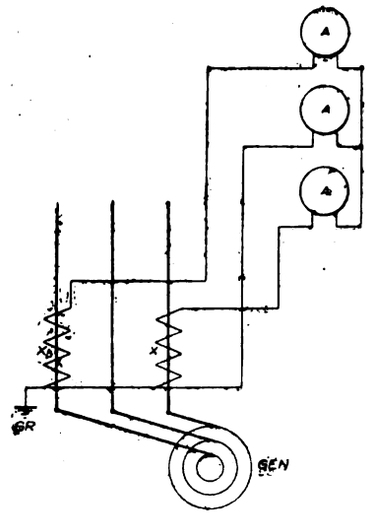
the former being in a slight majority. The rejected Bills included those of the London United Tramways Company, seeking power to construct a system under the Thames at Hammersmith; the East London and Lower Thames Power Company; and the Preston and Blackburn tramway. The Preston and Lytham Bill was withdrawn. Three public Acts were instituted—viz., the Electric Lighting (London) Act, the Expiring Laws (Continuance) Act (including the Light Railways Act, 1896), and the Wireless Telegraphy Act. The Supply of Electricity and the new Light Railway Bills were withdrawn. Electric lighting and provisional orders to the number of 61 and 13 tramway provisional orders were confirmed. Compared with past years, the new tramway schemes were few in number. Under the Private Legislation Procedure (Scotland) Act eight measures were confirmed. The features of the session included the Belfast Corporation Bill, under which the tramway is to be municipalised and electrified; the Tyneside Company's Bill, which ended in an agreement for through running after being referred back to committee; the rejection again of the London County Council's scheme for carrying the tramways over the river; and the passing of the Marylebone Borough Council's Bill, authorising a loan to buy out the lighting company.

Ammeter Connections.—Some particulars of certain features in the ammeter connections of the Union Stock Yards and Transit Company's lighting plant are given in the *Engineer* of Chicago. In connecting the ammeters in the generator circuit, the ground is utilised as a protection, but does not enter into the ammeter circuit proper, the circuit being complete without it. The ammeters are connected on the "open delta" system, as shown in the



accompanying diagram, and are regulated by the principle that the sum of the currents in the three legs is equal to zero, or that the current in one leg is equal to the resultant of the currents in the other two legs, this being an application of the triangle of forces. The parts marked X represent current transformers. There is no occasion to insert one of these in the middle leg or phase, because the third ammeter is connected as explained above, and represents the resultant current of the other two phases, which must be equal to the current in the third leg.

New Publications.—"Modern Electric Practice." (London: Gresham Publishing Company. 9s.) This valuable series has advanced to vol. 4, which is devoted to electric traction, the contributors being Messrs. I. E. Winslow, A. G. Seaman, H. C. Buckmaster, and Phillip Dawson. The different systems of tramway traction are fully discussed, and Mr. Winslow, while agreeing that the surface-contact principle, with its extra capital cost and operating expenses, not to mention other objections, is only justified under special circumstances, is not without hope for the magnetic and electromagnetic types. In another chapter he deals with tramway feeders at considerable length. Mr. Buckmaster contributes a chapter on rolling-stock and equipments, and Mr. Beaumont discusses electric boats and motorcars. In the section on railways Mr. Dawson deals comprehensively with the rival systems of electric traction, and concludes with the prediction that the overhead conductor will eventually supersede the third rail. The *Physical Review* for August has articles on "The Conduction of Electricity in Mercury Vapour," by A. P. Wills; "Some New Theorems analogous to Green's," by P. G. Nutting; "The Elastic Modulus and Elastic Limit of Rubber and their Relation to Change of Temperature," by J. C. Shedd and R. L. Ingersoll; "The Electric Arc," by C. D. Child; "A Study of the Silver Voltameter," by K. E. Guthe; "A New Form of Magnetic Contact Breaker," by J. C. Shedd; "Thermo-E.M.F. of Nickel Nitrate in Organic Solvents," by J. F. Meyer; "The Differential Telephone," and other subjects. We have received the calendar for the ensuing session of the Durham College of Science (London and Newcastle: Andrew Reid and Co. 1s.)

A New High-Tension Electrical Condenser for Continuous Use.—*L'Eclairage Electrique* gives some details of a new type of condenser developed, after lengthy experiments on existing makes, by M. Moscicki, of Fribourg. The ordinary condenser, made up of alternate laminations of conducting material and dielectric, has always been open to numerous objections. It is very liable to break down, especially under continuous use, is considerably affected by changes of atmospheric temperature, insulation considerations entirely prevent any attempt at internal ventilation, and, in spite of its unreliability and rapid deterioration, its first cost is very high. M. Moscicki found that most of the insulation breakdowns in such condensers occurred round the edges of the conducting plates and seldom in the centre. The new type of condenser finally decided upon is of tubular form, and in it the above difficulties are successfully overcome. The length of the dangerous edge of the conducting element can be reduced to a minimum relatively to the total active surface, and the thickness of the dielectric at this dangerous part can also easily be increased when required. It is possible to employ an electrolyte as the conducting element, and in this way obtain a cooling effect which is even superior to that existing in transformers. This system also permits the total amount of dielectric material to be considerably reduced as compared with the ordinary type, and the price compares favourably with that of any other high-tension apparatus. Several types of this condenser have been constructed. With one type a rating of 80 kilo-volt amperes is obtainable from a condenser occupying a space of only one cubic metre, the voltage being 10,000 or over, and the frequency 50. When dealing with voltages below 5,000 or 6,000 it is considered advantageous to raise the pressure of the condenser terminals by means of separate transformers, the price of these transformers being more than compensated for by the reduced cost of the condensers. The new condenser is said to have a minimum efficiency of 99 per cent., which is higher than that attained by any other electrical apparatus.

A New Flux Meter.—An instrument for directly measuring a magnetic field of approximately uniform amount by means of an exploring coil of known area and number of turns, is described in a recent number of *L'Electricien*. The instrument is due to M. Grassot, and

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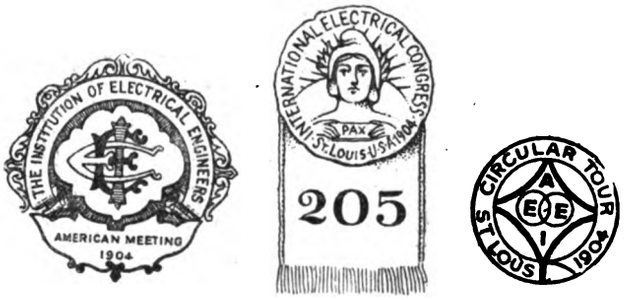
is similar in construction to a d'Arsonval galvanometer, but with a very weak controlling couple, and consequently a very high damping effect. When a minute E.M.F. is applied to the terminals of such a galvanometer, the coil, having practically no work to do, becomes deflected at such a speed that a counter E.M.F. is set up in it, opposing and practically equal to the applied E.M.F. If α is the deflection and E the applied E.M.F., we may put $\frac{d\alpha}{dt} = KE$, or $\alpha = K \int E \, . \, dt$. During the deflection the galvanometer coil cuts a flux Φ proportional to the deflection, $\alpha = K\Phi$, and the effect of this flux is equal and opposite to $\int E \, . \, dt$ applied at the terminals. If, instead of applying an E.M.F. at the terminals, an exploring coil with a known number of turns is connected to the terminals and is placed in a uniform magnetic field, every variation of this field will set up a corresponding change in the flux through the galvanometer coil—*i.e.*, an E.M.F. will be set up in the galvanometer coil equal to $E = \frac{d\Phi}{dt}$. When the variations of the external field stop, the instrument will have been subjected to a variation $\int E \, . \, dt = \Phi$, so that every variation in the flux through the exploring coil produces a definite deflection of the needle. The instrument is strongly made, and consists of a permanent magnet with an annular iron cylinder between the poles, giving a range of several millimetres with a gap magnetic density of about 1,000 C.G.S. lines per square centimetre. The moving coil of insulated copper wire is suspended in this field by means of a silk fibre attached to a spiral spring, so as to avoid the effects of vibration. The current is led in and out by two spirals of very fine silver ribbon. A needle moving over a graduated scale is fitted, and the exact value of a division, stated as a magnetic flux, is given. This value is about 10,000 C.G.S lines. An exploring coil is supplied with the instrument, having an area of about 10 square centimetres and a number of turns, chosen so that a total flux of exactly 100 C.G.S. lines—*i.e.*, 10 C.G.S. lines per square centimetre—through the coil may produce a deflection of exactly one scale division. For laboratory purposes the instrument can be made still more sensitive by fitting a mirror to the moving coil. It can also be used for measuring the total quantity of electricity passing through a resistance of known amount, and for many of the purposes for which a ballistic galvanometer is usually employed.

Launceston (Tasmania).—The report of Mr. Wm. Corin, the city electrical engineer at Launceston, for the year ended Dec. 31 last records a net profit of £1,115 on the lighting and power undertaking. This is somewhat less than that of the previous year, but the apparent decline is accounted for by substantial reductions in the charges for current and the increase of maintenance and distribution costs, which latter are not likely to advance much further. The revenue totalled £10,692 and the expenditure £5,116, showing a gross profit of £5,576, from which have to be deducted £3,781 for interest and £1,143 contributed to sinking fund. The surplus appearing from this is £652, but it is brought up to the amount given above through sums being credited to the ensuing year's account which properly belong to the period under review. The average cost per unit was 1·736d., and the average price obtained 3·27d. For lighting, power, and heating 453,601 units were supplied to consumers, and 248,550 units were used for street-lighting. The number of customers for private lighting advanced from 1,629 to 1,915, the motors connected increased from 59 to 65, and for energy for heating the consumers rose from 102 to 185. In regard to the future, Mr. Corin, without being unduly optimistic, presents a gratifying picture. Four three-phase generators have just been installed, each of treble the power of the alternators which they displace. With the price of current for motors reduced from 1d. to ½d. per unit after the first 200 units each quarter, and the rentals of motors also reduced, Mr. Corin confidently anticipates that out of the 1,000 h.p. or more now in use in the town the Corporation may count on capturing at least an additional 100 h.p. per annum during the next five or six years, the new charges being such that no user of power can well afford to disregard the service. The use of energy for heating also shows every indication of expansion. In regard to lighting, the receipts to May 31 last show an increase of £431 over the corresponding period of the year under review. Mr. Corin has prepared a table of estimated profits during the next half-dozen years, and, basing his calculations upon very reasonable increases in the consumption of energy, he forecasts a progressive surplus each year, £2,230 being the estimated profit for 1909. The extension of the plant has increased its revenue-producing power threefold without adding a penny to generating costs, and the prospects of the undertaking may be accounted distinctly bright.

The Electrical Congress.—The issue for Sept. 3 of our contemporary the *Electrical World* of New York, which extends a cordial welcome to the visitors to the International Electrical Congress, describes the special badges which have been designed to commemorate the occasion. These consist of the congress badge and the badges of the British,



Italian, and American Institutions. The diagrams reproduced illustrate the two first and the last named of these tokens, and represent their actual size. Our contemporary states that the badge of the British Institution is particularly handsome, and that in the absence of colour but a faint impression of its appearance can be conveyed. The outer rim and the enclosure of the monogram of the Institution are in gilt. The name of the Institute is in gilt letters on white enamel, and the inscription "American Meeting, 1904," is in gilt letters on light-brown enamel. The background of the central monogram is in dark blue. The congress badge is about the size of a cent, irregular in outline, and is struck in bronze finished to a dull colour. The subject is a reproduction of the main feature of the seal of the St. Louis World's Fair. Attached to the medal will be a ribbon carrying a number corresponding to that opposite the name of the wearer in the list of members in attendance to be printed daily in the *Bulletin* of the congress. The ribbons will be of seven colours to distinguish the various grades of members. The badge of the American Institute, which will be presented to those taking part in the circular congress tour, consists of the regular institute badge for full members, enclosed within a ring and bearing the inscription "Circular Tour" on a ground of blue enamel. A highly artistic silver medal, about the size of a quarter-dollar, represents the souvenir of the Associazione Eletrotecnica Italiana. On the face are the initials of the society in relief, enamelled in the red, white, and green of the Italian tricolour; while on the reverse side is a portrait in relief of Volta. The

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badge is carried by a button to fasten into the coat lapel, and is tied with silk ribbon, also in the tricolour.

The First 40,000-Volt Power Transmission in Europe.—A detailed and well-illustrated description of the 40,000-volt water-power transmission between Gromo and Nembro, in Italy, is given by the *Schweizerische Elektrotechnische Zeitschrift*. The contractors for the work are Messrs. Crespi and Co., of Milan, and the line was opened early in July, and has given every satisfaction since. The present scheme only includes the transmission of 2,000 h.p., but a further 2,000 h.p. from a neighbouring waterfall is to be transmitted along the same line later on. The distance is 20 miles. The present generating station contains three three-phase Escher-Wyss Brown-Boveri turbo-alternators of 1,000 h.p. each, one of them being a spare set. The alternators are standard three-phase 4,000-volt 50-period generators, and the output of each machine is transformed up to 40,000 volts in a single 850-kw. three-phase transformer. Each generator, with its transformer, is dealt with as a single unit, no main switches being provided on the low-tension side between alternator and transformer, although the ammeter and voltmeter transformers and the relays for operating the high-tension automatic circuit breakers are worked from the low-tension side. The transformers are oil-insulated and water-cooled, and consist of three straight limbs side by side, each surrounded by a primary and secondary winding in the form of concentric cylinders. Each transformer occupies a floor space of 5·25ft. by 4·17ft. and a height of 7·1ft. The triple-pole high-tension oil-break main switches have a multiple break on each pole, and are operated by chain gear, either direct by hand or electrically at a distance, by closing a small auxiliary switch, or automatically by means of a double-pole relay actuated by the outgoing current. In this way they act both as main switches and as automatic maximum cut-outs. The three poles of these switches are separated from one another by masonry walls 4·7in. thick. The line consists of three overhead copper conductors, ·256in. in diameter each, and is capable of transmitting 3,000 kw. at 40,000 volts, with a loss not exceeding 5 per cent. The conductors are carried on special porcelain insulators, tested up to 80,000 volts, mounted on wooden cross-arms in the form of an equivalent triangle, with a 33½in. side at an average height of 26½ft. above the ground. The mean distance between posts is 130ft. At the receiving station at Nembro 540-kw. three-phase transformers are employed to reduce the pressure from 40,000 to the distribution voltage of 500. Besides the special high-tension oil-break switches fitted in this station just as in the generating station, a separate emergency triple-pole switch of the horn air-break type is mounted on poles just outside the receiving station for the purpose of entirely isolating this station from the line when required.

Electricity in South Africa.—The information given in the *British South African Export Gazette* of Sept. 2 testifies to the headway which electricity is making in that part of the globe. The electric light and tramway installation at East London, set up some five years ago, is now working at a profit, and an extension of the tramway is under construction. The system has had a very beneficial effect in extending the area of the town. At Kingwilliamstown an extension of the plant of the King Electric Power Company, Limited, has been decided upon, and it is expected that tenders will be invited at an early date. Terms having been arranged between the Kimberley Corporation and Messrs. Gibson Bros., the proprietors of the tramway to Beaconsfield, the system is to be converted to electric traction on the overhead system, and extended to Alexandersfontein, some four miles beyond the present terminus. It is proposed to secure energy from the De Beers works. Negotiations are also proceeding between the Beaconsfield Town Council and the De Beers Company for the supply of current for lighting that town. The Council contend that current should be supplied on the same terms as it is to Kimberley—6d. per unit. The Council will have to undertake the installation of distributing apparatus, involving considerable orders for mains and fittings. The short line of electric tramway recently constructed at Lorenco Marques by the Delagoa Bay Development Corporation, Limited, is meeting with great success, especially considering the comparatively small population, and an extension has been decided upon. The electric lighting service is also greatly appreciated in the town and its suburbs. At Durban, the use of electricity for tramway, lighting, and power purposes has exceeded all anticipations, and repeated enlargements of the plant have been made. The number of orders for current for motors rendered an increase of the engine equipment of the power station necessary, for which purpose Mr. Roberts, the late borough electrical engineer, obtained quotations when he was in England recently. The Potchefstroom Town Council are contemplating the purchase of the light and power company's undertaking, and when the scheme has been carried out improvements and extensions are likely to be taken in hand. The Cape Town Corporation propose to spend £100,000 on electrical works. As there has been opposition from a certain section, the question will be settled by *pléliscite*, which is expected to result in an affirmative vote. An interesting project is under consideration from Umtata, which it is proposed to furnish with a combined electric and water supply by utilising the fine falls of the Umtata River. The consulting engineers are now engaged in preparing the scheme, which is being watched with great interest, as it will be the first installation of the kind in Cape Colony.

Light Motorcar Trials.—We gave last week a summary of the awards for non-stop runs. As the report of the judges remarks, a considerable element of luck enters into such tests; and their verdict upon special features of the cars embodies some interesting points. The 6-h.p. Siddeley and the 6-h p. Wolseleys, which were placed first and second respectively in Class C, come out well all round, both being awarded the gold medal. Their distinguishing qualities were general excellence of design, construction, and workmanship, and efficient hill-climbing. A gold medal is also awarded to the two 7-h.p. Swifts for general excellence of construction and workmanship, hill-climbing, and smoothness of running. Other awards are: silver medal to the two 6 h.p. De Dions for excellence of workmanship, consistent running, and hill-climbing; silver medal to the two-cylinder 7½-h.p. Humberette for general excellence and attention to detail; silver medal to the two 7-h.p. Alldays cars for general construction, neatness of design, and smoothness of running; bronze medal to the 6-h.p. Speedwell for construction and performance in relation to price; bronze medal to the 8-h.p. Brown for the quality and construction of details; bronze medal to the two 7-h.p. Stars for hill-climbing and construction in relation to price; bronze medal to the 9-h.p. Oldsmobile for ease of manipulation and details of construction; bronze medal to the 8-h.p. Prosper Lambert for the design and construction of parts; bronze medal to the 10-h.p. Croxted for performance and construction in relation to price; honourable mention to the 7-h.p. Clyde for low petrol consumption; honourable mention to the 8-h.p. Mobile for its general performance as a four-seated vehicle. A table of petrol consumption shows that the 7-h.p. Clyde averaged 47·3 miles per gallon, and that nine other cars averaged between 30 and 40 miles. On other

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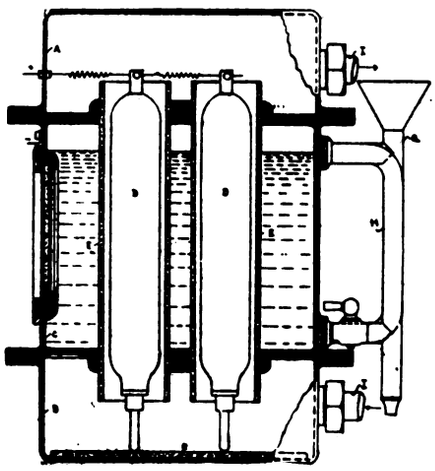
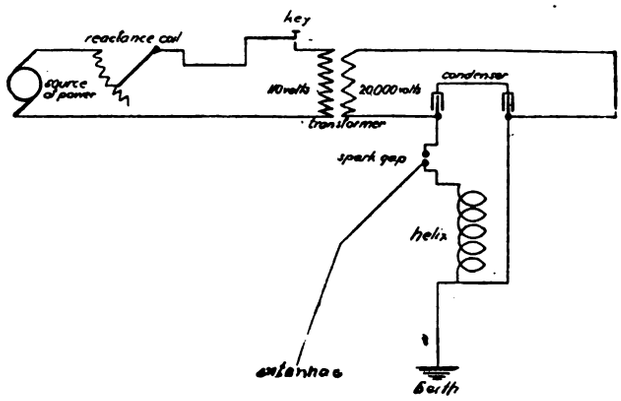
points the judges select the most meritorious cars as follows: absence of noise and vibration, 7-h.p. two-cylinder Swift; ease of manipulation, 6-h.p. Wolseleys, 8-h.p. Brown, 7-h.p. Swifts, and 9-h.p. Oldsmobile; comfort of passengers, 7-h.p. Swifts; hill-climbing, 6-h.p. Wolseley. Of the cars which failed to complete the runs a few were of promising novelty, and some of already proved merit failed through defects not likely to recur. The city of Hereford proved an ideal centre, and the roads selected were admirably suited to the purpose. A noticeable feature was the consistent running of the various teams. The trials brought together a large number of cars, though of few types. The judges observe, in conclusion, that the general design and construction of the cars showed much improvement compared with cars of the same capacity in previous years, and the prices are all lower. While the performances generally were remarkably good, the judges consider that a greater distance than 600 miles is necessary to bring out by automatic records the qualities of the cars and their minor but important details.

Ozone Apparatus.—Among the excellent German exhibits in the electrochemical group at the St. Louis Exhibition is a modern Siemens and Halske ozoniser, a description of which appears in the *Electrical World* of New York. The accompanying diagram illustrates the apparatus as it is used for the purification of water. The upper and lower lids are represented by A and B respectively, the tank is marked C, the inner pole D, E indicates a glass cylinder, F an insulating plate, G and H represent water outlets, and I the ozone pipe. The apparatus consists of a



cast-iron tank closed tightly on the upper and lower end by a case-shaped lid. In this case are mounted 10 glass tubes placed in the upper and lower lids, so that the middle chamber is made water-tight. In service the tank is filled with water, which partially serves for cooling purposes and partially as conductor for the electrical current. In the interior of the glass cylinders are mounted the so-called inner poles in such a way that an equal distance is kept between the same and the glass cylinders. These inner poles are joined together by an electric conductor and connected to one pole of the high-tension transformer; the other pole of the same is connected to the tank, closing the circuit through the water to the glass cylinders. The 50-cycle transformer, which is connected on the primary side to 120 volts and steps the voltage up to 10,000 volts, is of special construction, the primary side being in circuit with a rotating interrupter of the commutator type, with 11 segments, and running at 800 revolutions per minute, being fed through a 110-volt direct-current circuit. The air to be ozonised, after being submitted to a drying process, is brought into the apparatus by a motor-driven blower. The ozone developed by this process accumulates in the upper lid of the tank, and is conducted from there through pipes to the sterilisation tower, where it is forced through the water to be treated. The result of the application of ozone to the water is that practically all bacteria and putrefying substances injurious to health are killed, and the water leaves the apparatus entirely colourless, meeting all requirements of hygiene. The Siemens and Halske Company installed the system on a large scale at the cities of Wiesbaden-Schierstein and Paderborn with excellent results. This type of ozone apparatus is also employed largely for the expeditious bleaching of yarn, which, after being submitted to a short process with chloride of lime, is hung up in a room, where it is treated with the ozone.

De Forest Wireless Telegraph Exhibit.—Some further information respecting the De Forest wireless telegraphic installation at the St. Louis Exhibition is contributed by Mr. Cloyd Marshall to the *Electrical World* of New York. As already announced, this system is operating commercially, besides which long-distance overland experiments are being conducted between St. Louis and Chicago. The greatest undertaking of the De Forest Company has been the erection of a 300ft. steel tower for use as a wireless telegraph station and for observation. Two electric elevators carry passengers to the wireless telegraph station on the 100ft. platform and to the two observation platforms at the top. The power supply is 500 volts direct current, which is transformed by a 70-h.p. motor-generator to 240 volts for driving the elevator motors. At the tower station a 240-volt motor is belted to a 2-kw., 60-cycle, 110-volt alternating-current generator, which is the voltage used for the wireless telegraph transmitter. A transformer



raises the voltages to 20,000. The accompanying illustration shows the arrangement of circuits. The speed with which the Morse key of the transmitter can cut the 60-cycle current into the dots and dashes of the telegraph code is equal to that attained over any land wire. The apparatus is grounded on the frame of the tower itself, which makes the wave length of the antennæ considerably longer than if it were suspended from a wooden structure and the ground made in the ordinary manner. Although the steel frame of the tower renders the station inefficient for wireless telegraphic transmission, the service is stated to have been quite satisfactory, and messages are being received at Springfield, Ill, over 100 miles away. At another station, for which the company erected a 200ft. mast in the most elevated part of the exhibition grounds, 25-cycle alternating current only was available. A 20-kw. Fort Wayne transformer, built for 60 cycles, was found to operate very well on the lower frequency, but there was a drag at the key which would not occur with the higher frequency current. A Wagner motor-generator running on 25 cycles furnished 110 volts direct current used for operating the relay key, which breaks the main circuit. Messages have also been sent from this station to Springfield.

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EDDY-CURRENT LOSSES IN THREE-PHASE CABLE SHEATHS.*

BY M. B. FIELD, M.I.E.E.

The extensive use of three-core lead-sheathed cables for power transmissions renders the problem of the determination of the sheath losses due to eddy currents of considerable moment. In a paper recently read before the Institution of Electrical Engineers, the writer published several diagrams showing the general shape of the magnetic field which exists in the immediate neighbourhood of some typical multiphase cables, and also diagrams illustrating the variations in the magnetic field during each cycle. The nature of the currents induced in the lead-sheaths of the cables by these cyclic variations was discussed, and a few elementary calculations of the magnitude of the losses based thereupon. The object of the present communication is to determine more exactly the sheath loss in the case of a three-phase lead-sheathed cable.

Provided the cores are circular in section, and we know that the current distribution over the cross-section of each core is uniform, the problem presents (with certain reservations) no great difficulty. There are, however, two disturbing influences which tend to produce an uneven current distribution in the cores. They are: (1) the influence of the current in each core upon itself, producing the well-known skin-effect; (2) the influence of the current in one core upon the current in the other cores. We may take it, however, that except for the "twist" of the cable cores as explained later, the flow of current in each core is entirely axial, so that, however complicated the actual distribution of current over the cross-section may be, it may be divided into two components—viz, a uniformly distributed current and a system of longitudinally flowing eddy currents. The ohmic losses may then be computed as if these two components existed independently of each other.

Now, the criterion of an eddy-current distribution in a conductor (in which the current flow at every point is entirely axial) is that the surface integral of current density over any transverse section is zero. If $f(x, y)$ be the current density at any instant at the point x, y of a cross-section due to an uneven distribution of current, and if A be the average value of the current density, the actual distribution, $f(x, y)$, may be split up into two components, A and $[f(x, y) - A]$; but evidently $\iint [f(x, y) - A]\, dx\, dy = 0$, where the integration is extended over the core cross-section; $[f(x, y) - A]$ is therefore an eddy-current distribution.

We can further write down the following algebraic equation:

$$\rho \iint A^2\, dx\, dy + \rho \iint \{f(x, y) - A\}^2\, dx\, dy = \rho \iint f(x, y)^2\, dx\, dy - 2A\rho \iint \{f(x, y) - A\}\, dx\, dy.$$

If now ρ represents the specific resistance of the core material, the first term on the left-hand side represents the ohmic loss per unit length at any instant due to the uniform current distribution, A, the second term that due to the eddy-current distribution. The second term in the right-hand side is evidently zero; hence we see that at every instant the actual ohmic loss is equal to the sum of the ohmic losses due to the two components reckoned separately. Thus any effect which causes an uneven distribution of current, is in reality inducing an eddy current.

We have, therefore, to consider not only the eddy currents induced in the sheath, but in the cable cores themselves. It will be convenient to consider the eddy currents induced in the cores under two headings: (1) the self-induced eddy currents, usually termed skin-effect, and (2) mutually induced eddy currents.

Cable cores, when of circular cross-section, are usually built up of a number of strands arranged in concentric layers, the whole having an axial twist or "lay" about the core axis. Now the skin effect in a circular conductor is such as to cause the current to assume a distribution expressed by some function of the distance from the axis only; in fact, the current may almost be considered to flow in cylindric layers, and hence the effect of stranding or twisting the core in reducing the skin-effect will be very small. This, however, is not the case when we consider the mutually-induced eddy currents.

* Paper read before the British Association at Cambridge.

Let us consider two circular cores lying near one another, current being started up one and back along the other (Fig. 1). The generation of the magnetic field due to C_1 will tend to oppose the flow of C_1 and will assist the flow of C_2. The effect will, however, be more marked in the strand a than in the strand b. There will therefore be a tendency for the current-density to be greater in strand a than in strand b. Owing, however, to the fact that the strands are spiralled round the core axis, the strands a and b will have changed places at a point some few inches further along the cable, and the tendency at this point will be for the current-density to be greater in b than in a. If, however, the current-density actually differs at two points of the same strand a few inches apart, current must have entered or left the strand sideways between these two points; but the strength of the current which can thus pass between two contiguous strands depends upon the difference of potential between them and the contact resistance of the current path.

It is easy to see that the difference of potential between two contiguous strands due to the E.M.F.'s induced by the currents in the other cores is excessively small, while the contact resistance will be comparatively high. In paper cables, for example, it is usual to find the resin oil used in the manufacture of the cable has permeated to the centre of each core, thus forming an insulating film between strands. We may otherwise consider the strands a and b as together forming a loop which is threaded by the magnetic lines generated by C_1; the loop is, however, twisted in the magnetic field, and hence the induced E.M.F.'s neutralise each other.

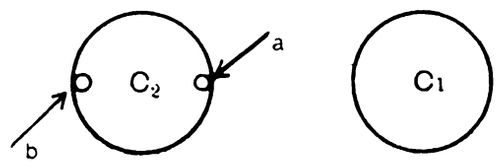

FIG. 1.

While it is evident from the above considerations that in a well-stranded and twisted cable the mutual induction of the cores cannot give rise to such a disturbance that the current-density has different values at different points in any given layer of strands, nevertheless mutual induction may produce in such a core a disturbance similar to skin effect—*i.e*, it may cause the current to be distributed to a certain extent in cylindric layers. For if we compare the E.M.F. induced in a strand lying, say, in the outer layer with that induced in a strand lying in an internal layer, the length of the strand under consideration in each case being that which makes one complete turn or spiral round the core axis, we see that the *mean* E.M.F. per unit length induced in the outer strand is greater than the *mean* induced in the inner strand, hence it is evident that a small effect is produced by the mutual induction exactly similar to the self-induced disturbance, or skin-effect proper. This effect, however, is very small. It is important to observe that in a properly constructed cable the total disturbance of current-density in each core is given by some function of the distance from the core axis, and therefore, as far as the calculation of the sheath losses is concerned, we may consider the current in each core as concentrated at the axis of that core.

In dealing with cores of irregular cross-sections, an exact consideration of the skin effect must of necessity be very complicated. An old patent taken out by Mr. Ferranti specified stranded cores made by twisting together or otherwise combining into one conductor several smaller separately twisted and stranded cores. It is clear that by this means the self-induced as well as the mutually-induced eddy currents may be reduced to negligible limits, and the subsequent calculations in the case of segmental conductors have reference more particularly to cores constructed on this principle. In publishing the following calculation, I wish to acknowledge the very kind assistance given me by Mr. G. F. C. Searle, of the Cavendish Laboratory, Cambridge. After reading the paper above referred to, Mr. Searle showed me the calculation of the induced-current loss due to two parallel conductors of circular cross-section

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forming a single-phase circuit, symmetrically placed within a thin non-magnetic cylindrical sheath. The following is based upon Mr. Searle's work.

Consider a circuit having one side along the axis of the cable and another side parallel to the axis and passing through the point P (Fig. 2), these two sides being each of unit length, and suppose the circuit be completed by two lines at right angles to the axis. Let k be the total number of lines of force which pass through this circuit due to the currents in the three cores, and let dk be the number passing through it which are due to the currents flowing along the three elements of the cores at Q_1, Q_2, Q_3. Then

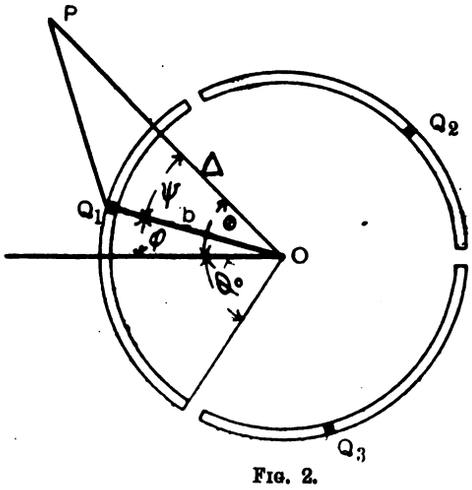

FIG. 2.

$$dk = \frac{b\,db\,d\phi}{5}\Big[A_1 \log b - A_1 \log\Big\{\Delta^2 + b^2 - 2\Delta b \cos\psi\Big\}^{\frac{1}{2}} + A_2 \log b - A_2 \log\Big\{\Delta^2 + b^2 - 2\Delta b \cos\Big(\psi - \frac{2\pi}{3}\Big)\Big\}^{\frac{1}{2}} + A_3 \log b - A_3 \log\Big\{\Delta^2 + b^2 - 2\Delta b \cos\Big(\psi + \frac{2\pi}{3}\Big)\Big\}^{\frac{1}{2}}\Big]$$

where A_1, A_2, A_3 are the current-densities in the three cores in amperes per square centimetre. We shall take

$$A_1 = A_0 \cos pt;$$

$$A_2 = A_0 \cos\Big(pt - \frac{2\pi}{3}\Big);$$

$$A_3 = A_0 \cos\Big(pt + \frac{2\pi}{3}\Big);$$

where $p = 2\pi f$, and f represents the number of cycles per second.

With these values we have at every instant

$$A_1 + A_2 + A_3 = 0.$$

Now when $\Delta > b$, we may write

$$\log(\Delta^2 + b^2 - 2\Delta b \cos\psi)^{\frac{1}{2}} = \log\Delta - \frac{b}{\Delta}\cos\psi - \frac{b^2}{2\Delta^2}\cos 2\psi - \text{etc.}$$

We thus obtain, after simplification,

$$dk = \frac{3\,b\,db\,d\phi}{10} A_0 \Big[\frac{b}{\Delta}\cos(pt-\psi) + \frac{b^2}{2\Delta^2}\cos(pt+2\psi) + \text{etc.}\Big]$$

the terms in b^3, b^6, b^9, etc., vanishing.

In order to find k, we have to integrate this expression over the surface of one of the three cores. We therefore insert $\psi = \theta - \phi$, and for segmental shaped cores integrate with regard to ϕ between the limits $\pm\phi_0$, and with regard to b between the limits b_1 and b_2, and we have:

$$k = \frac{3}{5}A_0\Big\{\Big[\frac{b_1^3 - b_2^3}{1^2\times 3\Delta}\cos\theta\sin\phi_0 + \frac{b_1^4 - b_2^4}{2^2\times 4\Delta^2}\cos 2\theta\sin 2\phi_0 + \frac{b_1^6 - b_2^6}{4^2\times 6\Delta^4}\cos 4\theta\sin 4\phi_0 + \text{etc.}\ldots\Big]\cos pt + \Big[\frac{b_1^3 - b_2^3}{1^2\times 3\Delta}\sin\theta\sin\phi_0 - \frac{b_1^4 - b_2^4}{2^2\times 4\Delta^2}\sin 2\theta\sin 2\phi + \frac{b_1^6 - b_2^6}{4^2\times 6\Delta^4}\sin 4\theta\sin 4\phi_0 - \text{etc.}\Big]\sin pt\Big\} \quad (1)$$

While for cores of circular cross-section of which the area is a, the centres being situated on the centre lines of the segmental cores in the diagram, at a distance b_0 centimetres from the cable axis, we have

$$k = \frac{3\,a\,A_0}{10}\Big[\frac{b_0}{\Delta}\cos(pt-\theta) + \frac{b_0^2}{2\Delta^2}\cos(pt+2\theta) + \frac{b_0^4}{4\Delta^4}\cos(pt-4\theta) + \text{etc.}\ldots\Big] \quad (2)$$

If we neglect all other magnetic forces producing flux through the imaginary circuit except those due to the core currents, the total E.M.F. in volts acting in the circuit will be $10^{-8}\frac{dk}{dt}$. Now any E.M.F. we may consider generated in the side of the circuit which lies along the axis must, owing to the symmetry of the case, bear the same phase relation to the currents in each of the three cores, a condition only possible provided the E.M.F. is zero. Further, the E.M.F. generated in the two sides at right angles to the axis taken together must be zero; hence we may regard the entire E.M.F. generated in the imaginary circuit as existing in that side which passes through the point P.

Moreover, from a consideration of the longitudinal nature of the currents in the sheath (supposed to be insulated), and of their phase change circumferentially, it is clear that the ohmic drop per unit length at every point is equal to the E.M.F. generated in the same length. Hence we have

$$\rho_s u_\theta = -10^{-8}\frac{dk}{dt},$$

where u_θ is the current density at the point θ of the sheath, and ρ_s is the specific resistance of the sheath material.

The average power lost in the sheath per unit length is, therefore, the time-average value of

$$\frac{10^{-16}}{\rho_s}\int_{\Delta_2}^{\Delta_1}\int_0^{2\pi}\Big(\frac{dk}{dt}\Big)^2 \Delta d\,\Delta d\,\theta \text{ watts.}$$

Inserting the values of k given by (1) and (2), we find that for segmental cores the time-average value of the loss, W, in watts per centimetre length of cable is

$$W = \frac{1\cdot 44\,A_0^2 f^2\pi^3}{10^{16}\rho_s}\Big\{\Big[\frac{b_1^3 - b_2^3}{3}\sin\phi_0\Big]^2\log\frac{\Delta_1}{\Delta_2} + \Sigma\Big[\frac{b_1^{n+2} - b_2^{n+2}}{n^2(n+2)}\sin n\phi_0\Big]^2 \times \frac{1}{2n-2}\Big[\frac{1}{\Delta_2^{2n-2}} - \frac{1}{\Delta_1^{2n-2}}\Big]\Big\} \quad (3)$$

where n has the values 2, 4. 5, 7, 8, 10, etc., successively, the intermediate values, 3, 6, 9, etc., not appearing. If τ be the thickness of the sheath in centimetres, and this be small compared with Δ_0, the mean radius,

$$\log\frac{\Delta_1}{\Delta_2} = 2\Big[\frac{\tau}{2\Delta_0} + \frac{1}{3}\Big(\frac{\tau}{2\Delta_0}\Big)^3 + \frac{1}{5}\Big(\frac{\tau}{2\Delta_0}\Big)^5 + \ldots\Big]$$

or $\log\frac{\Delta_1}{\Delta_2} = \frac{\tau}{\Delta_0}$, when the higher powers of $\frac{\tau}{\Delta_0}$ are neglected.

We may furthermore write $\frac{1}{\Delta_2^n} - \frac{1}{\Delta_1^n} = \frac{n\tau}{\Delta_0^{n+1}}$; so that, in these circumstances, the equation (3) becomes

$$W = \frac{1\cdot 44\,A_0^2 f^2\pi^3\tau}{10^{16}\rho_s\Delta_0}\Big\{\Sigma\Big[\frac{b_1^{n+2} - b_2^{n+2}}{n^2(n+2)\Delta_0^{n-1}}\sin n\phi_0\Big]^2\Big\} \quad (4)$$

where n has the values 1, 2, 4, 5, 7, etc., successively.

Owing to the rapidity of convergence of this series, for practical applications all terms except those involving $\sin^2\phi_0$ and $\sin^2 2\phi_0$—*i.e.*, the first two terms when the above expression is expanded—may be neglected.

In the case of circular cores we have from (2)

$$W = \frac{0\cdot 36\,a^2 A_0^2 f^2\pi^3 b_0^2}{10^{16}\rho_s}\Big\{\log\frac{\Delta_1}{\Delta_2} + \Sigma\frac{b_0^{2n-2}}{n^2(2n-2)}\Big(\frac{1}{\Delta_2^{2n-2}} - \frac{1}{\Delta_1^{2n-2}}\Big)\Big\} \quad (5)$$

or, if the sheath be very thin, we have

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$$W = \frac{0{\cdot}36\, a^2 A_0{}^2 f^2 \pi^3 b_0{}^2 \tau}{10^{16} \rho_s \Delta_0} \left\{ 1 + \Sigma \frac{b_0{}^{2n-2}}{n^2} \cdot \frac{1}{\Delta_0{}^{2n-2}} \right\} \quad . \quad (6)$$

where n has the same values as before, from, and including 2, onwards.

It is instructive to form some idea of the magnitude of the currents flowing in the sheath. We may consider the sheath sub-divided into three segments each subtending the angle $\frac{2\pi}{3}$ at the axis, the segments corresponding as regards position with their respective cores—*i.e.*, the sheath is sub-divided by the three radii defined by $\theta = \frac{\pi}{3}$, π, $-\frac{\pi}{3}$.

The total current flowing in the sheath segment opposite to core 1 will be

$$-\frac{1}{\rho_s 10^8} \int_{\Delta_2}^{\Delta_1} \int_{-\frac{\pi}{3}}^{\frac{\pi}{3}} \frac{dk}{dt} \cdot \Delta \, d\Delta \cdot d\theta.$$

With segmental cores the value of this expression is

$$\frac{6\sqrt{3}\,\pi A_0 f}{5 \times 10^8 \rho_s} \left[\frac{b_1{}^3 - b_2{}^3}{3} \sin \phi_0 \, (\Delta_1 - \Delta_2) + \frac{b_1{}^4 - b_2{}^4}{2^3 \times 4} \sin 2\phi_0 \log \frac{\Delta_1}{\Delta_2} - \frac{b_1{}^6 - b_2{}^6}{4^3 \times 6 \times 2} \left(\frac{1}{\Delta_2{}^2} - \frac{1}{\Delta_1{}^2} \right) \sin 4\phi_0 - \text{etc.} \right] \sin pt \, . \quad (7)$$

While for circular cores with a thin sheath we have

$$\frac{6\sqrt{3}\,\pi a A_0 \Delta_0 \tau f}{10^9 \rho_s} \left\{ \frac{b_0}{\Delta_0} + \frac{b_0{}^2}{4\Delta_0{}^2} - \frac{b_0{}^4}{16\Delta_0{}^4} - \frac{b_0{}^5}{25\Delta^5} + \text{etc.} \right\} \sin pt \quad (8)$$

In each case the current in the sheath segment is in quadrature with the current in the corresponding core. We must thus consider the sheath currents as a *three phase* eddy-current distribution.

Up to the present we have neglected the magnetic forces due to the sheath currents, and it is important to determine to what extent this is permissible. We may consider the magnetic force at any point of the sheath as consisting of a tangential and a normal component. First, with regard to the tangential component; if the diameter of the cable be large compared with the thickness of the sheath, we may consider any small portion as a plane slab subjected to magnetic force parallel to the surface. In these circumstances we know that the magnetic force will be less in the interior than at the surface. If τ be the thickness in centimetres, H_1 the maximum value of the magnetic force at the surface, H_2 the maximum value at the centre of the slab,

$$H_2 = H_1 \frac{2}{\sqrt{\epsilon^{m\tau} + \epsilon^{-m\tau} + 2\cos m\tau}}$$

where $$m = 10^{-4} \times 2\pi \sqrt{\frac{\mu f}{10\,\rho_s}}.$$

It is easy to demonstrate that if $m\tau < 1$ the ratio $\frac{H_1}{H_2}$ is very nearly equal to $1 + \frac{m^4\tau^4}{48}$, and, consequently, as $\frac{m^4\tau^4}{48}$ is small compared with unity, H_2 may be taken as sensibly equal to H_1.

If the material of the slab be lead, and if $f = 50$, $\tau = 1$cm., $\frac{m^4\tau^4}{48}$ is of the order of $1{\cdot}9 \times 10^{-4}$. We may take it, therefore, that the tangential component of the magnetic force within such sheaths as are likely to be met with in cable practice is not affected by the sheath currents in the immediate neighbourhood. Secondly, with regard to the normal component of the magnetic force; let us consider the sheath to be concentrated along a very thin cylinder of thickness τ, radius Δ_0 (the mean radius of the sheath), the conductivity of the imaginary sheath as a whole being equal to that of the actual one.

We will calculate the value of the normal magnetic force at P due to the sheath currents and compare this with the value of the normal magnetic force obtaining at the same point due to the core currents. In order to preserve the convergency of our expansions, we consider the point P (Fig. 3) slightly off the sheath so that O P $= \gamma \Delta_0$ and, $\gamma < 1$, but on account of the continuity of the normal induction this will evidently give us the desired result.

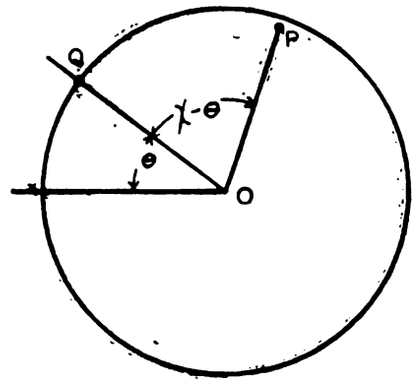

FIG. 3.

We will consider, as before, an imaginary circuit of unit length, one side lying along the axis, one parallel to it and passing through P, the remaining two being at right angles to the axis. The total number of lines, dk', which thread this circuit due to the current in the sheath element at Q will be

$$dk' = -\frac{u_\theta \tau \Delta_0 \, d\theta}{5} \log\{1 + \gamma^2 - 2\gamma \cos(\chi - \theta)\}^{\frac{1}{2}},$$

and the normal induction at P due to this element of current will be*

$$d H_n = -\frac{1}{\gamma \Delta_0} \frac{d}{d\chi} (dk')$$

$$= \frac{u_\theta \tau}{10\,\gamma} \frac{d}{d\chi} [\log\{1 + \gamma^2 - 2\gamma \cos(\chi - \theta)\}] \, d\theta.$$

The total normal magnetic force at P is, therefore,

$$H_n = \frac{\tau}{10\,\gamma} \int_0^{2\pi} u_\theta \frac{d}{d\chi} \log\{1 + \gamma^2 - 2\gamma \cos(\chi - \theta)\} \, d\theta.$$

Inserting the value of u_θ for segmental cores—viz., $-\frac{1}{\rho_s 10^8} \frac{dk}{dt}$, where k is given by equation (1)—we have

$$H_n = \frac{3\pi\tau p A_0 10^{-6}}{25\,\rho_s \gamma} \left[\frac{b_1{}^3 - b_2{}^3}{1 \times 3\Delta_0} \gamma \sin \phi_0 \cos(pt - \chi) - \frac{b_1{}^4 - b_2{}^4}{2^2 \times 4\,\Delta_0} \gamma^2 \sin 2\phi_0 \cos(pt + 2\chi) + , \text{ etc.} \right]$$

We can now make $\gamma = 1$, and we have the normal magnetic force at the point χ on the sheath due to the sheath currents only. The normal component due to the core currents is given by

$$-\frac{1}{\Delta_0} \frac{dk}{d\chi},$$

or,

$$-\frac{3 A_0}{5 \Delta_0} \left\{ \frac{b_1{}^3 - b_2{}^3}{1 \times 3\Delta_0} \sin \phi_0 \sin(pt - \chi) - \frac{b_1{}^4 - b_2{}^4}{2 \times 4\,\Delta_0{}^2} \sin 2\phi_0 \sin(pt + 2\chi) + \text{etc.} \right\}$$

These two series are not directly comparable on account of the different numerical coefficients of the second and succeeding terms, but they are fairly rapidly convergent, so that in any given numerical example it is easy to compare the relative values of the magnetic forces at any point due to the sheath and core currents respectively. If, as an approximation, we compare the first terms of the two series, we find that the self-induced magnetic force is very nearly in quadrature with that due to the core currents, and that for the former to be negligible the quantity

* Positive normal magnetic force is here considered as directed radially outwards and positive current as flowing upwards from the plane of the paper.

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$10^{-9}\, p \times \frac{2\,\pi\,\tau\,\Delta_0}{\rho_s}$ must be small compared with unity, or the conductivity of the sheath as a whole (centimetres per ohm) multiplied by $2\,\pi\,f$, must be small compared with 10^9. On the other hand, as far as the magnitude of the sheath loss is concerned, it should be noted that, on account of the two magnetic forces being nearly in quadrature, the smaller may be a fairly large percentage of the other without seriously affecting the accuracy of the calculation. Such considerations show that even for such large cables as that considered below (6·8cm. outside diameter) the sheath loss may be calculated without reference to the self-induced disturbance of current density.

Although we have hitherto assumed the sheath to be insulated, we see that the results would be the same if the cable were laid in a semi-conducting medium such as damp earth, provided it be symmetrically surrounded, and the conductivity of the same be not great enough to permit of currents whose magnetic force at any point of the sheath is comparable with that due to the currents in the cores. This will be seen to be true, when it is considered that the distribution of the sheath currents is such as to give zero potential at all points of the sheath.

From the shape of the expression for W, we see that for cables of similar cross-sections the sheath watt-loss at a given frequency and maximum current-density in the cores is proportional to the sixth power of the diameter. This is of the greatest importance, for it indicates that the

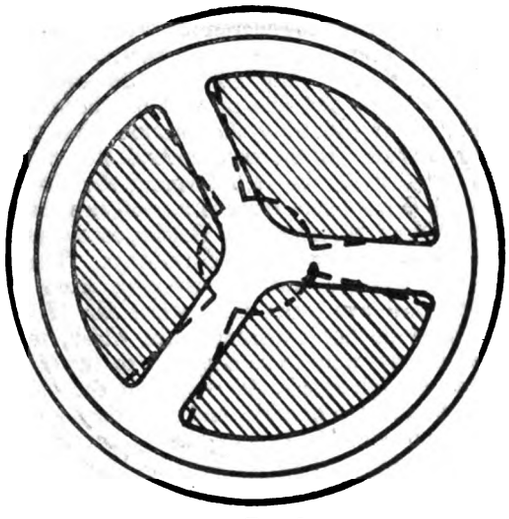

FIG. 4.

sheath loss alone, and apart from all other considerations, would limit the size of economical cables. Indeed, it can be demonstrated very easily that this is true whatever may be the arrangement and shape of cores and sheath, provided the current system be balanced, and that in comparing two cables of *similar* cross-sections the maximum current-density and the phase relations of the various core currents is the same.

We might thus express the sheath loss per mile in a two or a three phase cable of moderate dimensions in the form

$$\frac{A_0^2\, f^2\, d^6}{\rho_s} \times P,$$

where A_0 represents the maximum current-density in any one of the cores, f the frequency, d the external diameter of the sheath, ρ_s its specific resistance, and P is a coefficient depending on the type of cable—*i.e.*, two or three phase, etc.—on the arrangement of the cores and sheath, and the relative proportions of the same, but *not* upon any absolute linear dimensions. Thus, if the values of P be determined for a number of different types of cross-section, we can at once determine the sheath loss in any cable whose cross-section is similar to any one of the types.

We may now, by way of example, consider a definite case. Fig. 4 represents a low-tension three-phase lead-sheathed cable, full size. The full areas (shaded) are the shapes the cores would in all probability take in practice, while the segmental shapes (dotted) are readily amenable to calculation. The segmental section is smaller than the true section by the small obtuse-angled area near the centre. The additional sheath loss due to the currents in these areas, however, is negligible; and we may say the loss calculated on the basis of the segmental sections is slightly less than that due to the dotted sections. The dimensions are: $b_1 = 2{\cdot}5$ cm.; $b_2 = 0{\cdot}8$ cm.; $\Delta_1 = 3{\cdot}4$ cm.; $\Delta_2 = 3{\cdot}0$ cm.; $\phi_0 = 0{\cdot}85$ radians; $f = 50$ cycles per second; $A_0 = 162$ amperes per square centimetre; $\rho_s = 21 \times 10^{-6}$ ohms. Gross area of core (if solid) = 4·7 square centimetres Nett area allowing for stranding = 3·5 square centimetres. A_0 is reckoned on the basis of a solid core, so that the actual current-density in the copper is 223 amperes per square centimetre. This is the maximum value of the sine function, so that the effective value may be taken as 156 amperes per square centimetre (= approximately 1,000 amperes per square inch). Applying the formula above, we find W = 4·19 kw. per mile, it being only necessary to consider the first two terms of the series.

The total effective current per core is 545 amperes, so that on the basis of an ohmic drop of 44 volts per mile the C^2 R loss in the three conductors becomes 72 kw. per mile—*i.e.*, the sheath loss is 5·8 per cent. of the core loss. If, now, we take an extreme case and consider a cable similar, but whose cross-section is of twice the linear dimensions, the sheath loss per mile as given by the formula would be increased sixty-four-fold, while the core loss would be increased only fourfold. It must not be lost sight of, however, that with so large a cable it would no longer be permissible to neglect the magnetic forces in the sheath due to the sheath currents themselves.

Returning to the case represented in Fig. 2, we find that the sheath currents can be considered as a three-phase eddy-current distribution, and the current per phase is calculable from equation (7). It is in the above case 41·8 amperes maximum, corresponding to 771 amperes maximum in each core. As we have seen, the total current in each sheath segment is in quadrature with the current in the corresponding core. Quite apart from the magnitude of the sheath loss occurring in large cables, which might possibly be reduced to reasonable limits by making the sheath sufficiently thin and providing adequate mechanical protection, the above considerations show that as the size increases the mean effective current-*density* in the sheath will rise to a prohibitive figure, a point being eventually reached at which the danger of actually fusing the sheath is introduced.

We have described "skin effect" in a cable-core as a self-induced eddy-current system, the ohmic loss attributable thereto being proportional to the square of the effective current in the core for a given frequency. Lord Kelvin gave formulæ and tables in his presidential address before the Institution of Electrical Engineers on Jan. 10, 1889, for calculating the value of $\frac{R\,(N)}{R\,(S)}$ for a solid conductor of circular cross-section, where R (N) represents the ohmic resistance (not impedance) the conductor apparently has when traversed by an alternating current of frequency, N, and R (S) its true ohmic resistance. $\frac{R\,(N)}{R\,(S)}$ is therefore a coefficient depending on the size of conductor, etc., by which the resistance must be multiplied to obtain an *apparent* resistance which would account for the actual ohmic losses that occur when the conductor is traversed by an alternating current of given frequency.

By exactly the same procedure we can allow for the eddy-current loss in the sheath of the three-core cable; in fact, we can represent the total losses—viz., skin-effect and sheath loss numerically—by taking a definite increase of the resistance of the core per unit length for a given frequency. If ω_1 is the effective resistance of the core per unit length, and ω_2 its actual resistance per unit length

$$\omega_1 = \omega_2 \left(\nu + \frac{\xi}{3\,\omega_2} \right),$$

where

$$\nu = \frac{R\,(N)}{R\,(S)};$$

and

$$\xi = \frac{\cdot 72\, f^2\, \pi^3\, b_0^2}{10^{16}\, \rho_s} \left\{ \log \frac{\Delta_1}{\Delta_2} + \Sigma \frac{b_0^{2n-2}}{n^2\,(2n-2)} \left(\frac{1}{\Delta_2^{2n-2}} - \frac{1}{\Delta_1^{2n-2}} \right) \right\}$$

where n has the values 2, 4, 5, 7, 8, 10, etc., successively.

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In calculating ν for a stranded core of circular section, the strands being laid on in concentric layers, we must insert for the specific resistance of the material the actual resistance of a centimetre cube of stranded core, measured between opposite transverse faces. This is generally about 33 per cent. greater than the specific resistance of the solid metal.

If we take the following figures as representing a typical three-phase cable with cores of circular section: radius of core = ·698cm.; distance between centres of cores = 2·03cm.; distance between centre of cable and centre of core = 1·18cm.; mean radius of sheath = 2·67cm.; thickness of sheath = ·477; current per core (effective) = 200 amperes; frequency = 60 cycles per second. We find

$$\nu = 1{\cdot}00 \quad \frac{\xi}{3\ \omega_2} = {\cdot}0236.$$

Thus the skin-effect is represented by an increase of the resistance of the core of less than 1 per cent., while the sheath loss by an increase of 2·36 per cent. If, now, we increase the linear dimensions of the cable cross-section $\sqrt{2}$ times, we have

$$\nu = 1{\cdot}035 \quad \frac{\xi}{3\ \omega_2} = {\cdot}0944.$$

We thus see incidentally that the sheath loss is a more important factor in large cables than the skin-effect.

HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.*

BY ALEXANDER SIEMENS, PAST-PRESIDENT.

On Sept. 4, 1901, Mr. O. Lasche, of Berlin, read a paper on a high-speed railway car before the engineering conference in Glasgow, which has been published in vol. 31 of the *Journal* of this Institution. Since that time three sets of experimental runs have been made with high-speed cars on the military railway between Marienfelde and Zossen, near Berlin, which had been equipped electrically for the purpose, and last autumn speeds of over 200 km. per hour were attained. Although further experiments are in contemplation, it may not be out of place to give a short history of the trials and of the preparation for them, as the main objects of the investigation have been accomplished. The English patent, 10926/86, "Improvements in the application of Volta inductors or secondary generators for distributing electrical energy and for regulating alternate-current motors, more particularly applicable to electric railways," communicated by Siemens and Halske, Berlin, forms a convenient starting point for such a narrative, as the Zossen experiments may be considered the latest link in the chain of development of the ideas enunciated in that patent. It is pointed out in the specification that "the use of Volta inductors or secondary generators for transmitting electrical energy offers the advantage of enabling a much higher tension to be employed than is possible with transmission by continuous currents, so that considerable energies can be transmitted through great distances by means of comparatively small conductors, while at the same time the regulation of the power of motion is capable of being effected much more easily." About the method of using the transformers in connection with electric railways, the specification suggests either to place them on the carriages or at certain distances apart along the line of rails. In the first case the primary coils are connected by rolling or sliding contacts to the conductor extending alongside the rails, which conveys alternate currents of high tension thereto; while in the second case the secondary coils of the transformers would supply low-tension currents to the working conductor, and thence to the motors on the carriages. As motors, dynamo machines that can produce continuous currents are recommended, and various methods of regulating them are described. The results obtained with such motors at that time were, however, not very encouraging, chiefly on account of the high frequency of the currents employed, and no important practical steps were taken until the three-phase motors began to occupy the attention of electrical engineers.

In March, 1892, Mr. Wilhelm von Siemens gave instructions to have a short experimental line constructed at the works of Siemens and Halske at Charlottenburg, and to try a 20-h.p. three-phase motor on it. The line was 360m. long, with a curve of 40m. radius, and 70m. long about the centre, the whole line being practically level. The current was supplied by a 50-h.p. three-phase machine, type R 32/26, and between two terminals of the same a difference of potential of 500 to 600 volts was kept constant. At the end of July the motorcar was finished, and it was successfully tried on Aug. 2, when loaded with 3,000 kil. At starting the motor was connected triangle fashion, and afterwards star fashion, running 1,400 revolutions per minute when the car was travelling at a speed of 22·5 km. per hour. The movement was transferred from the motor to the wheels by worm gear at the rate of 11 to 1. Encouraged by the results, Messrs. Siemens and Halske formally applied, on Oct. 29, 1892, to the Government for permission to equip from 40 km. to 50 km. of some Imperial railway near Berlin, in order to investigate experimentally the possibility of working the ordinary railways by means of electricity. They proposed to place transformers along the line, from which a low-pressure current would be supplied to the cars, and they explained their desire for such a long line by their intention to run the cars at a speed of from 60 km. to 70 km. per hour. On Nov. 12, 1892, the Government declared its readiness to take the proposal into serious consideration after the experimental line had been inspected by experts. Their visit took place on Dec. 2, but on Dec. 22 the application was declined, as the experts had not been satisfied with the method of collecting the current from the conductor along the line. In the experimental line two overhead wires were used, the rails forming the third conductor, and the Government experts, as well as some of the engineers of Messrs. Siemens and Halske, considered such a system as inapplicable to full-sized railways. The consequence of this attitude was another long pause in the development, until five years later, when Mr. Wilh. von Siemens initiated further experiments, in which, however, high-tension currents were to be supplied to the car. His view was that, at high speeds, the weight of the collectors had to be kept as low as possible, and that they would, for this reason, not be suitable to carry heavy currents; consequently the tension had to be kept as high as circumstances would permit in order to allow sufficient energy being transmitted to the car.

A waste piece of land near Gross Lichterfelde was placed at the disposal of Messrs. Siemens and Halske by the parish, and they built a short line, about 1,800m. long, of normal gauge, in 1898, equipping it with three overhead conductors for three-phase current of either 750 or 2,000 or 10,000 volts. At first the conductors were carried by insulators, each fastened to a movable wooden arm, and the current was collected by a horizontal bar, turning round a horizontal pivot, and pressed by a spring from above against the conductor. When the speed of running was increased, these horizontal bars jumped at the insulators and caused so much sparking that this arrangement had to be abandoned. In rebuilding the line the three conductors were placed vertically one above the other, at a distance of 1m., and the insulators to which they were attached were supported by an elastic cord stretched between the two ends of a channel iron bent in the form of an ellipse and fastened to the poles. The collectors were also modified, each consisting of a horizontal arm, turning round a vertical pivot, and carrying a vertical bow sliding along the conductor, a spring pressing the arm against the conductor. This arrangement was eventually found satisfactory for the highest speeds attained. While it was possible to settle by the experiments on this short line a suitable form of collector and a reliable construction of the overhead conductors, it became obvious that for trials at greater speeds the assistance of the railway department of the Government was indispensable. In the course of negotiations to obtain this, the scope of the proposed trials was widened in so far that the co-operation of other firms was secured by the formation of the "Studiengesellschaft fuer elektrische Schnellbahnen,"

* Paper read before the Institution of Electrical Engineers.

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on Oct. 10, 1899. This syndicate consists of the Deutsche Bank, Delbruck Leo and Co, National Bank, Jacob S. H. Stern, A. Borsig, Phil. Holzmann, Friedrich Krupp, v. d. Zypen and Charlier, Allgemeine Elektrizitäts-Gesellschaft, and Siemens and Halske.

The War Office placed their single line between Zossen and Marienfelde at the disposal of the syndicate, and the President of the Imperial Railway Office became its chairman. Each year the syndicate has published a report of the trials of the preceding year, and all the data given in this paper are taken from these official reports, unless another source of information is specially mentioned. The permanent way of the military line consisted of rails weighing 33·4 kg. per metre, placed on iron and partly on wooden sleepers, and its condition was such that no greater speed than 80 km. per hour was allowed on it. In the first instance this was improved by relaying about 800 rails of 12m. each, increasing the number of sleepers by 4,000, and adding broken stone ballast to the extent of 4,000 cubic metres. This work was finished and the line, 23 km. long, ready for the trials on Sept. 3, 1901, when the official inspection was satisfactory. At the same time electric contacts, to be actuated by the wheels, were placed at 500m. distance from each other all along the line, and a registering apparatus at Mahlow station was connected to them, so that the speed of the cars could be verified there. The overhead conductors along the line were constructed by Siemens and Halske practically in the same way as the line at Gross Lichterfelde, with a device added to earth the line in case a conductor should break. At every insulator a metallic loop, about 30 cm. in diameter, extending horizontally towards the pole, is connected to the conductor, and a vertical copper wire passes through the centre of the loops, the copper wire being efficiently connected to the running rails and through them to the zero point of the three-phase generators, the rails being in addition connected to metal earth-plates at intervals of 1 km. Any interruption of a conductor brings it, therefore, at once into contact with earth, and prevents any accident by shock from the falling conductor. The efficiency of this arrangement was tested, both intentionally and by an accident, when the conductor fell on an official, but in both cases the earthing served as an absolute protection. The line is fitted at every kilometre with means of adjusting the strain, kept at about 1,000 kg., and with lightning dischargers of the horn pattern. At a distance of about 1 km. from Marienfelde (km. 8·5) the feeding line from the generating station Oberspree (13 km. distant), and built by the A.E.G., is joined to the line along the railway by a main switch.

Two carriages were built for the trials by v. d. Zypen and Charlier, constructed and fitted as corridor carriages in accordance with the rules of the German Railway Union. One of these cars, called "A," was furnished with its electrical outfit by the A.E.G., and has been described by Mr. Lasche as stated above, while the other was fitted out by Siemens and Halske, and has been described by Dr. Reichel (*E.T.Z.*, 1901, p. 671); in the reports the latter is called "S." Both cars carry the collectors, tested and approved of in the experiments of Siemens and Halske at Lichterfelde, with this modification, that in the "A" car each collector is carried by its own standard, while in the "S" car one standard carries all the three collectors. There are two groups of three collectors on each car. These cars were delivered on the experimental line in the beginning of September, 1901, and at first were drawn by locomotives so as to ascertain whether all their parts, especially the brakes and springs, were properly adjusted, and to study the mechanical behaviour of the collectors and conductors. Observations were also made as to the relative movements of the bogies and the carriages.

A final inspection was made on Oct. 1, and the permission to start running the cars by electricity was given on the following conditions: (1) The trials may be commenced at a speed of 100 km. per hour. This may afterwards be increased to 120 km., 140 km., and 150 km. per hour, and subsequently at increments of 10 km., provided that before increasing the speed an official inspection shows that the permanent way, the rolling-stock, and all other apparatus have given no trouble at the last speed. (2) Level crossings are to be closed all along the line before runs at more than 100 km. per hour are commenced, and proper catch-nets should be fitted under the conductors at the level crossings. (3) Experiments should at once be made to ascertain whether the electric instruments of the State railway and of the military railway are in any way affected by the working of the electric cars or by any breaking of the conductors. (4) The time-table for the runs is to be agreed with the direction of the State railway, running alongside the military railway, and the stationmasters from Marienfelde to Zossen are to be advised on what days trials at speeds of more than 100 km. per hour are to take place. (5) The conductors must not be charged with electricity, apart from the time-table, except at times sanctioned and announced to the railway authorities by the syndicate with a view of trials on the shunting rails.

At the trials the following rules and regulations had to be observed:

(*a*) *By Permanent-Way Officials.*—(1) The trials and electric tests take place only between 8 and 11.30 a.m. Except during this time the main switch at 8·5 km. must be open. It is to be kept under lock and key, which is in the custody of the representative of the syndicate. (2) Due notice of the time of the trials is to be given to all stations, Marienfelde to Zossen, and to all officials, including navvies, and no work is to be carried on during that time which might occasion contact with the conductors, nor is anybody allowed during that time to remain directly underneath the conductors or to lean against the posts. (3) As soon as the departure of a trial car has been announced by gong signal all gates at level crossings have to be closed, and the officials have to remain outside the gates until the trial car has passed. (4) If a conductor breaks during a trial nobody should touch the fallen ends until reliable advice has been received that the current has been cut off. Should the conductor break during the time the current is off, the ends should be placed out of the way of the ordinary traffic, and notice should be given to the inspector. (5) If any irregularity of the posts or of the conductors is noticed, the inspector should at once have this put right, or cause the syndicate to remedy the defect. (6) The permanent way between Marienfelde and Zossen is to be carefully inspected every day after the close of the trials, and any important irregularity is to be reported to the inspector, and no further trials must be run until the permanent way has been repaired. (7) To the stations, to the inspectors, and to the guards of level crossings, a copy of the pamphlet "First Aid for Accidents Caused by Electricity," is to be handed.

(*b*) *For Trial Runs.*—(8) When trials at a speed exceeding 100 km. are to be run, the representatives of the military railway and of the State railway at Marienfelde have to be informed the day before. (9) On the days of the trials the main switch at km. 8·5 may be closed after 8 a.m. The representative of the syndicate will permit the conductors to be charged when all work on the cars has been finished and all other preparations are complete. He then, with the consent of the engineer-in-charge of the respective electric company, will have the collectors brought into contact with the line, after a signal by a loud gong has been given in the shed. (10) As soon as the conductors are charged nobody is allowed on the roof of the cars, and after the collectors are in contact with the line no further work must be done on the cars in connection with their electric fittings or with their bogies. Offenders against this rule to be removed from the shed, and will not be readmitted. (11) Should it become necessary after the conductors have been charged to work at the bogies or at the electric apparatus of a car, the collectors are to be carefully removed from the conductors, and locked in that position in such a manner that no unauthorised person can move them. (12) Due care must be taken that the line and the level crossings are properly guarded before a run at a speed exceeding 100 km. per hour is commenced. (13) A commissary of the military railway, the representative and at least one other member of the syndicate, the engineer in charge and a fitter of the respective electric company, the driver on duty, and the car inspector should be present during each trial run. (14) The apparatus for starting and stopping the car must only be

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handled by the engineer-in-charge or by the driver. (15) A portable telephone is to be carried, so that in case of accidents a communication with the adjacent stations can be established with the help of the two lowest wires of the military telegraphs. (16) Before the commencement of each run the representative of the syndicate and the engineer-in-charge will settle the speed and the brake trials of the run. (17) At each trial sand and water, for extinguishing fire, are to be carried, together with such tools as may be wanted for slight repairs. (18) When the run is interrupted owing to a defect observed on the car, the collectors have to be removed from the conductors before an investigation takes place. (19) During the run the driver should note any places where the car does not run smoothly, and should inform the representative accordingly. (20) Should a fuse melt at the generating station, Oberspree, it should at once be replaced, but if it blows again nothing further should be done until telephonic communication has been established. (21) After completing the trials for the day the car inspector should minutely inspect the car and remedy any defects. Particular attention should be paid to the state of the axles, the tyres, the bearings, the springs, and all parts of the pneumatic and hand brakes. A similar inspection of the electrical apparatus is to be carried out by the engineer-in-charge of the respective electric company, and the conductors along the line are to be examined by an engineer of Siemens and Halske. (22) In the car-shed a copy of the pamphlet "First Aid for Accidents Caused by Electricity" is to be exhibited, and all notices concerning the touching of apparatus, entering the cars, etc., are to be strictly followed.

On Oct. 3 and 4, 1901, the conductors along the line were officially inspected and tested under pressure, and on Oct. 7 the electric current was for the first time turned on to the cars. The Technical Committee of the syndicate had settled on Sept. 24 that the trials should be undertaken in such a manner as to ascertain (1) the highest safe speed on the line; (2) the proper construction of the permanent way; (3) the most advantageous construction of the car; (4) the most suitable electrical outfit; (5) the amount of energy at the various speeds; (6) the cost of working. To obtain the necessary data each car has been fitted with the following instruments: (1) a speed indicator for the driver; (2) a speed-registering apparatus; (3) an acceleration indicator; (4) a voltmeter; (5) an ammeter; (6) a wattmeter; (7) a phase indicator; (8) a pyrometer; (9) air-pressure indicators. The speed indicator registers the kilometres per hour, and is checked by the speed-registering apparatus on the car and by the instrument at Mahlow station, where the position of the car is indicated every 500m. by the wheel contacts along the line. Of the greatest importance are the observations in connection with the brakes, both as regards the time and the distance taken to bring the car to a standstill after it had attained certain speeds. At the generating station at Oberspree suitable instruments for registering volts and amperes were connected to the feeder, so as to check the apparatus on the cars.

Four sets of trials were to be run: (1) Starting and braking experiments up to a speed of 100 km. per hour. The generating station to supply current at 25 periods and the motors to receive current only long enough to attain the prescribed speed, when the current is to be cut off and the brakes are to be applied. (2) Running at an equal speed, with current of 25 periods, first from station to station and afterwards along the whole line, with resistances in circuit so as not to exceed the prescribed speed. (3) Similar experiments as under 1 and 2, but with currents of higher periods for speeds from 100 km. to 130 km. per hour. (4) Running with currents of 45 periods at speeds exceeding 130 km. per hour. The two cars were to be used on alternate days, and no increase in the speed was allowed unless everything had worked satisfactorily at the last speed.

On Oct. 8, 1901, the "S" car made its first run between the car-shed and km. 10·5, but while the current was on the signalling apparatus of the State railway and of the military line were sufficiently affected to require the construction of metallic returns along the whole line. This was finished in time for the regular runs of both cars to commence on Oct. 14, and they were continued until Nov. 30, with the exception of 12 days, during which the permanent way had to undergo extensive repairs. During these trials the cars ran about 3,000 km., of which 2,200 km. were under current, and for 800 km. the cars were pulled by locomotives before any current was used. The first two sets of experiments were carried out according to programme, and dealt with speeds up to 130 km. per hour, and they were principally utilised to ascertain the rate of acceleration and the data of braking. During the third set the speed was gradually increased until the "S" car reached a speed of 160 2 km. per hour on Nov. 5, while the railway officials made an inspection of the line in accordance with the regulations governing the trials. Even at a speed of 140 km. the running of the cars became irregular, owing to the condition of the permanent way, and at higher speeds the rails were bent, and their level was so much disturbed that the speed of the subsequent runs had to be restricted to 130 km. per hour. It was, however, possible to make valuable measurements of the energy required, and the working of the collectors and conductors could be observed with currents of 48 periods and 13,500 volts.

About the behaviour of the various component parts the report of the syndicate enters into great detail, of which a short summary only is given. At the generating station the steam dynamo and transformers worked quite satisfactorily, and supplied current of 25 to 50 periods and 6,000 to 14,000 volts. The feeder consists of four conductors, each of 50 square millimetres in section, the fourth conductor connecting the rails to the zero point of the two transformers. The conductors along the line, constructed, as described above, by Siemens and Halske, have given no trouble whatever even in heavy rain or hoar-frost. One of the most important problems—namely, to ascertain how large quantities of energy can be transferred from a standing conductor to a rapidly moving car—has been successfully solved by the construction of the conductors and of the collectors, both of which were the outcome of the experiment at Gross Lichterfelde. Both carriages, built by Van der Zypen and Charlier, ran in a very satisfactory manner, and ran steadier at a speed of 120 km. to 130 km. per hour than an ordinary corridor train carriage at 90 km. per hour. At higher speeds, the irregularities of the permanent way made the running dangerous. In the two articles mentioned above, the electrical arrangements of the two cars are described in detail.

The report of the syndicate makes the following observations: (*a*) It considers the switching arrangements of the "S" car more complicated than those of the "A" car, and suggests for both cars that it should be possible from either end to set both groups of collectors simultaneously. (*b*) The transformers in both cars are cooled by air, and have worked well during the trials. In car "S," after running 230 km. in succession, necessitating 14 accelerations to a speed of 120 km. per hour, the temperature of the transformers was only 25deg. C.; they were therefore considered sufficiently large to stand long runs, especially as they worked well with 12,000 to 13,000 volts. On the other car the transformers were much lighter, but they were never overheated, only on Nov. 19 a primary coil was short-circuited by a current of 12,000 volts. After that date currents of no more than 8,000 volts were permitted, so that the point could not be settled whether the transformers on this car could be used for long periods with high voltages. (*c*) Each of the motors on both cars is designed for 250 h.p., the "A" car motors taking current at 435 volts, and the "S" car motors 1,150 volts, while the pressure in the secondary circuit is 650 volts when standing still and during acceleration. No difference in running was experienced, although the motors on the "S" car are rigidly fixed to the axles of the wheels, while the motors on the "A" car are carried by the bogie frame and drive by an arrangement of springs. The report prefers the latter arrangement, and suggests trying a third method—driving the wheels by connecting rods. (*d*) The switches and resistances present another feature in which the electrical arrangements of the two cars differ; on the "A" car liquid resistances were employed, regulated by pumps, while metallic resistances were carried on the "S" car. Both arrangements gave no trouble during

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these trials. The metallic resistance switches are more complicated than the others, but they work faster.

(To be continued.)

COMPARISON BETWEEN DIRECT-CURRENT AND POLYPHASE SYSTEMS FOR ELECTRIC WINDING PLANT.

BY JOHN G. HOOGHWINKEL, M.I.E.E.

In the first place, the choice of the type of motors to be used for driving winding plant depends on the type of winding engine to be used, and on the source of the electric power. The latter may be generated in a power

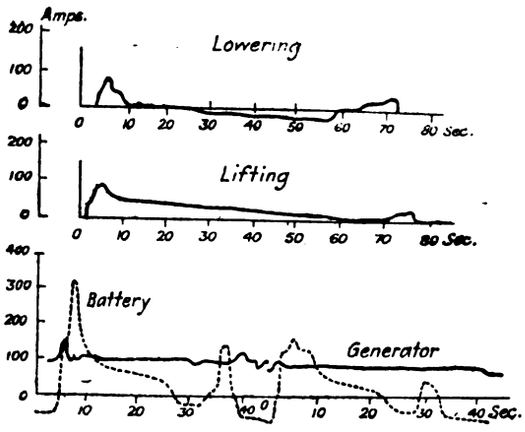

FIG 1.

station on the mine, only, or at least for the greater part, generating power for the winding machines; or it may be taken from the supply mains of a central power company, supplying several mines or a whole district. In the first case the power station will be near the pit's mouth, and probably generating continuous current. In the latter case the supply will be at a high voltage—say, 10,000 volts three-phase current with a periodicity of 40 to 50.

I. *Separate Power Station.*—Dealing with the first case—a separate power station for the winding plant (which is the most important part of a mine equipment and requires most of the total power used)—let us consider

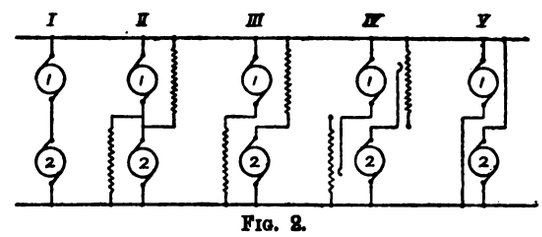

FIG. 2.

for speed regulation. (3) There are heavy losses, due to braking, as all the energy is wasted, while continuous-

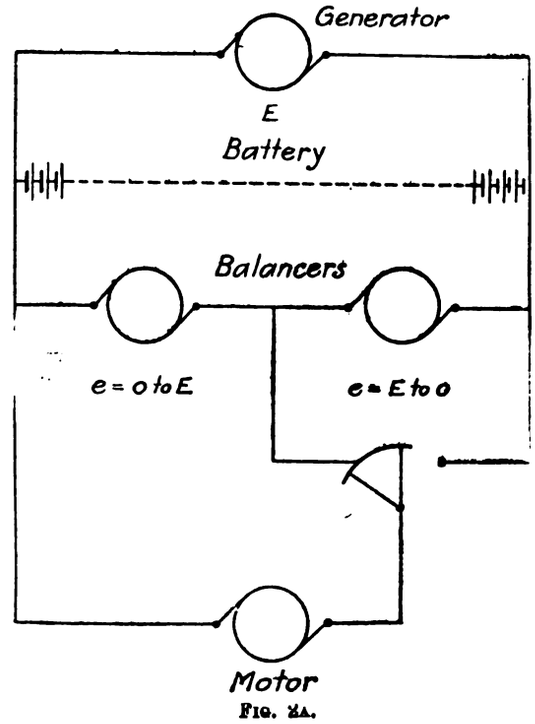

FIG. 2A.

current shunt motors constitute an efficient automatic brake while paying back energy to the system. (4) It is

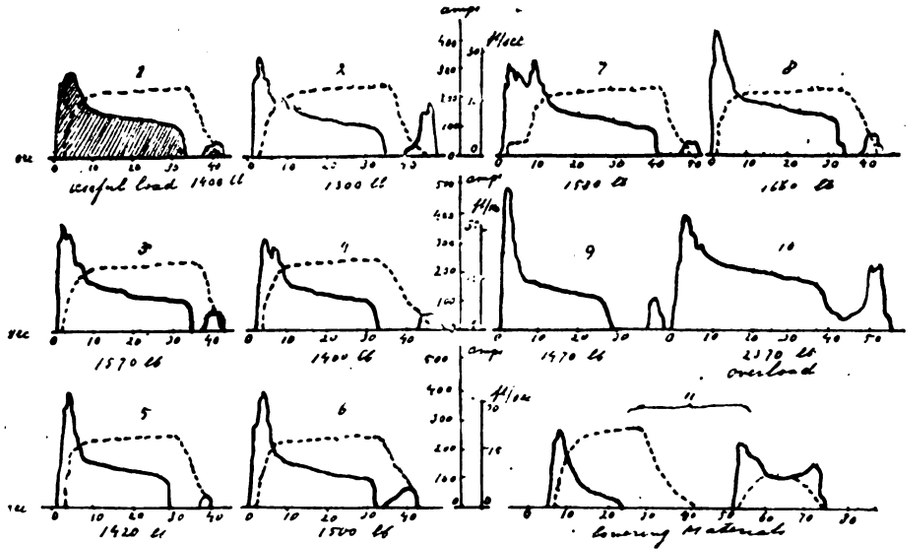

FIG. 1A.—Winding Diagrams of the Winding Plant at Tiederhall—Direct Current, with Battery, Double Drum; useful load, about 1,600lb.; non-balanced rope; speed, 22ft. per second; depth, 650ft. .... speed; — current.

first of all the efficiency and first cost of a direct-current and a polyphase equipment. If we are free in our choice of the system, the direct-current system is undoubtedly the best, owing to the following inherent qualities: (1) The polyphase motor cannot be started and regulated without considerable losses, which losses can be for the greater part avoided in direct-current plant. (2) The polyphase motor working at low speeds (40 to 60 revolutions per minute) requires a frequency of 25 or less, so that the station is not very well adapted for other purposes, such as not possible to make use of the highly equalising powers of a storage battery for equalising the load on the main engines. (5) The main engines have to be of greater capacity with three-phase plant, and the flywheels which may be used to produce the same effect as a battery are extremely heavy (up to 100 tons). The losses referred to in (1), which are by far the most important (up to 50 or 60 per cent. of the required total energy for each complete wind), can be for the greater part avoided with continuous-current motors by using one of the following

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arrangements. The writer does not propose to describe each system, but simply to point out the advantages and drawbacks of each in particular.

By the battery method the equalising battery is divided into several, say five, parts, which provides a starting device without the usual rheostatic losses, in switching on the battery groups one by one, thus applying a gradually increasing voltage to the motor. The battery, of course, introduces losses in the battery, but these are very small. The writer would refer to the Tiederhall mine, where a winding plant on this system has been at work for three years. About one-third of the total energy passed through the battery, which has an efficiency of 85 per cent., being used as a battery in a traction station, *not* as a capacity battery, as in lighting stations. The most important advantage of the battery, however, is its equalising effect. The main steam-engines need only supply the *average* power, which is much lower than the amount of energy required to overcome the *static* forces. Fig. 1 shows the proportion between the maximum required energy and the average. The writer took the diagram from the Tiederhall mine after the installation had been running one year without a single hitch If no battery had been used, the main generators would have been calculated powerful enough to give the static torque. This saving in the output of the steam sets *largely* balances the cost of the battery, as a battery costs about half the price of a steam set (and boiler capacity) of the same output. As regards efficiency, it was found at the Tiederhall mine that for every horse-power useful load lifted at the shaft the required power at the steam-engine was 2 b.h.p. to 2·2 b.h.p. These figures have been checked by the writer in several other modern electric winding installations established on the same system. They compare with 3 b.h.p. to 3·25 b.h.p. in the three-phase installation at the Hohenegger mine, which is of about the same output. The annual saving in coal, therefore, fully pays for the maintenance cost of the battery, not to mention the other advantages—such as longer life for the steam sets, steady load, economical cut-off, etc. While lowering materials, etc., and during the braking period, energy is stored in the battery, and the writer considers this system the best for *heavy* electric winding plant supplied either by its own steam set or by a continuous-current main station.

It is not necessary to describe in detail the various arrangments which have been designed to gain the same advantages as the battery starting system, but they will be shortly enumerated. The disadvantage of using an equalising battery at the same time for starting, is a certain complication and the necessity of heavy switches. To obviate this, it is possible to use *for starting* (the use of a battery as equaliser is independent of this duty) in order to avoid the rheostatic losses: (1) a set of balancers to supply different voltages and to equalise the discharge of the battery, doing away in this case with the battery switches; (2) Leonard's system of separate excitation of the dynamo and the winding motor; (3) the starting motor-generator system.

Starting motor-generators can be arranged in different combinations. The best arrangements are II. and IV. (in Fig. 2), as the machines are only half the size of the winding motor. Although the first cost of these machines is rather high, their use secures some very valuable advantages—viz.: (*a*) Any position of the controlling lever of the winding machine corresponds to a fixed speed, which does not vary, even if the load becomes negative (when lowering materials, etc.). This is all-important, as it gives great security in handling the plant. (*b*) The starting losses are reduced to a minimum, and, therefore, the same saving in coal is obtained as with a battery. The losses are only confined to the no-load losses of the motor-generator, which are small. Also, it may be remarked, that any speed can be maintained without increasing the losses in the motor-generator. (*c*) The regulating switches and apparatus are small, being only inserted in the shunt circuits. (*d*) Anothe advantage is the brake action of these machines, as when pulling the lever back we brake the winding motor, and gradually stop at the same time, thereby putting energy back into the network. This system has been installed in various collieries—viz., Friederch Franz Mine, etc.

A combination of a starting motor-generator and the Leonard system of separate excitation, combined with the use of a high-speed flywheel on the motor-generator, has been introduced under the name of Ilger system (Fig. 3). This system can be used with any supply of *any* frequency, and is, therefore, in the writer's opinion the only system to be used with winding plant, taking its supply from a power company, which, having regard to its lighting load, will often work at a frequency of 50. It has been installed in the Zollern II. mine. Many installations (up to 17,000 h.p.) are in course of erection.

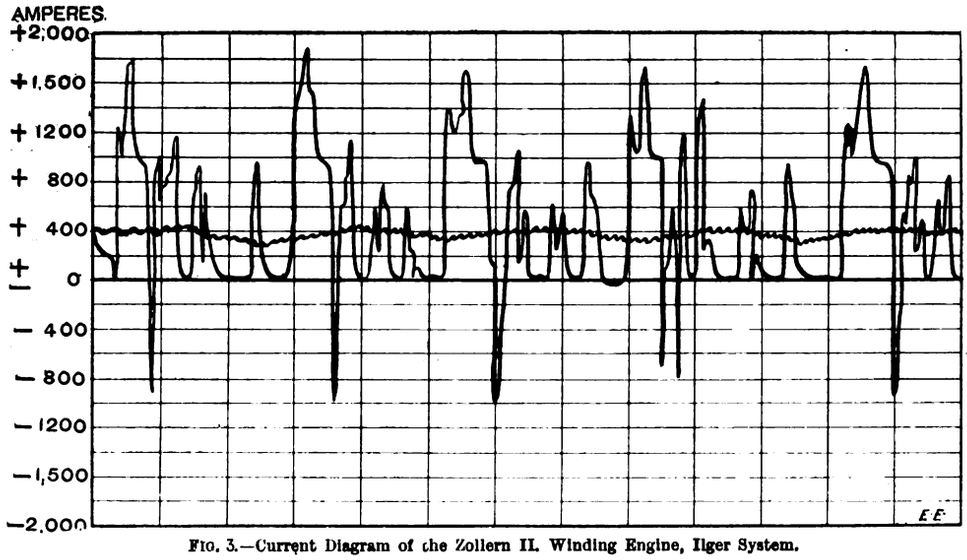

FIG. 3.—Current Diagram of the Zollern II. Winding Engine, Ilger System.

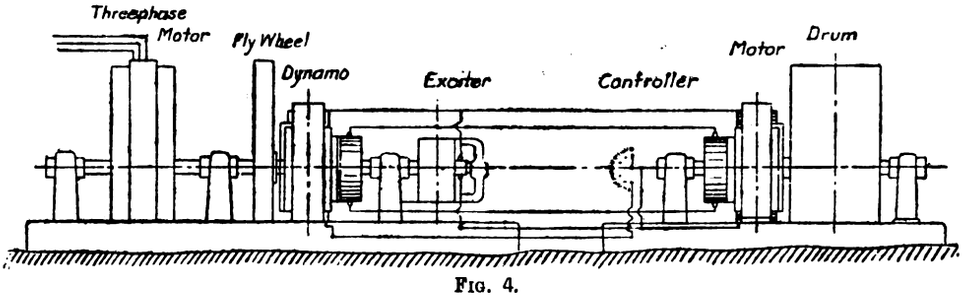

FIG. 4.

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All these arrangements for starting aim at reducing the heavy starting losses to a minimum. With polyphase motors this is not possible. The only way is by using two motors in concatenation, but the difficulties due to the required heavy starting torques and to field leakage have not been successfully overcome for this kind of motor, although for railway motors it has been done (because of the less frequent and easier starting). Also the automatic electric brake action has not been successfully arranged for yet. The heavy losses due to the resistance in starting and regulating remain, and, as remarked before, often amount to 40 to 50 per cent. of the total energy. Also the steam sets have to be more powerful, as explained above, and, moreover, the steam consumption is greater than with a continuous plant with battery, as the engines run between 0 and maximum cut-off, or, even when a heavy flywheel is used, at least below the normal cut-off.

Recapitulating, we have, therefore, the following advantages for the continuous current, comparing a separate polyphase electric winding installation, where the winding load forms the greater part of the output, to a continuous-current installation with battery or on the Ilger system: (1) Capital outlay is practically the same, as cost of battery or other auxiliary plant is nearly balanced by high cost of more powerful main generators. (2) Steam and fuel consumption are about 30 per cent. less with continuous-current plant, due to the absence of starting and braking losses and equal load on the steam-engines, running at their most advantageous and constant cut-off. Also no losses due to the presence of a heavy flywheel. This estimate of 30 per cent. has been found to be correct in actual practice, as referred to before, but cannot very well be calculated, because of the varying steam consumption curves of engines of different class and output, and because of the varying starting losses. The writer is of opinion that it can be exceeded. (3) There is a greater security and easier and more perfect speed regulation, owing to definite and constant speed corresponding to each position of handle, also automatic braking without wear and tear on the other brakes and plant. (4) As regards the Ilger system, there is the possibility of using a frequency as high as 50 periods, giving greater facilities for lighting, etc. (5) Light and simple regulating gear is used. (6) There are no prohibitive load variations at the station having regard to lighting, etc. 7. Less copper is required in high-tension line to winding motor due to equally distributed load. In Fig. 3 can be seen the perfect equalising effect of the Ilger system on the last diagram taken at the Zollern II. mine.

II. *Power taken from a Large High-Tension Power Station supplying several Mines or Districts.*—In this case, of course, where the winding load is only a small part of the total load on the power station, or where even more than one winding machine is run from one station, most of the advantages of the continuous-current winding plant, though still to be considered, decrease or even disappear. The fluctuations of the load having less influence on the main engines, these are running on more even load, their steam regulation does not vary between 0 and maximum cut-off, and the steam consumption is much better. However, the starting losses remain, and these are 40 to 50 per cent. of the total energy, especially when the winding speed exceeds 12 yards per second. The writer is, therefore, of opinion that in most cases continuous-current plant with starting motor-generator and high speed flywheel has decided advantages which will soon pay back the extra cost of the slightly more expensive plant of the continuous-current system. For winding plant supplied from a main power station supplying several pits, three-phase motors should be adopted. For a large winding plant supplied by its own generating station, continuous-current with motor-generator or battery is superior to almost any other arangement.

ON INSULATION.

It may be taken for granted that testing the insulation of an electrical machine after completion, without any previous satisfactory knowledge of the insulating materials used in its manufacture, is far from being the correct thing to do. If, then, we are to choose between the various insulating materials on the market (each of which may be good for a particular purpose), it becomes essential to institute some preliminary tests. As to what should be the nature of these tests, it would be profitable to first consider what the insulation has to do, and under what conditions. These points will determine the nature of the tests it will be profitable to make.

It will be beneficial here to note some of the conditions which have to be fulfilled by a good insulator, though it may not be absolutely necessary that one particular insulator should meet every possible condition. These conditions may be broadly divided into two classes—viz., those necessary for convenient and cheap manufacture, and those essential to the longevity or commercial efficiency of the machine.

Taking first "paints or varnishes," we find the following features desirable, if not absolutely essential: (1) they should be quick drying, and yet should not lead to great waste owing to the drying up of the solvent; (2) they should have considerable elasticity and strength; (3) have a high melting point, and should not lose their insulating properties or char with possible rises of temperature in practical use; (4) should not chemically affect the copper conductors; (5) must be waterproof and unaffected by oils, acids, and, as sometimes specified, salt water; (6) last, but not least, should be good insulators.

Secondly, with regard to insulating fibres, papers, and tapes, we know that some depend on the nature of the material for their insulating properties, whilst in others this is merely a medium for carrying an insulating "varnish or paint," and it is on this that the strength of the insulator, as such, depends. This latter class, which also includes a certain variety of tapes, should, as far as the insulating medium is concerned, with which they are impregnated fulfil the conditions enumerated above for paints and varnishes. Regarding fibres and papers in their "natural" state—*i.e.*, not impregnated with an insulating medium—they might be approved of if they meet the following conditions: (1) they should be tough, yet pliable; (2) should not suffer excessively as insulators should they be creased; (3) they should, as far as it is possible to make them, be non-hygroscopic; (4) should be able to stand all temperatures experienced in practice without charring or reducing their insulating properties; (5) should have high insulation per mil of thickness, except where their mechanical strength is the principal consideration. It will be obvious from the varied nature of insulating materials, and also from the fact that no one material meets all conditions, that a choice has to be made of such as will best suit the varying conditions of service, both mechanically and electrically. With careful attention to this point considerable reduction in the cost of insulating materials may be effected in the manufacture of various electrical apparatus, though the cheapest insulation is not always the best.

Returning to the subject of varnishes and paints, let us look at the first of the properties required—viz, "quick drying." It will be obvious to anyone acquainted with shop methods the great saving in time and the increased output that can be obtained from a given drying stove, the more "quick drying" the insulating medium is. With this object in view resource has been made to shellac, copal and resin varnishes, using alcohol as a solvent. This would not be objectionable but for the fact that when the spirit (and also the water it carries) has been dried out, the resulting solid is too brittle. This solid under vibration or due to expansion and contraction, as the winding heats up and cools down, is in time reduced to a powder, and is then, of course, useless as an insulator. Should it be a revolving portion of a machine that is insulated with these varnishes, then centrifugal force will assist in the destruction of the insulation. Oil "varnishes" are not "quick drying" unless an objectionable amount of "dryer" is introduced. A considerable amount of waste occurs where the varnish has to be painted on coils such as are inconvenient to dip. Further, all tanks used in dipping coils should be provided with covers when not in use. Even whilst in use attention has to be paid to the consistency of the material owing to constant evaporation, and

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"thinners" have to be added, as when used too thick more insulation is added than is required, leading to needless expense.

2. The second property claimed is that of elasticity and strength. From this point of view all mixtures, as distinct from chemical compounds, should be avoided. They are objectionable because of separation through settling. Should this be overcome by frequent stirring it is only temporary, as separation can take place after application. These mixtures are often brittle when thoroughly dry, and this considerably impairs their use. The American asphaltums, or, as as they are re-christened here, varnishes, are satisfactory at first as regards elasticity, but in time become brittle.

3. If high melting point is forthcoming, coils or armatures may be satisfactorily baked. Armatures, however, running at high peripheral speeds, especially turbine armatures, throw off the varnish in which they have been dipped at comparatively low temperatures, as the high centrifugal force assists in this work. This is, of course, a great disadvantage, covering as it does the field winding and poles with a discolouring varnish. It may be noted here what temperatures may be expected under working conditions. The writer knows of one or two electric lighting stations where the temperature is not infrequently about 100deg. F., and with the usual 70deg. F. rise of temperature stipulated in most specifications, we get 170deg. F. as the final temperature. This, it should be noted, is only at points convenient of reaching, and consequently internal parts of the windings will be considerably higher. It is certain, therefore, that insulating materials should not melt or have their insulating properties deteriorated under a temperature of at least 212deg. F. Even this will probably leave no margin. Insulating materials should be tested throughout the working limits of temperature, as some lose their previously high insulating properties when the temperature is raised to the working limit, whilst the insulation in some cases chars or carbonises. This is a very important point, as many engineers insist that pressure tests on plants must be made immediately after a lengthy full-load run, and sometimes an additional run of two hours on 20 or 30 per cent. overload. The machine will, of course, be still warm and most likely warmer than at any time on load, as the cooling effect of the revolving parts has then ceased.

4. Affecting the copper winding chemically applies more particularly to varnishes, but as insulating materials are generally secret mixtures, it is not safe to say that all paints are free from this fault. If, however, care is taken to neutralise any acids, such as would attack copper and gives us the green deposit of copper sulphate, this fault is done away with. The moisture in the cotton covering of wires, not dried out before varnishing, assists in this chemical action which destroys the cotton covering, and thus leads to short-circuiting of the turns. It would be as well to mention here that cotton covering is much to be preferred to paper, which is readily cut on the edges of flat strip copper. Cotton covering should never be single, and if to be roughly handled should be braided.

5. The material should be impervious to moisture, unaffected by oils, acids, and salt water. It is, of course, well known that water is an undesirable attendant of insulation, and, therefore, there is no need to labour this point beyond mentioning the specially adverse conditions to which some outside work is subjected, as, for instance, traction motors of all descriptions, motors for small tools in shipyards, etc. Insulation should certainly not wash off within a reasonable time. Regarding oils, many machines are subjected to trouble from this cause; motors from faulty bearings, etc., and generators from this cause and, where placed between engine standards, from splashing of oil from the engine. Acids are detrimental to insulation, and more than one machine has had to be rewound owing to being subjected to the acid fumes from battery-rooms. Salt water has been added by engineers in cases of exposed stations near the coast, especially where the voltage generated is high, though in the case of low voltage it would only be a question of time if the insulation was not impervious to salt water.

6. The material should be a good insulator. This goes without saying, and if this is not forthcoming, the properties previously enumerated are of no account whatever. A thickness of insulation of ·003in. thickness should stand at least 2,000 volts alternating R.M.S. value. It is well to notice that fibrous materials dipped in insulating compound rarely add their full breakdown strength to that of the varnish, and it is as well to look upon the material as only a medium of applying the insulating varnish.

Turning now to fibrous materials (including papers and tapes), it will be obvious that where the paper, tape, etc., is used merely as a medium for carrying the insulating varnish, that that insulator should remain intact, that it should not crack on handling the tapes, etc.; consequently those insulators having the property of elasticity are invaluable for this use.

Considering the fibres in what we have called their "natural" state, the first property mentioned was pliability. This is essential from a manufacturing standpoint. A pliable material is much easier to work with than a stiff one, and results in a considerable saving of time. It is frequently found more convenient to use several layers of thin material for ease in handling. It is here that a good insulator scores over a poorer one, as fewer layers are then necessary.

In handling many fibre and paper insulators, it is almost impossible to avoid creasing the sheet, these materials being usually supplied in sheets or rolls. This brings us to the second point regarding this class of material. This creasing, whether accidental or intentional, should not materially weaken the strength of the material as an insulator. Further, creasing "fibre, presspahn, etc.," destroys the glazed surface, and this makes the material more hygroscopic, and is thus likely to reduce its insulating value. This class of insulator is naturally hygroscopic, and it is almost entirely on the glazed surface that dependence is made to keep out moisture. Care should be taken to inspect fibrous materials other than woven fabrics, as it sometimes happens that pinholes and very thin places are to be found, and at times small particles of metal, such as filing dust, is rolled into the material. Both of these faults are undesirable, the latter especially so.

4. That insulating materials should stand all temperatures likely to be experienced without charring will need no demonstration, but many of this class get brittle when subjected to even "reasonably" high temperatures, and then lose whatever merit they had as to strength, especially mechanical strength. In case of a short-circuit on a machine, the increase of temperature in the portion of the machine supplying current to the short is frequently very great; but it is certainly undesirable that this should necessitate the rewinding of a considerable portion of the machine.

5. That insulators of any description should have a high insulation per mil of thickness is a very important matter, especially in generators and motors, when looked at from the "space factor" point of view. It is surprising what a large percentage of the available winding space is taken up by insulation in generators and motors, more especially in high-tension alternating-current work.

Having considered in detail the points of good insulation, it remains to consider what tests can be conveniently made with a view to securing as many good points in the insulation used, always bearing in mind that electrical tests are by far the most convenient in a manufacturing works, which is generally far from being a chemical laboratory. Particulars of tests as published by manufacturers of insulation are at times misleading, as frequently it is not stated whether the breakdown voltage was with continuous current or alternating current, and if the latter, whether the value is R.M.S. or maximum. Further, some manufacturers test between terminals shaped hemispherically and others between two flat discs. Again, some only test for an instant at the voltage named, merely bringing the voltage up and down again. It is possible, therefore, for the material to break down under a much lower voltage even if only sustained for a short time. Information of this description is of no use to the designer, that will readily be understood. Consequently some systematic way of testing all insulating materials is required. This need only be "thorough" on first testing a new material,

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as there will be probably many evidences visible on mere inspection which would lead one to expect changes in the material. Subsequently a far less pretentious test will be all that is required to ensure repeat orders of material being satisfactory. As the best means for obtaining high pressures, and also of varying the pressure, is by means of alternating current, this, of course, should be used. It must be noted that varying periodicity would give varying results; also that the shape of E.M.F. curve affects the results in the same way, a peaky curve being more apt to break down the insulation than a flat curve, though both may have the same R.M.S. value. An alternator giving 50 periods and approximately a sine curve of E.M.F. would be suitable and would correspond somewhat to prevailing practice in alternating-current work in England. A variable-ratio transformer is practically indispensable for obtaining the varied voltages required to test the different classes of insulators. Though it may be possible at times to use one of two machines for testing purposes, it is preferable to stick to one (unless the machines are identical), as the more constant the conditions of testing the more reliable is the information obtained. The larger the works and the more elaborate might be the testing, but however simple the apparatus, it is desirable to pressure test all insulating papers, etc., at varying temperatures on first testing unknown materials, afterwards it would probably only be necessary to test at one temperature, supervision being kept over the appearance of all materials, as variations from the standard article are thus detected. Supervision is most essential in connection with varnishes and paints, and attention to appearance should, if possible, be supplemented by testing with the hydrometer to see that the specific gravity does not change. This is partly a check on its chemical constituents, any alteration in chemical composition generally affecting its specific gravity.

Taking tests for the specific points, mentioned for insulating materials in the foregoing, in the order named, we have for paints and varnishes:

1. *Quick Drying.*—This is merely a matter for trial, and can be done either in the open air or in a drying stove, as desired.

2. *Elastic Strength.*—This may be tested by coating a piece of pressphn, tin or copper (metal for preference), and when dry bending backwards and forwards. An electrical test can also be made after the bending, to see if this has affected the insulating material.

3. *High Melting Point.*—First dry off the liquid components and then heat the residue, and see at what temperature it melts. If the drying was done in a thin layer, it would also be possible to note when it commenced to char.

4. *Affecting Copper.*—Copper strips may be coated and examined after an interval (which is practically working conditions), but a quicker way is to put copper filings into a quantity of the varnish. They will readily show if the varnish will in any way affect the copper.

5. *Waterproof, etc.*—The varnish or paint could be tested on some plant about the works, where there is generally some motor or other running under adverse circumstances as regards oil, etc. A test might be made of a piece of metal left exposed to the elements for some considerable time.

6 This we will deal with later, along with 4 and 5 for fibres, etc.

Taking now fibres, papers, etc., we find

1. *Pliability.*—This is, of course, purely a matter of trial.

2. *Creasing.*—A good test to subject the material to is to make two creases crossing each other. This is likely to be as severe as anything short of an actual tear.

3. *Non-Hygroscopic.*—This might be tested by immersing all samples systematically for a short time in water and then testing for breakdown after drying the surface.

The tests for 4 and 5 for fibres, papers, etc., and for 6 in varnishes and paints, can conveniently be made in a felt-lined box, heated by either lamps or a resistance frame, the latter for preference if the higher temperatures are desired. If a thermometer be fixed projecting into the box, the desired temperature is easily noted, and can be regulated by varying the current through the resistance. The box should be fitted with two terminals about 1½in. in diameter, the flat surfaces having the sharp edge rounded off to prevent excess of pressure at these points. If one of the terminals be fitted with a flat spring, a fairly uniform pressure will be secured, as the thickness of the samples tested does not vary within very wide limits. Ordinary instruments would be necessary for reading current and voltage, the ammeter indicating at once the breakdown of any specimen under test. It is the systematic recording and making of these electrical tests that enable the designer to make the most of the materials at his disposal. They also, as previously noted, keep the materials used up to sample, and therefore more reliance can be placed on the work of the various departments. One point remains to be emphasised in pressure testing, and that is that the breakdown strength is not proportional to thickness, especially in the case of fibres and such like materials which are built up in layers. It would appear very difficult to get rid of moisture in the thicker sheets, and this brings down the insulating strength.

A very important test which should not be overlooked is the galvanometer test for leakage, as some materials may be good against piercing and yet be bad from a leakage point of view. Take mica-paper for instance. This, if the mica is well laid—that is, with all joints well lapped—will show well under a disruptive test, but for leakage would depend entirely on the mucilage or varnish with which the mica flakes are built up. Failing a standard galvanometer testing set, a rough test may be made by testing against a known good insulator, and noting the discharge and the length of surface over which it takes place. This can, of course, only be done when the thickness of the piece tested is secure against breakdown from the pressure applied to obtain this discharge. Every care should, of course, be taken to accurately gauge the thickness of material under test, especially at the point of breakdown.

In conclusion, it may be said that attention to this question of insulation is amply repaid, and it is well to bear in mind that it is not well "to spoil the ship for a ha'porth of tar."

GERMAN COMPETITION.

BY SIMPLEX.

Out of respect to our German competitors the following verses are written in English as they understand it.

Dere vos a man from Yarmanie
Mit glow lamps dat vos made to sell.
His voice was voll of 'armonie
Und he could blow his trompet well.

He vos not moch at which to look.
His manners were der greasy sort.
But he could yaw like any book,
For he der English tongue vos taught.

He vos a piggish little man.
His moral code vos a surprise.
He fed himself upon a plan
Of diet dat you would despise.

But ach! Der sheapness fon dose lamps!
Die (verbal) guarantees he gave
Of candle-powers compared mit amps.
Und cost of energy we'd save!

Ach me! sechs tousand lamps we bought!
Dey looked so nice und goot und new—
Der first one caused a total short.
Die rest—we give dem *all* to you!

Dey haf *no* life to talk about;
Und if you schwear at dem, dey break!
Die globes are always coming out;
Die plaster crumbles at a shake.

We do not lofe das Doitcher Mann!
But he is now a Companie,
Und advertises all he can
"Support a British industry!"

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THE WOOD GREEN CASE.

There was recently held at Wood Green a Local Government Board enquiry to consider an application from the District Council for a loan of about £43,000 for electric lighting purposes. There was considerable opposition to the application from the North Metropolitan Electric Power Distribution Company, who wished to obtain a contract to supply electricity in bulk to the Council. In consequence of this the enquiry lasted over two days, and a large amount of figures were given on each side as to the relative financial advantages of the rival proposals. The engineers for the Council, Messrs. Hawtayne and Zeden, have been able to convince their clients that even during the first seven years it would be quite as cheap for the Council to generate current as to buy in bulk at 2½d. per unit from the company, but apparently they have not convinced the inspector. The Local Government Board's decision as to the loan has just been received, and it opens up various questions. It reads as follows: "I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the enquiry held by him with reference to the application of the Urban District Council of Wood Green for sanction to borrow £43,200, since increased to £43,570. The Board have very carefully considered all information placed before them by the District Council, and it appears to them upon that information to be extremely doubtful whether the scheme, if carried out, would be likely to prove a financial success. The evidence given as to the probable demand for current was of an unsatisfactory character, for it was first stated that the demand was estimated to be equivalent to 330 consumers at sixty 8-c.p. lamps per house, but when it was pointed out and admitted by the engineer that the number of lamps estimated for was far too high considering the class of property to be supplied, the estimate of the demand was altered to 660 consumers at thirty 8-c.p. lamps per house. It does not clearly appear in what manner either estimate has been arrived at. The Board consider that the District Council before undertaking a scheme of the magnitude proposed should obtain more reliable information as to the extent to which the electric light is likely to be taken up. Moreover, the Board are by no means convinced by the evidence submitted to them that the District Council are acting prudently and in the best interests of their district in proposing to erect a generating station for the supply of electricity, and they think that the whole question, including the methods of supply, should be reconsidered by the District Council." The report is signed by Noel T. Kershaw, assistant secretary. There is no doubt that the consulting engineers were incorrect in their estimate of the number of consumers amongst whom the twenty thousand lamps estimated for would be distributed. It is equally certain that the estimate of twenty thousand 8-c.p. lamps is an exceedingly moderate one for the district in question, which has a population of close upon forty thousand. The alteration in the number of consumers required before these lamp connections have been obtained means an increase in the first cost for house connections. It does not invalidate in any way, however, the accuracy of the estimates for revenue and expenditure, and only slightly increases the capital charges. We are exceedingly surprised to see the Local Government Board asking for more reliable information as to the extent to which electric light is likely to be taken up. The Board of Trade returns are surely at the disposal of all Government departments, and the probable lamp connections from a given class of population can be quite accurately estimated from these, as can also the revenue. The letter reads as

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though a canvass throughout the district as to who would and who would not become consumers were desired. If such is the case, we should have expected the inspector, Mr. Hooper, to correct the erroneous opinion of the Board, that such a canvass is of any service whatsoever. It is an Englishman's prerogative, and a freely exercised one, to refuse to state in writing what he will or will not do a year hence. Experience has shown in this country that a canvass is absolutely useless in ascertaining the probable support of a new undertaking. It is as futile as an attempt to sell goods which are yet to be manufactured and the character and fashion of which are unknown. It seems to us that the Local Government Board have on account of a quibble as to the number of consumers refused a loan which is required by the Wood Green Council to carry out its statutory powers There is, of course, the broader reason that the inspector may consider it more advisable for the Council to take a supply in bulk. This, however, raises a moot point as to the powers of the Local Government Board. The Wood Green Council has been authorised by a provisional order, confirmed by Act of Parliament, to supply electricity and to erect a generating station. It has agreed by a large majority of the elected representatives of the ratepayers to do so, and to make the station part of a scheme including a refuse destructor and baths. The sections of this scheme are to mutually assist each other. Thus the electric light department is to take steam from the refuse destructor, and help to pay the capital charges on the same. Has, then, the Local Government Board the power to compel the Council to throw away these advantages and to take supply from a private company? We, if we were councillors, should renew the application after reconsideration and reapproval of the present scheme, and ask that the inspector appointed be supplied with some Board of Trade returns from electric light undertakings in similar London areas.

A SPORTING OFFER.

The report of Mr. Hammond presented to the Dublin Council is something exceptional in character, and deserves more than casual attention. Without entering into the history of the Dublin installation, it is enough to say that Mr. Hammond is the consulting engineer. During the past twelve months he has also been the responsible manager, and under his management chaos has become order. An immense amount of organising work has been done, and according to the report the outlook is decidedly good. Fortunately or unfortunately, according to the temperament or politics of the individual, a good deal of rough, if not virulent criticism has been launched against the Dublin work and the consulting engineer. It is evident that he is quite sanguine as to the results in the future, and we should say, much to the dismay of the critics, has offered to prove his convictions in the most conclusive manner. This will be gathered from the alternative offers he has submitted to the Council. The criticism on this offer is, "If it would pay Mr. Hammond or his syndicate to work the undertaking from London, surely it will pay the Corporation of Dublin." All other things being equal, that is the natural and legitimate conclusion, but in this case we fear that it is a little difficult to give adhesion to the conclusion. Efficient administration under an autocrat is one thing, under the Dublin Council is another. Nepotism is the unknown factor which may play an important part in the future, unless the Council strictly adhere to employment of merit and ignore influence without merit. Fancy a consulting engineer of high repute having to explain the nationality of the members of the staff he employs. His aim is efficiency and economy, and from all points of view he would prefer the home-made article if it gave him what he wanted. We shall watch the future history of Dublin with interest.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SECTION G OF THE BRITISH ASSOCIATION.

SIR,—The remarks in your issue of the 25th ult. on this year's work of Section G of the British Association at Cambridge have only lately been seen by me. In the past, no one more than I have has felt the deficiencies of arrangement and want of interesting matter in our proceedings, so I feel myself justified in asking your readers to realise the improvement which has lately taken place not only in the subject matter, but also in its arrangement. A few years ago, in these respects G section was worthy of all your severest strictures. I do not remember if it formerly escaped your notice or not.

As a member of the committee which assisted the president and the recorder, I may point out that the faults of arrangement, such as they were, were due, not to want of foresight, but to the traditional practice of the section in accepting papers up to and during the meeting itself. The meetings, as you are aware, are much less formal than, *e.g*, those of engineering societies, and it has always been the custom to accept papers when there is a fair chance of finding time for them, rather than decline them in fear of there being insufficient time to read and discuss them. If you will refer to the provisional programme published in your own columns before the meeting, you will notice that a considerable number of papers, including the whole of Wednesday's programme, were accepted after the meeting began. This was in accordance with the practice I have described, and you will perceive at once the difficulty of introducing a number of fresh papers into an already carefully constructed programme without the appearance of confusion.

The elaborate papers by Mr. Campbell Swinton and Mr. C. H. Merz, which occupied so much of Monday morning, had been promised, and had been set down for that day, as long ago as last January. This, as well as their own character, you will admit, justified the hearing they received. As to whether other papers, through pressure of time, received less, we shall not differ.

The committee of the section were anxious that papers contributed to the proceedings should not be lost, as has been too often the case, and this year for the first time it was suggested to all authors of papers accepted before the meeting that they should endeavour to arrange for the publication of their papers by the technical Press. A very large proportion of the papers of this year's programme have been already published *in extenso*, which you will admit is a valuable result. You have yourself published several.

The section has shared in the general growth and development of the association. It may be that, with growth, some modification of habit is required, but I think you have overstated the case.—Yours, etc.,

C. E. WEBBER.

[We are pleased to publish the above letter from Major-General Webber, and can assure him that our strictures on the management of Section G at Cambridge were prompted by a desire to improve the usefulness of the same. Our view is that when papers can be distributed in proof form to the meeting, as six out of the seven down in the Monday's programme were, it is a waste of time to read them in full. The discussion on Mr. Campbell Swinton's valuable paper was perhaps the most interesting that day, and it would have been equally possible if the paper had been distributed and then read in abstract. The same applies to the paper by Messrs. C. H. Merz and W. McLellan, which was very similar to one read by the same authors before the Institution of Electrical Engineers this year. With seven papers on the programme to get through and discuss in three hours, it does not require expert engineering know-

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ledge to allot to each its due proportion of the time available. Thus, if Major-General Webber will turn to the programme of Section H for the same day, he will find the following: "Monday, Aug. 22.—10.15 a.m. punctually: (1) Sir Richard Temple, Bart., C.I E, 'A Plan for a Uniform Scientific Record of the Languages of Savages' (30 minutes); (2) A. W. Howitt, 'The Practice of Group-Marriage in Australian Tribes' (20 minutes); (3) R. S. Lepper, 'The Break-up of the Matriarchate' (20 minutes); (4) Edmond Demolins (Paris), 'Classification Sociale,' (20 minutes); (5) Prof. W. Ridgeway, 'An Anthropological View of the Origin of Tragedy' (30 minutes)." Thus some two hours were devoted to papers, leaving 45 minutes for the five discussions. Surely the committee and recorder of Section G, as engineers, are as capable of organising a three hours' meeting as the anthropologists.—ED., *E. E.*]

TELEPHONY AT GLASGOW.

SIR,—I must take issue with your statement of this controversy on p. 309 of the *Electrical Engineer*. My credibility is not in question at all. I have merely quoted various references by Mr. Bennett to the 1897 Glasgow estimate which directly conflict with Mr. Bennett's recent statement, quoted in your issue of Aug. 12, to the effect that the estimate was prepared for the special purpose of showing what the then existing system ought to have cost the National Telephone Company. As Mr. Bennett has made two conflicting sets of statements regarding this estimate, and all I have done has been to quote some of them, the only person whose credibility can be in question is Mr. Bennett. It is not a case of Bennett *v.* Webb; it is Bennett *v.* Bennett. As there are two directly conflicting sets of statements by the same author, the world must judge whether the weight of the evidence supports Jekyll or whether it supports Hyde.

The estimate is now said to have been made for the special purpose of showing what the then (1897) existing system in Glasgow ought to have cost the National Telephone Company. Let us see what is the evidence for and against this statement:

Pro.—1. That Mr. Bennett said so on cross-examination at Glasgow in 1897.

2. That Mr. Salvesen said so in his closing speech.

3. That Mr. Bennett said so at Hull in 1903. After a brief triangular squabble between the inspector, Mr. Robb, and Mr. Bennett, the inspector declined to hear the matter out, and gave no opinion on the point at issue.

4. That Mr. Bennett says so now.

Contra.—1. The then existing system was a single-wire overhead system. The estimate describes a metallic-circuit underground system. (*Vide* Glasgow Blue-book.)

2. The estimate specified a greater length of wire, a larger number of junction lines, and a larger number of exchanges than the existing system contained. (*Vide* Glasgow Blue-book.)

3. Mr. Bennett stated in 1896 (*vide* "The Telephone Question," by A. R. Bennett, published by Biggs and Co.) that Glasgow could be telephoned in modern style for £17 a line.

4. The Glasgow Corporation applied for a telephone license for the whole area in September, 1897. (*Vide* Glasgow Blue-book.)

5. The Glasgow Corporation sent out circulars previous to the enquiry inviting applications from prospective subscribers to the proposed municipal system. The circular said that the Corporation were advised by an experienced telephone engineer. (*Idem.*)

6. Members of the Telephone Committee of the Glasgow Corporation, in sworn evidence, said that they contemplated establishing a system to serve the whole area; that they had detailed estimates which would be explained by the engineer (Mr. Bennett's evidence followed that of the town councillors); and that they contemplated spending £100,000 or £120,000. (*Idem.*)

7. Mr. Bennett put in an estimate entitled "Estimate for Glasgow Municipal Exchange." (*Idem.*)

8. Mr. Bennett described the estimate in detail, showed and described a map illustrating the situation of the exchanges and the proposed cable and distribution system. He spoke of the system in the future tense, said that it "will do" and "will be" this, that, and the other, and that it "will give" a superior service to the existing service. He showed that it contained more line plant, more exchanges, and more junction lines than the existing system, and he drew many distinctions between the proposed system, as specified by the estimate, and the existing system. (*Idem.*)

9. Two independent expert witnesses supported Mr. Bennett's estimate. (*Idem.*)

10. Mr. Sinclair and Mr. Webb were both examined on the estimate on the basis of it being a working estimate for a proposed municipal system. (*Idem*)

11. The question of the cost of the existing system was ruled out by the commissioner, and was not discussed at all. (*Idem*, p. 61.)

12. The commissioner, in his report, refers to the estimate as having been for a Glasgow municipal system, and makes no reference to it being for any other purpose. (Report on Glasgow Enquiry, p. 17.)

13. Mr. Bennett told the 1898 Select Committee that the 1897 Glasgow estimate was quite correct, and that it was a statement of the ascertained cost of a Glasgow municipal system. There was nothing, he said to modify his Glasgow evidence, and he stood on the estimate with perfect confidence of its correctness. (1898 Blue-book.)

14. Mr. Bennett wrote to a Dublin paper, saying that Sheriff Jameson had not questioned the accuracy of his Glasgow estimate, that the 1898 committee had accepted it as correct, and that it was in effect correct and as applicable to Dublin as to Glasgow. (*Freeman's Journal*, September, 1899)

15. Mr. Bennett, in his report of February, 1900, to the Glasgow Telephone Committee, when work on building the system was about to begin, said that the 1897 estimate remained substantially correct, and appended a complete copy of it as the estimate to be worked to. He recommended that an additional £20,000 be spent on spare plant in and near the exchanges, but gave no detailed estimate or specification of this extra work. (Report by Mr. A. R. Bennett to Glasgow Telephone Committee, February, 1900.)

16. All statements put out by Mr. Bennett or by the Glasgow Telephone Committee relating to average capital cost compare the present calculated cost with the original estimate, or, to be strictly accurate, with the slight departure from the original estimate made in Mr. Bennett's covering report of February, 1900, in which he rounded out the £97,833 of the detailed estimate to an even £100,000. (*Vide* "Noteworthy Points," Glasgow Corporation Telephone Accounts, 1904, Report by A. R. Bennett.)

Now, Sir, as you say, the public, your readers, must judge on which side the weight of evidence lies. In this Jekyll and Hyde estimate you back Hyde, and I simply point out that Jekyll has talked much more emphatically than Hyde, and more often. Whether the public decide for Jekyll or for Hyde, they knock at the same door.

I have derived no little amusement from this controversy, and more, perhaps, from a feature which has not been touched on at all than from those which have been pulled and pounded out of shape by your other contributors. It has amused me immensely to observe that writers on the staff of a technical journal have failed to see the absurdity of arguing that an estimate for one thing could seriously be put forward to show what something entirely different ought to have cost. What engineer in his senses, instructed to appraise an existing system, would prepare an estimate for a system radically different in style of construction and quantity of materials? I may have an unflattering opinion of Mr. Bennett's attainments as a telephone engineer, but I give him credit for more common-sense than to imagine that if he were instructed to inform his employers as closely as he could what an existing system ought to have cost, he would retire to his office and elaborate an estimate for something totally different in all the essential points of design, construction, equipment, distribution, and general arrangement.

It must be clear to the most casual reader that if the 1897 estimate was intended to show what the then existing

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system ought to have cost, it was not worth the price of a match to burn it.

I purpose now to leave this aspect of the subject in the hands of your readers. I have summed up the evidence, and I am content to let them give the verdict. For the next few weeks I hope to be where the *Electrical Engineer* is never seen and the fame of Glasgow telephones has not penetrated. When I return I may have something to say on some other points in connection with the Glasgow system not without interest to those concerned in telephony.—Yours, etc., HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.,
Sept. 5, 1904.

SIR,—Mr. Webb has now restricted this controversy to a question of the consistency of Mr. Bennett. I do not intend to expand this question. I always think it is fairly easy to read inconsistencies where none are intended, but I exercise no stretch of the imagination in reading Mr. Bennett's utterances and actions as perfectly consistent throughout. It was on Oct. 2, 1897, that Mr. Bennett was examined. It was on Oct. 4, 1897, that Mr. Bennett explained, in his answer to question 5,359, what he meant regarding this much-debated estimate. Thus it is perfectly clear that if Mr. Bennett says now what he said then, his statements cannot be termed inconsistent. As I read it, Mr. Bennett does say now what he has said all along and what he said then. Let me once more quote Mr. Bennett's reply to the said question: "I think I made it clear in my evidence in chief that the estimate which I have prepared was designedly founded on a similar number of subscribers as exists at present in Glasgow, *for the specific purpose of ascertaining the approximate cost of such a system as exists here.* (The italics are mine.) That was the object, and it was never proposed that in the event of the scheme being given effect to the lines should be laid for such a small number of subscribers as 5,000 or 6,000."

From this it will be seen that the estimate was then said as is now said to be: "For the specific purpose of ascertaining the approximate cost of such a system as exists here." What other interpretation can anyone put upon these words of Mr. Bennett than the one I have put? I do not mind telling Mr. Webb that if I read Mr. Bennett's evidence as given on p. 103 of the telephone enquiry minutes, and also on other pages, *without* his explanation on p. 113, and especially his answers 5,359 and 5,360, I should perhaps be inclined towards Mr. Webb's view to admit some inconsistency, and possibly an attempt in some of Mr. Bennett's subsequent remarks to read something into his evidence. But I cannot see how Mr. Webb or anyone else can get over the explanation given in these replies, which are proof positive, without the slightest shadow of evasiveness, of what Mr. Bennett's evidence was intended to mean at the time it was given, and make quite clear the answers 5,041, 5,042, 5,043, 5,044, 5,045, 5,046, 5,047, etc.

It is perfectly evident from the answers at the enquiry that Mr. Bennett never intended to put forward this estimate as an estimate for a scheme he would suggest, and that it had not, and has not, the remotest connection with the scheme he carried out; hence the oft-repeated comparisons "cost of work" with cost as shown by this estimate are wholly misleading. After this controversy, and a further careful reading of the evidence if the comparisons are persisted in, I shall say, and say much more emphatically than will be good for the repute of those who persist in the comparison, that the comparison is not from ignorance of the truth, not from misinterpretation, but from a wilful desire to foist a lying tale upon an ignorant public.

I am sorry, Sir, that I find it necessary, in scotching this mistake, to consider shortly the "contra" items of Mr. Webb's letter.

1. Mr. Bennett never said, never suggested his estimate was for an *identical* system to the "then existing system." He took an equivalent in instruments, but connected them up in a better way, giving a benefit to the cost of the existing system. As I read it, his evidence was to the effect: "Here is what you have now got in Glasgow. I can give you the same result—aye, a better result—for £97,833. 3s. 8d. My estimate to obtain this result is practical, and here are reputable firms to carry it out if asked to do so, so that there cannot be much mistake in the figures. It will work, work well, better than the existing system, that I maintain." What was this evidence for? I don't know, but I can give a pretty shrewd guess. Not "identical," please, Mr. Webb, but "equivalent." Thus Contra No. 1 goes.

2. Contra No. 2 goes as No. 1. Mr. Bennett's evidence is to the effect, not only equivalent, but better; hence more of the things mentioned.

3. In the paper quoted Mr. Bennett was discussing Continental experience, and upon that founded an argument as to what the cost should be at such places as Glasgow, Liverpool, and Manchester. Nothing to do with estimate 1897. So Contra 3 goes.

Contras 4 and 5. Nothing to do with the matter.

Contra 6, again to effect: Yes, if we want an equivalent, there is the estimate and the cost. Mr. Jameson's report explains this, and proves that my contention is the true one. I have quoted his remarks (p. 308, Aug. 26).

Contras 7, 8, 9, 10, 11, 12, and 13 are merely incidental to an examination on the practicality of the equivalent estimate. How on earth could an examination take place, except to assume that the estimate might be put to practical use? Sinclair and Webb would argue the scheme must be a failure. Bennett and his side would maintain the contrary. All these go because Bennett merely said, "Here's a workable scheme for an equivalent, or something better, if that's all you want; but it is *not* my scheme."

Contra 14. The accuracy has not been questioned yet, only its accuracy when applied to something else.

Contra 15. Bennett has explained again and again that while he holds to the accuracy of his estimate at the enquiry, when Glasgow really made a start it wanted something different. I cannot give the date when Glasgow decided to have a completed and far different scheme to the mere equivalent, probably after the report mentioned.

Contra 16. Very probably. Mr. Bennett has his fads, one of which is around £20. He may be right, or he may be wrong, but that has nothing to do with what the estimate at the enquiry was intended to be.

Thank goodness, Mr. Webb's amusement is nothing to that he causes in telephonic circles. He fails to see that he is the culprit who perpetrates the absurdity. He compares an estimate for one thing with the cost of another, and damnifies Bennett accordingly. He fails to distinguish between a similar or an equivalent, and interprets these words as identical. He won't even have approximate, or allow that such a system means aught but an identical system, though the enquiry shows conclusively that Bennett estimated to arrive at the same ends by modified means.

I have done. I am quite willing to leave the conclusion in the hands of the reader.—W. O. T.

ERRATA.

SIR,—Allow me to call attention to two mistakes which occurred in my answer to "E. S. C.'s" question *re* dynamo test. Page 33, line 9, should read:

$$-\frac{d\,E}{dt} = \frac{d\left(\frac{S^2}{2} \times I\right)}{dt} = \text{etc.}$$

The twelfth line and following on the same page should run: "$I\left(\frac{\pi}{30}\right)^2$ is a constant value for any particular machine. The expression $n\frac{dn}{dt}$ represents the subnormal of the n/t curve."—Yours, etc., R. E. C. IHLEE.

WIRE STRIPPING.

SIR,—Can you or any of your readers inform me, through the columns of your paper, of a tool which will remove a small portion of the cotton covering on electrical wires and at the same time clean the exposed wire preparatory to

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soldering it to a metal connection? I am employed in a large electrical engineers' works, and am anxious to find out a quicker way of cleaning wires than by using a knife to scrape off the cotton and then a small piece of emery cloth to brighten the exposed surface. A tool or power-driven appliance to do this work would save much time if it were used to clean the ends of armature coil sections during the operation of coupling the same to the commutator.—Yours, etc.,

OWEN L ILBERT.

28B, Mildmay-road, Chelmsford, Sept. 14, 1904.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

VII.—On Going Teaching.

My Dear Young 'Un.—Your last letter betrays the influence which I have been trying to warn you against—perhaps the only bad effect of College life—the aversion to "roughing it." In your case the temptation has presented itself in a very alluring form. You have shown yourself remarkably clever at book work (I had no idea you had it in you). Your Professor is very pleased with you, and has offered you a job as junior demonstrator with opportunity for research. Oughtn't you to take it, and go in for a scientific career?

Now, before answering you directly, it is necessary to say that if some fellows didn't accept such offers there would be fewer technological teachers. Particularly at present there is a demand for men of your type to bridge the gap between primary education and the University College standard. If this is the work that is going to make you satisfied with yourself throughout life, you had better close with the offer. Only you should know what you are going for.

Firstly, your capabilities will be limited. You will have no adequate means of expressing your ideas in practical form. You will be unable to use your hands; you will have no knowledge of practical considerations of economy in machine processes. You will, therefore, be dependent on someone else to bring your ideas to fruition. And experience shows that the money goes to the man who *does*, rather than to the man who *thinks* about doing it. Plenty of machinists make a fat little living out of putting scraps of iron and gunmetal together to the instruction of some inventive genius who can't use his hands. Usually the machinist buys some houses and lives on the rents. The inventor gets a jerry tailor to turn his year-before-last coat outside in—because he likes the pattern so much, you understand, not because it was getting green and greasy.

Secondly, you will be poor. Teaching ought to be paid well, but it isn't. I knew a poor beggar who was a D.Sc., a Ph.D., and various other letters of the alphabet—a man who had discovered six or seven organic compounds with names as long as the faces of the chaps who tried to read them; a savant who wrote learned articles in the scientific papers at about 1½d. a line. Well, that man started teaching at a University College at £100 a year, and in the course of five years he had reached £150! And he had learnt to do without talking about the glorious mission of educating The Young. He knew The Young, and cursed them with all the curses he had learnt at Cambridge and Leipsic. He was careful to point out, when any bold man interrogated him as to why he continued to live, that what he was really hanging around for was a Professorship. A Professor gets anything from £250 to £1,000 a year, and becomes so absorbed in administrative duties that he relegates most of the teaching to his lecturers (at £150). Now, this man had worked out a calculation, and had found that his chance of becoming a Professor was 0·006 in a hundred. The last time I heard of him he was getting discouraged, and was trying to save enough money to go to Monte Carlo and either break the bank or shoot himself.

In the third place, colleges are getting more exacting in their requirements as time goes on. Here are some extracts from the specification of a lectureship in electrical engineering according to modern standards. The lecturer would receive £200 a year, which is a large-sized plum in teaching. Consequently half the teachers in the kingdom would rush at it.

"... He will be required to teach in the electrical engineering classes, ... and perform such other duties as may be assigned from time to time in connection with the work of the department." That is, to rig up apparatus for popular lectures—possibly give one himself gratis if he is big enough; also to enrol students, give free consultative opinions to research students, and so on.

"... The standard of teaching must be equal to that of a University College." Engineering calculus, a hash of the latest articles in the English, German, and French technical papers, and second-hand dynamo design.

"... Candidates should possess workshop experience, and should have received a sound scientific and laboratory training of at least three years in some institution of University rank. Previous teaching experience is essential." So if you went demonstrating now, without getting some workshop practice, you would be barred from this plum of £200.

"Research will be encouraged, and reasonable facilities will be given for it. No outside work may be taken without the permission of the principal. The work will be partly evening class work and partly daywork. The engagement will be terminable by one month's notice on either side, to expire at any time."

My dear fellow, you can do better than this in practice. Even if you don't like dirty work, you can get into an engineering office and play about with drawings and schedules to your heart's content. Remember that although a million people a month can pass a given railway signal box without overcrowding the trains, there is only room for one signalman in the box. If you are a teacher, you will only act as the signalman for the surge of engineers that will pass you by. And it is only so long as the surge continues that your position will be of any value.—Yours,

THE OLD 'UN.

STEAM TRIALS ON WILLANS CONSTANT-THRUST ENGINES AT THE POPLAR AND THE BLACKBURN ELECTRICITY WORKS.

On April 6 steam trials were made at the Poplar electricity works, where Mr. P. N. Hooper is the chief electrical engineer, on one of the 500-kw. Willans engines recently installed, with a view of ascertaining the commercial efficiency of the Willans-Mather and Platt steam sets under working conditions. The trials were carried out under the supervision of Mr. Hooper by representatives of Messrs. Willans and Robinson and Messrs. Mather and Platt, and are of considerable interest at the present time, as showing the results obtainable with this type of engine under working conditions with only a moderate amount of superheat and with a comparatively poor vacuum. It will be noticed in Table A that at full load with a vacuum of 25in. in the engine, and with 25deg. of superheat only, a total steam consumption of 18·64lb. per kilowatt was obtained on one trial and 19·52lb. of steam per kilowatt on a second trial. This means that the mean of the two trials was about 19lb. of steam per kilowatt, or about 11½lb. of steam per indicated horse-power. It will be conceded that these results are very good considering the conditions. It is unnecessary to emphasise the fact that with higher degrees of superheat the steam consumption would have been considerably lower, as this engine benefits to an abnormal extent by the addition of superheated steam. The exhaust steam from the engines was collected and condensed in a tank mounted on a weighbridge, which was measured at definite periods. The electrical instruments recording the output of the dynamo were of the Western standard type, and were calibrated by an independent authority after the tests. The results in the tables herewith are corrected to allow for an error in the instruments, which were found on calibration to be reading rather high.

On May 14, 1904, similar tests were carried out at the Blackburn Corporation electricity works, where Mr. A. S. Giles is the chief electrical engineer. The tests were made with a view of ascertaining the commercial efficiency of the 750-kw. Willans steam dynamos recently installed in conjunction with Dick, Kerr, and Co.'s 10-pole continuous machine, giving an output of approximately 1,600 amperes

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at 500 volts when running at a speed of 180 revolutions per minute. The trial under consideration at the present time was made on engine 3,416 by representatives of Messrs. Willans and Robinson and Messrs. Dick, Kerr, and Co., under the direct supervision of Mr. Giles. The steam consumption results, which are given in Table B, are the mean results of three separate trials, which, considering the poor vacuum prevailing—viz., 22in.—and the moderate degree of superheat — viz., 112deg. F. — the results obtained—viz, 18 34lb. per kilowatt, say 11·05lb. per indicated horse-power—are distinctly good. The steam consumption was obtained by measuring the water into the boilers, the tank used, which belonged to the station, being calibrated before the trial against a properly calibrated tank. The instruments were of the Western type, calibrated against standards before and after the trial. At the present time engineers are chiefly interesting themselves to a considerable extent in results which are being promised with steam-turbines, and consequently the two results given will be of interest as showing what is possible with reciprocating engines, even in the smaller sizes.

TABLE A.—Poplar Trials.

—	Steam pressure in Boiler.	Steam pressure in Steam chest.	Temp. in steam chest. deg. F.	Degree of superheat. deg. F.	Vacuum in engine. In.	Speed R.P.M.	Output. I.H.P.	Output. E.H.P.	Output. Kw.
Full load.	130	165	398	25·1	25	260·5	825·8	672·6	501
¾ load ..	130	133	408	51	25	266	653·2	512	381
½ load ...	130	88	402	72	26	272	458·2	338	252

	Guaranteed lbs.	Full load. 1st trial. Obtained lbs.	Full load. 2nd trial. Obtained lbs.	¾ load. Obtained lbs	½ load. Obtained lbs.
Water per I.H.P.	— ...	11·33 ..	11·80 ...	12·1 ...	12·49
,, E.H.P.	16 ...	13·90 ...	14·56 ...	15·46 ...	16·86
,, Kw....	— ...	18·64 ...	19·52 ...	20·72 ...	22·63

TABLE B.—Blackburn Trials.

Lbs. steam pressure in boilers.	Temperature of steam in deg. F. at Boiler pressure.	Temperature of steam in deg. F. at Stop-valve.	Degrees of superheat in deg. F.	Vacuum (inches)	Mean kw.	Water per I.H.P.	Water per E.H.P.	Water per Kw.
179·6	379	491	112	22	775·2	11·05	13·7	18·3

JUNIOR INSTITUTION OF ENGINEERS.

Summer Meeting in Germany.

Perhaps the decision that Germany should be the location of the present summer meeting of this vigorous and useful society may have been regarded by some of its many friends as of too ambitious a character, but the great success of the gathering has justified in a most ample manner the council's selection of the rendezvous. They had, no doubt, counted upon a warm welcome from the German engineers. It was unmistakably so, the members being received with the greatest kindness throughout the extensive tour, which included Düsseldorf, Oberhausen, Benrath, Elberfeld, Hanover, Berlin, Mariendorf, Charlottenburg, Leipsic, Frankfort-on-Maine, Hanau, Homburg, and the Rhine.

The proceedings opened on Aug. 13, when, in the evening, at the fine municipal concert hall at Düsseldorf, the civic authorities tendered greetings on the institution's first entrance to the Fatherland. Associated in the ceremony as hosts were the Institution of German Ironfounders, the Lower Rhine District Association of German Engineers, and the Düsseldorf Institution of Architects and Engineers. Mr. Samuel Cutler, jun., M.I.M.E, the Junior Engineers' genial chairman on this occasion and at other times, gave fluent utterance in the Teutonic tongue to the institution's acknowledgements, as did also Mr. F. R. Durham, A.M.I.E.E., of Frankfort-on-Maine, the indefatigable hon. secretary of the meeting.

The following day was spent in an inspection of the Düsseldorf Exhibition, under the guidance of Mr. Emile Hess, its engineering features, of course, receiving special attention. Next morning an early train was taken for Oberhausen, where are situated the great iron, steel, and engineering works of the Gutehoffnungshutte. Two divisions were formed for visiting them, one proceeding to the blast furnaces, steelworks, rolling mills, etc., the other to the steel, iron, and metal foundries, engine and bridge works, etc. There appeared to be plenty of work under execution, and an extensive addition to the rolling mill was in course of building. After being entertained to luncheon in the works' clubhouse, the members went on to the Benrather Crane Works, which is one of the largest of its kind in Europe and has attained such a well-merited reputation for the excellence of its products. Both steam and electricity are employed as motive power. The methods of testing the various parts, systems of erection, and other details were fully explained to the visitors.

On leaving Düsseldorf the party made for Elberfeld for the purpose of seeing the Langen Monorail Suspended Electric Railway, which presents so many novel points of engineering interest. In this system the carriages are hung and travel from an overhead rail, which may be fixed at any level above ground, or may be carried along the roof of a brick tunnel or iron tube. Another example occurs at Loschwitz, near Dresden. The Elberfeld line has a length of 8¼ miles, and has been in operation since March, 1901. It now carries about 10 million passengers per annum. Under the guidance of the engineers a complete inspection of the line was made, including car-sheds, power-house (current is supplied from the municipal works), stations, etc.

In the afternoon the members arrived at Hanover, where on the next day the first visit was to Messrs. Korting Bros.' works, erected in the year 1871, and now giving employment to 2,500 hands. The chief products are gas-engines, appliances for steam users and manufacturers, pumps, boilers for steam and water heating, radiators, etc. Some special experiments with Korting injectors, steam-jet elevators, condensers, blowers, pulsators, etc., were carried out. The Korting ejector condenser is well known in England, over 50 electric light and power stations being fitted with it. An interesting application of the spray nozzle was illustrated as it would be employed in cooling condenser water. It was also applicable to laying dust in colliery workings, purifying air of public buildings, damping tobacco, etc, cleaning blast and producer gases. Some powerful gas-engines were seen in the erecting shop, both of the Otto and the Clerk cycle. The former are built up to 200 h.p. in one cylinder and the latter single-acting up to 300 h.p., or double-acting up to 1,500 h.p. in one cylinder. The largest installation (40,000 h.p.) of the Korting double-acting Clerk cycle engine is at the Lackawanna Steelworks. The importance of the heating engineering department of Messrs. Korting may be gathered from the fact that annually 5,500 tons of castings, 1,500 tons of wrought-iron tubes, and 33,000 valves are made use of. Hospitable entertainment followed the visit, and the Hanover Engine Works were then inspected. These were founded in 1835, and have developed to such an extent that about 2,000 workmen are now employed. The manufacture of locomotives forms the principal work carried on, that department having been started in 1846. The total output to date has been close on 4,300, and 40 engines can be fitted up simultaneously. The electric central station, with engines of 1,500 i.h.p., attracted special attention, and various processes with heavy tools, etc., were arranged to be going on during the members' tour of the works. The toast of the "Hannoversche Maschineban" having been observed on leaving, the members then made their way to the Westinghouse Brake Company's works, the construction and operation of the brake being fully explained with the aid of an experimental apparatus such as is installed at the London depôt, King's Cross. The Hanover Gasworks were then entered so that the Paris electro-turbine gas retort charging machine might be seen at work. The rapidity of its action was most striking, but as the machine has only just been introduced, it is not possible to give definite results of its working at Hanover for any length of time. In carriages which were kindly provided by Mr. L. Korting, the engineer of the works, and who, by the way, is president of the German Association of Gas and Water Engineers this year, the members then had a most enjoyable drive to Herrenhausen; the fountain display, a notable feature

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of the beautiful grounds, was seen. Mr. Korting also acted as cicerone to the members on the following morning, when the zoological gardens, provincial museum, and other places were visited. In the afternoon came the journey to Berlin, which was reached at about seven o'clock.

Friday morning was occupied by a most interesting visit to the Berlin electric overhead and underground railway and to the works of Messrs. Siemens and Halske. Assembling at the Potsdamer Platz Station of the railway, the party were met by the engineers and taken by train to the terminus of the line, Warschauer Brucke. The car depôt and workshops were shown, and after proceeding by rail from Schleischer Thor to Mockern Brucke, the members walked over the bridge to the power station of the railway. The plant here consists of three Borsig engines of 1,200 h.p. maximum, and an engine of 1,800 h.p. by the Gorlitzer Maschinenfabrik. The dynamos are directly coupled to the engines, and are shunt generators for 800 kw. at 750 volts, constructed by Siemens and Halske. After going through the junction triangle, the party took train again to the terminus of the line and at the Students' Union Club at Charlottenburg were entertained to luncheon by Messrs. Siemens and Halske, their works being visited in the afternoon. In the large machine shop of the works the preparation and mounting of the various parts of dynamos, motors, etc., was seen. Other shops were occupied with resistances, starting and regulating resistances, apparatus for lifts, and accessories for lifts and cranes, switchboards and switches, high-current apparatus, switches, cut-outs, and line articles. The manufacture of arc lamps was also shown, and in the testing-room a highly interesting collection of different types of lamps were seen running. The institution's summer dinner was successfully held in the evening at the Central Hotel, Berlin, the opportunity being taken for presenting to Mr. Durham a leather writing case suitably inscribed in expression of the members' appreciation of his valuable services as hon. secretary.

On the following day the Mariendorf gasworks of the Imperial Continental Gas Association were visited in the morning, and the Royal Technical High School at Charlottenburg in the afternoon. The gasworks are of the most modern description, and afforded the members an excellent example of the latest practice in that class of work, having been completed as recently as the autumn of 1901. Special features consist of the coal-handling plant, inclined retorts, coke-conveying machinery, naphthaline washer, cyanogen washer, overhead loading station for the tar, ammoniacal liquor, etc. A new holder was seen in course of erection by the Berlin Anhaltische Company. The whole of the side sheets are to be riveted by pneumatic riveters, air-compressing plant having been put down for the purpose. At the Charlottenburg School, where, unfortunately, there were no technical guides to show the members round, perhaps the most striking feature was the large laboratory containing representative gas, oil, and steam engines of every type, aggregating over 800 h.p., with corresponding boiler power, by means of which the students could test under actual working conditions every kind of motive-power plant. This visit concluded the programme of the first week.

On Monday afternoon, Aug. 22, the party left Berlin for Leipsic, remaining there till Wednesday, when they went on to Frankfort-on-Maine. On the invitation and under the guidance of Mr. W. H. Lindley, M.I.C.E., an English engineer who has achieved great distinction on the Continent, the water and electricity works at Frankfort and the sewage works at Hanau, all of which were designed and carried out by him, were inspected. The arrangements made for these visits were most excellent, and might well be followed in this country. Previous to the members going over each works Mr. Lindley, with the aid of diagrams and drawings, gave a general description in the form of a short lecture. Members were thus in possession of the general characteristics of the undertaking, and in a much better position for seeking any special information having reference to their own branch of work. A fact which may not generally be known, which was elicited in the course of the visit, is that to Mr. Lindley is really due the introduction into Germany of the Parsons steam-turbine of large power.

An excursion to Homburg took place on Friday afternoon, when the director of the baths conducted the members over the old and new buildings, where baths of every description are obtainable. The eight mineral springs were also seen, and the pumping plant for raising the water for use in the baths. On the historic Kurhaus terrace dinner was served in the evening, followed later by the fireworks of the annual summer festival. It was a delightful experience altogether. The next day the members travelled by train from Frankfort to Biebrich to join the Rhine express steamer for the trip to Bonn, and thence by train to Cologne, and so on to Flushing and England. It should be mentioned that two extra visits occurred, one at Berlin to Mr. W. Pittler's experimental works and the other to Messrs. Pittler's lathe works at Leipsic.

EAST HAM ELECTRICITY ACCOUNTS.

From the recently published accounts of the Urban District Council's electricity works herewith are given abstracts of the revenue account and balance sheet for the year ended March 31, 1904, also a statement of electricity generated, sold, etc. The capital expenditure to date amounted to £97,154.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	7,438	7	0
Distribution of electricity	350	9	7
Public lamps	984	18	7
Incandescent lamps for artisans' dwellings	7	3	5
Management	611	9	10
Rates, taxes, and insurance	388	7	3
Bad debts	121	3	7
Gross profit, carried to net revenue account	8,583	7	0
	£18,485	6	3

Cr. Income.	£	s.	d.
Sale of current	18,249	12	5
Miscellaneous receipts	235	13	10
	£18,485	6	3

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages	103,296	5	6
Sundry creditors	1,295	12	9
Loans repaid out of revenue, depreciation, etc.	6,650	16	6
Revenue account—balance	908	12	10
Cash due to bankers	4,069	18	9
	£116,221	6	4

Cr. Assets.	£	s.	d.
Capital outlay	97,153	19	11
Cash in bankers' hands	9,406	15	11
Sundry debtors	5,312	7	0
Insurance premium paid in advance	40	0	0
Stores on hand	4,303	3	6
Petty cash in hands of electrical engineer	5	0	0
	£116,221	6	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,988,553
Quantity sold	Private supply	457,210	1,774,163
	Public lighting	396,257	
	Traction	920,696	
Quantity used on works			69,717
Quantity unaccounted for			144,673
Total maximum supply demanded (kilowatts)			880

Number of public lamps: 171 arcs and 149 32-c.p. incandescents.

APPOINTMENTS VACANT.

Chief Assistant Engineer, Heston and Isleworth Urban District Council, £130 per annum, Sept. 24. See advertisement.

Clerk, Heston and Isleworth Urban District Council, £100 per annum, Sept. 24.

Various.—Meter Fixer and Motor Inspector, £2 per week; two Switchboard Attendants, £1. 10s. per week; Fitter and Engine Driver, £2 per week; Assistant Engine Driver, £1. 10s. per week; two Stokers, 7d. per hour; Arc Lamp Attendant, £1. 10s. per week; Assistant to above, 15s. per week. Heston and Isleworth Urban District Council, Sept. 24. See advertisement.

Draughtsman, Manchester district. See advertisement.

Estimating Assistant, North Country Cable Works. See advertisement.

Electrical Assistant, Canterbury. Wages, 25s. per week. Applications to Engineer, Electricity Works, by 16th inst.

Chief Engineer and Manager, Southwark.

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TRADE NOTICES AND NOVELTIES.

Wirt Rheostats.

Of the divers types of dynamo field and other rheostats now on the market, that bearing the name "Wirt" ranks high for ingenuity of design and reliability in working. It is one of the many useful devices for which we are, in the first place, indebted to American inventive genius. Referring to the first of the accompanying illustrations, it will be seen that the resistance material is employed in the form of a continuous ribbon, wound without break or joint into the desired number of steps. This ribbon is tapered in such a manner as to give the proper ampere capacity at each point, while still maintaining the continuity, whereby the necessity of introducing a twisted or soldered joint at every step where it is desired to change the size of the ribbon or resistance wire is entirely obviated. The resistance coils make direct contact with the commutator bars, the area of such contact being very great and absolutely positive. Moreover, the commutator bars are graded so that each bar has an area of contact with its corresponding coil, varying in proportion to the current to be carried. Mica is used exclusively as insulation. The resistance coils, with their accompanying commutator bars and mica discs, are placed between two metal plates, the back one of pressed steel, the front one of cast iron. These plates are held firmly together by means of a steel rim-band. Thus the resistance ribbon lies flat against the radiating plates, the only intervening substance being a thin sheet of insulating mica. This construction permits the heat to be most readily conducted to the external surface, and thence dissipated. The result is that the resistance material always runs comparatively cool, a condition which best fortifies it against injury in case of an accidental overload. Besides, the method of distributing the heat by tapering the resistance and grading the steps enables each plate to work at its maximum efficiency, and therefore permits a heavier load for the size of the plate than is possible under any other condition. The graded commutator bars, extended radially, are exposed at the inner end for contact with the switch. They are trued up at this end by mean of a centre porcelain disc, which ensures a smooth commutator for the switch to pass over. The switch itself, of spring phosphor bronze, makes connection with the centre ring and the commutator section upon which it is placed. This avoids passing current through the bearings. Fig. 2 herewith will serve as an aid to the above description, and at the same time speak for the compactness of the complete apparatus. Apart from field rheostats, the same principle has been applied with equal success for theatre dimmers, speed controllers, etc. It remains to add, in conclusion, that Messrs. J. Defries and Sons, Limited, 146 and 147, Houndsditch, London, E.C., are the sole licensees and makers of the apparatus in this country.

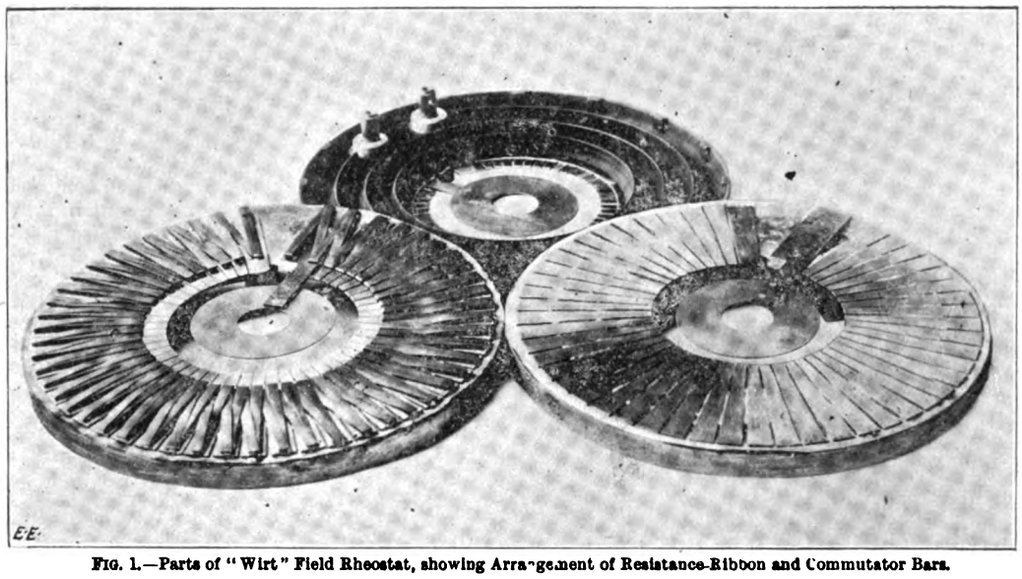

FIG. 1.—Parts of "Wirt" Field Rheostat, showing Arrangement of Resistance-Ribbon and Commutator Bars.

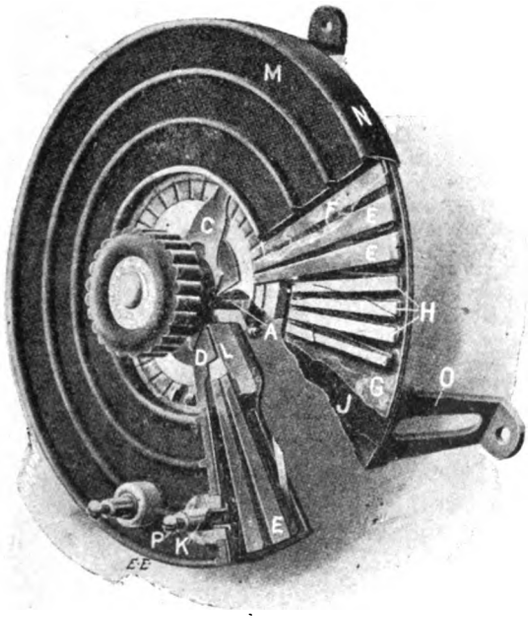

FIG. 2.—"Wirt" Field Rheostat. C, Switch Blade; D, Centre Contact, in one piece and rivetted to binding post K; F and G, Mica Insulation; J, Case Plate; H, Resistance Ribbon; L, Porcelain Block: N, Rim-Band.

The Ondograph.

We are indebted to the British Thomson-Houston Company, Limited, Rugby, for the following description of a new recording instrument which they are introducing, called the ondograph. This instrument has been designed for service in the study of alternating-current phenomena, and will register waves directly upon a sheet of paper within the space of half a minute. In principle the instrument is based, to a large extent, upon the well-known Joubert method of plotting alternating-current waves by means of a momentary contact obtained by a revolving commutator. A clear idea of the principle on which the ondograph works will be gained from a study of the accompanying illustrations, Figs. 1 and 2. A synchronous motor of the alternating-current type is operated from a source of current the wave of which it is desired to take. The motor is provided with gearing which operates a revolving commutator, the speed of which is so regulated that while the motor makes a certain number of revolutions the commutator makes a like number increased or diminished by unity. The motor in this case makes 1,000 revolutions while the commutator makes 999, thus causing the instrument to indicate a complete wave at every 1,000 revolutions. The commutator is used for the purpose of making automatic connections with the condenser and the galvanometer. It consists of an ebonite cylinder carrying a

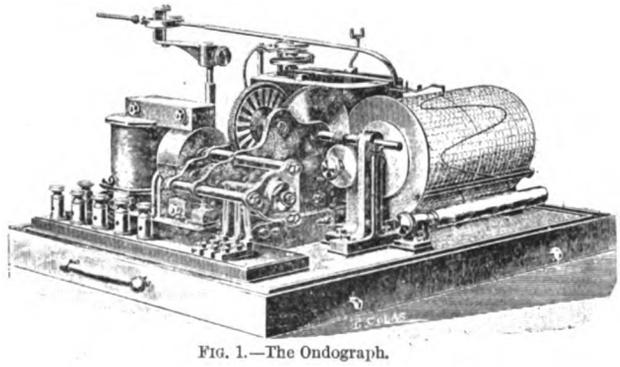

FIG. 1.—The Ondograph.

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brass tube cut out in the form shown in Fig. 3, and has three brushes bearing against it. The brushes are connected with the condenser, C, and a galvanometer, I, while at A are the main terminals of the circuit whose wave is to be taken. M is the metallic part of the commutator. As the commutator revolves the condenser is first put on the main circuit for an instant, then the condenser terminals are connected for a like period with the galvanometer, and the latter thus receives the discharges of the condenser and indicates the voltage at which the condenser has been charged. As this voltage increases and diminishes throughout the 1,000 revolutions, the galvanometer needle swings slowly back and forth and shows the voltage variations corresponding with a complete cycle. By changing the capacity of the condenser the sensitiveness of the indicator

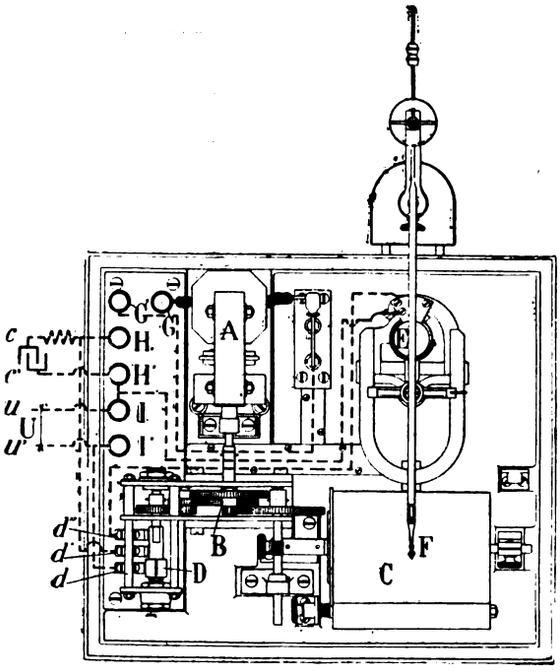


FIG. 2.—Plan of Ondograph.

can be regulated. In Fig. 2, G G′ represents the terminals of the motor, which also receives the current of the main circuit, and works at 110 volts, the latter being obtained, if necessary, by a regulating transformer. The terminals, H H′, are connected to the condenser, *c c′*, through a resistance which is sufficient to avoid sparks at the charging brushes. I I′ are the terminals of the main circuit which receives the voltage, U, to be taken. The synchronous motor makes a number of revolutions per minute which correspond to one-half of the frequency of the main circuit. At D is the commutator with its three brushes, *d d′ d″*. The indicating instrument for voltage or current wave is a galvanometer with a permanent magnet and rectangular current coil of fine wire mounted between the poles. The movable part, E, receives the discharges of the condenser in rapid succession, and turns slowly from one side to the other, passing through the zero position. The movable part operates a long needle which carries a pen, F, which swings to and fro, tracing the curve upon a revolving cylinder. The needle is not mounted directly upon the coil of the galvanometer, but, in order to use as long a needle as possible, and thus make it move nearly in a straight line, it has its pivot fixed considerably in the rear, while the coil has a short arm which works the needle by a projection passing in a slot. The record is made upon a sheet of paper which is rolled upon the revolving

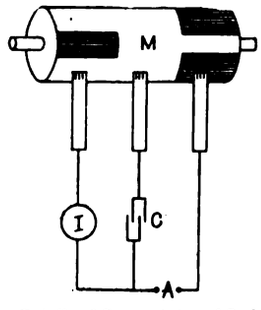
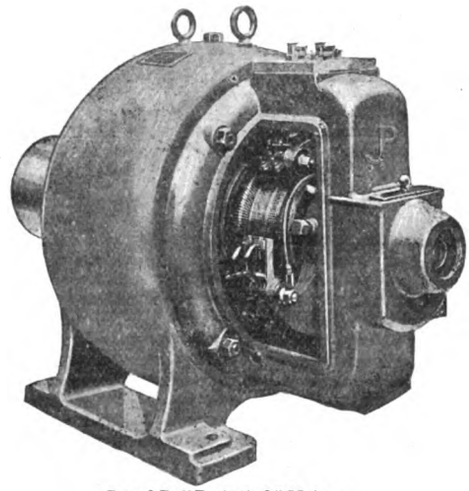


FIG. 3.—Details of Commutator of Ondograph.

cylinder. The cylinder is operated by the synchronous motor, by gearing, at a speed which makes it register three complete waves upon its circumference. The ondograph is the first instrument by which watt curves can be registered directly. For this purpose the permanent magnet form is replaced by a wattmeter carrying a set of fixed coils, which act upon a swinging armature of fine-wire coil. The current traverses the fixed coils continuously, while the movable coil is placed in the voltage circuit. The regulation is carried out by an ohmic resistance, which is placed in the circuit of the movable coils. The Thomson meter is found to be the most satisfactory form of wattmeter for this purpose. Two spiral springs for carrying the current are attached to the armature shaft, and therefore no brushes are used. The main current passes through the fixed coils, and the movable coil is actuated once every period for a short time with the voltage circuit. For use with the wattmeter the revolving commutator is reduced to a simple strip placed along the ebonite cylinder, which closes the circuit through the movable coils once every revolution. Under the influence of the successive impulses in the movable coils, it reacts upon the fixed coils, and takes an angle which corresponds to the power at each instant of the period, and therefore traces the watt curve directly upon the paper. The ondograph may also be used to study continuous currents. To accomplish this the synchronous motor is replaced by a direct drive effected by establishing an unyielding mechanical coupling between the ondograph and the shaft of the machine to be studied. The instrument has been specially designed with a view to facilitating the removal and replacement of the motor. The application of the instrument is not limited to periodic phenomena. It can be extended to all phenomena of short duration, provided that the phenomenon can be reproduced to such a manner that it is periodic by repetition.

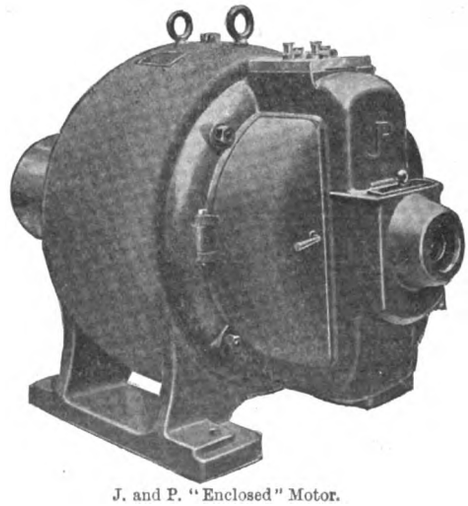
J. and P. Electric Motors.

Messrs. Johnson and Phillips, Old Charlton, Kent, have recently issued a revised price-list of their direct-current electric motors. These motors, we are told, are designed on a uniform plan, from ¼ h.p. up to 100 h.p., with their speeds properly



J. and P. "Protected" Motor.

graded according to the horse-power, and as dictated by the most advanced theoretical and practical considerations. They are made to the standards issued by the Engineering Standards Committee in four classes — viz., "Open," "Protected," "Ventilated," and "Enclosed." A specification applying to



J. and P. "Enclosed" Motor.

all J. and P. direct-current motors is included in the list, the many excellent features of their design being fully enumerated therein. As regards the outward appearance of these motors, we may leave the accompanying illustrations of the "Protected" and "Enclosed" classes respectively to speak for themselves.

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DUBLIN ELECTRICITY WORKS.

The following is a report by Mr. Hammond, the consulting engineer for the new Dublin electricity station, upon the working of the same for the past 12 months. The report is dated Aug. 25 last, and addressed to the town clerk:

DEAR SIR,—The agreement entered into with me by the City Council for the supervision of the operations of their electric supply undertaking for a period of 12 months came to an end on the 31st ult. I am glad to feel at the conclusion of the 12 months that the work therounder has proved so successful, and that, since the staff settled down to their duties, there has not been a single cessation of the city lighting. It has been a great satisfaction to me to have had so excellent an opportunity of demonstrating the practicability of the new system, which, at its inception, was so derided. I do not desire to minimise the boldness which characterised the Dublin Corporation in their adoption of my recommendation of a system of electrical distribution which had never before been attempted in the United Kingdom, and the members of the City Council will, I am sure, share my pleasure in reporting that in the actual working of the new system there has not been a single hitch, and it has proved simple, flexible, safe, reliable, and economical. In relinquishing the task of supervision, it occurs to me that the Corporation may desire to receive from me a short report of my stewardship. The Council passed the resolution conferring the appointment upon me on July 29, 1903. On the following day I started the work thereunder, and since that date either I or other members of my firm have been in regular attendance in Dublin.

Staff.—The first matter to which I had to devote my attention was the appointment and organisation of the technical and general staff for working the new undertaking, which demanded mature consideration. On Sept. 6, 1903, I was able to submit to the Lighting Committee a schedule of the first appointments grouped under the following heads: (*a*) generating department; (*b*) distributing department—(1) Fleet-street station, (2) distributing system; (*c*) public lighting; (*d*) office staff. It will be remembered that prior to entering into the agreement to supervise the working of the undertaking for 12 months I made it a *sine qua non* that I should be absolutely unfettered in the choice of staff, with power to appoint and to dismiss. That power was conceded to me by the Council, after a pledge on my part to give preference to Irishmen wherever possible. I have to report that at the outset I took over the whole of the old staff. Obviously, however, this staff was not numerous enough for the greatly enlarged undertaking. A word here may be acceptable as to the work to be performed by the staff. The electrical energy is generated at Pigeon House, and it is thence transported by three trunk mains to Fleet-street, whence it is distributed to the various sub-stations throughout the city. At the sub-stations it is transformed "automatically" from high pressure to low pressure without the use of any moving machinery. From the sub-stations it is distributed throughout the streets in the new area of supply—namely, the area outside that in which the supply was formerly given from the Fleet-street works. At Fleet-street a portion of the Pigeon House current is used for driving machines which feed the arc lights, which can, therefore, be turned on and off at Fleet-street. It will be seen, therefore, that provision had to be made first for a staff to run the much larger generating works at Pigeon House, involving three shifts of men and electricians-in-charge, each working eight hours. Then provision had to be made for the operations at Fleet-street, also involving three shifts of men and their electricians-in-charge. Then the 20 sub-stations had to be regularly inspected and a staff arranged for taking charge of the distributing mains and making connections to new consumers all clamouring to be first served. In addition, the 488 arc lamps had to be carboned regularly. It will be seen, therefore, that I had placed upon me an onerous task in the selection of the new men. Needless to say that I bore in mind my pledge to the Council, and, in this connection, I desire to set forth an extract from my report to the Lighting Committee of April 30, 1904:

"It has been stated, much to my surprise, that the new appointments have been given to Englishmen in preference to Irishmen, and I desire to take this opportunity, therefore, of saying that such statements are absolutely unfounded. As a matter of fact the reverse has been the case, and in making the appointments, where the necessary qualifications for the posts were assured, preference has been given in every case to Irishmen. Apart from the old staff, all the members of which were taken over, some 16 new appointments have been made on the engineering staff, of which 14 were given to Irishmen and two to Englishmen. The two exceptions were the cases of the distributing engineer, in which the committee themselves considered that it was of great importance to appoint the gentleman who had had all the experience of superintending the laying of the mains, and of the works superintendent at Pigeon House, in which case special experience with large plants on polyphase systems was an indispensable condition. All the other appointments are now filled by Irishmen and by the old staff. The statement to which I have referred caused me great personal disappointment, as it had been a source of gratification to me that I had been able to bring back from England and Scotland several young Irishmen, and most of them Dublin men, who, having obtained sound experience across the water, were glad to have the opportunity of taking an appointment in their native country."

When the staff was finally selected for the respective duties, I notified all the members that the arrangements which were then made were of a provisional nature, and that their positions and ultimate remunerations would be taken into consideration after experience had been obtained of the manner in which their duties were performed and of the value of their services to the undertaking. Accordingly, I, in due course, was able to make various rearrangements to add to the staff in certain directions as the different parts of the undertaking were taken over from the contractors. A full list of the complete staff, with the salaries fixed by me, has been recently handed by me to the Lighting Committee. The chief of the separate departments acting under the city electrical engineer are: office department — Mr. G. Archer, chief assistant; distributing system—Mr. E. A. Ellicott, distributing engineer; generating works—Mr. R. Knowles, works superintendent. Upon these gentlemen a large responsibility rests, and I consider that they are entitled to high commendation for the excellent way in which their departments have been controlled, especially during the period when they were deprived of Mr. Ruddle's guidance by his absence through illness. I must pay a special tribute to the efficient manner in which Mr. Archer managed the undertaking as Mr. Ruddle's deputy. I desire also to add a word in favour of Mr. Chas. Clancy, the assistant distributing engineer, who, during Mr. Ellicott's illness, acted as the chief of the distributing system with conspicuous ability. Other members of the staff, too, have carried out their duties in a highly capable manner, and I am glad to be able to speak with satisfaction as to the smooth working of the whole of the staff.

Residential Quarters for Staff.—In order to assure the presence at the generating works at all hours of certain members of the staff, residential quarters have, with the kind assistance of the Improvements Committee, been provided at Pigeon House for a few of the men, and these have been readily taken up. It would be an advantage if still further accommodation in this direction could be provided, and I repeat the suggestion made in my report to the Lighting Committee of July 25 last, that negotiations towards this end be opened with the Improvement Committee, who have charge of the premises at Pigeon House.

Change-over of System.—After the appointment of the staff, the most pressing work was the arrangement for the changing over of the supply from the old Fleet-street works to the Pigeon House works. This was the rock upon which our critics urged that we should suffer shipwreck. The new system employs three-phase 5,000-volt feeders with 50 periods. The old one was single-phase 2,000-volt with 84 periods. Under the new scheme there are provided at Fleet-street transformers to reduce the 5,000 volts pressure to 2,000 volts, and these transformers under the new scheme take the place of the generators in the old. I am glad to be able to report that the change-over was most successfully effected on Sept. 20, 1903, without the slightest inconvenience to the consumers; indeed, with hardly a blink on the lights. Though the Fleet-street plant was kept as a stand-by for a short time, it was never once used.

Administrative Department and Consumers' Records.—On turning my attention to the internal organisation of the administrative department, at Fleet-street I found that a considerable alteration was necessary in the method of dealing with the technical records of consumers and their installations. At the time of my appointment the system of these records was not suited to the requirements of a large business, and I therefore considered it necessary to arrange a new plan of records for the undertaking on the card system, the most modern method of dealing with consumers and meter records, this being on similar lines to that which I have adopted with great success in other cases. I am glad to be able to report that it is working most successfully. The system which has been specially devised for Dublin, so as to suit the special tariff of charges and the three-phase system, embraces the following: consumers' index cards—an index for the complete system; meter-reading cards, upon which the meter readers record the registrations of the meters and indicators; consumers' ledger cards, upon which the details, technical and financial, of the consumers' quarterly accounts are set forth, these cards being regularly transmitted to the city accountant's department for the purpose of making-up the quarterly bills and for entering into the consumers' ledger; ledger cards (general charges) dealing with private works and small works executed by the department for consumers, etc., other than for electricity supplied; installation cards, upon which all the technical records of each consumer's installation, including tests, number of lamps, etc., are recorded; balancing

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cards for entering up the demands in each street so as to enable the engineer to preserve a good balance of the load on the mains; meter test-cards for recording particulars of each meter with results of its tests and its position from time to time on the circuits; demand indicator test-cards for exactly similar purposes to those of the meter test-cards; guide cards for the complete system by which the separate sections and classes are arranged for easy reference; cabinets embracing five special cabinets for filing the card records.

Supplies.—In systematising the purchase of supplies, I have, through the Supplies Committee, introduced the plan of inviting tenders to rigid specifications for coal, oil, and carbons with eminently satisfactory results, the recent contract for delivery of coal at the wharf at Pigeon House to my specification being made at the favourable rate of 9s. 2d. per ton. The tenders for machinery oils have also been productive of significant figures, with the result that first-rate oils will be obtainable under my specification at considerably lower prices than those which have hitherto been paid by the department.

General Management of Undertaking.—The arrangements for dealing with existing and prospective consumers are, in my opinion, incompatible with the requirements of a large system of electric supply, and I feel that they could be vastly improved by centralising the authority for this branch of the business at Cork-hill. It would, I consider, be wise to centralise the entire responsibility of the business part of the undertaking upon the secretary to the committee instead of leaving it divided as at present, and to make the committee offices at Cork-hill the office of enquiry and reference, leaving the administration at Fleet-street to deal with the technical side of the undertaking. I think it might also be advisable that some arrangement should be adopted by which the accounts of the undertaking should be kept at the committee offices, so that easy reference could be made thereto, and the consumers saved the trouble and inconvenience which the present system entails.

Consumers.—The connecting on of new consumers has, under the new arrangements, proceeded smoothly and rapidly, the number having been considerably more than doubled within the first year. The following is a monthly record of the consumers for the past 12 months: July 1, 1903, 350 consumers; Aug. 1, 373; Sept. 1, 409; Oct. 1, 482; Nov. 1, 551; Dec. 1, 608; Jan. 1, 1904, 665; Feb. 1, 676; March 1, 708; April 1, 734; May 1, 754; June 1, 767; July 1, 790 consumers. At July 1, 1903, there were 35,791 lamps connected to the mains, at July 1, 1904, the number had increased to 68,322. Applications for supply still continue to come in steadily from ordinary consumers, and, in addition, the Lighting Committee are in negotiation for the supply of electricity to a number of the Government offices, several of the city hospitals, the Richmond District Lunatic Asylum, the North and South Dublin Unions, and other institutions.

Working Costs and Financial Results.—The accounts of the undertaking, which have recently been published, are made up to March 31 last, but as this period covered 3½ months running of the Fleet-street works alone, 2½ months of the Pigeon House works and the old works simultaneously, and only six months of the working of the new undertaking in the early portion of which the Fleet-street works were being kept as a stand-by, the results therein shown are no guide to what will be the result for future years. I am glad to report, however, that even for this period, with all the initial charges incidental to the starting of a large scheme, the cost of working was considerably reduced, the total amount, exclusive of the special fee paid to me under the supervision agreement, being 2·43d. per unit, as compared with 3·09d. per unit for the previous 12 months, and 3·75d. per unit for the year 1901-2. Notwithstanding adverse public criticism and the frequently-quoted report made by Mr. Ruddle in March, 1901, in which he stated that the average cost of production and distribution for the first seven years would be 2½d. per unit, I have no hesitation in stating that the operations of the new undertaking have convinced me of the soundness of the estimate made by me in my original report of the possibility of generating and delivering electrical energy in Dublin at a cost, exclusive of capital charges, of 1½d. per unit.

Now that the undertaking has been so well established, and is giving evidence of such success, I presume that it is unlikely that the Corporation would care to continue leaving the working of the undertaking in my hands. If, however, there be those who are persuaded by the pessimistic criticisms which are in some quarters still rife that the undertaking cannot be worked within the above-named estimate, I desire to state that I am prepared to submit to the Municipal Council the terms of an arrangement for taking control of the working operations, and assuring the Council for a period of seven years against a higher cost than the 1½d. per unit, my remuneration for my supervision and for my guarantee being the difference between 1½d. per unit and the lowest figure at which I may be able to generate and distribute, no special fee for my supervision or guarantee being paid to me at all. I can quite understand that such an offer may not commend itself to those councillors and ratepayers who have formed the idea that the capital expenditure has been out of all proportion to the extent of the undertaking, and that even if the electrical energy can be generated and distributed at 1½d. per unit, the interest and sinking fund charges upon the present capital and upon that which will be required from time to time as the business develops will far exceed the profit on working, and leave a heavy annual deficit to be borne by the ratepayers. Under these circumstances, and having regard to the other financial obligations which the progress of the city has placed upon them, the Municipal Council may feel inclined to enter into an agreement by which they would be relieved of the capital charges on the electricity undertaking for a period of years. In this event I shall be prepared, as an alternative offer to that named above, to place before them the terms of an arrangement for taking over the working of the entire undertaking for a period of not less than 14 years, and for substantially guaranteeing to the Council for that period the annual charges upon the loans raised or to be raised for the purposes of the undertaking, including the productive proportion of the Fleet-street works, the Clontarf scheme, and all extensions of the electric supply system. This arrangement would, of course, include a guarantee that the supply would be provided at rates to be mutually agreed upon, which would certainly not be higher than those at present in force. Under my first offer the Council would be relieved of all anxiety with regard to the working expenses. Under my second offer they would, by parting with the working of the undertaking for only a limited period, be relieved of all responsibility for the capital charges during the earlier years of the undertaking, while at the same time the citizens of Dublin would be assured of a supply of electricity at favourable prices. Whether, however, my offers be accepted or not, I am glad at the close of my 12 months' supervision to be able to hand over to the city a concern that has for many months past been performing its work most satisfactorily from the point of view of the consumer and of the general public. It is true that in my capacity of consulting engineer to the undertaking, it is my duty in certain directions to withhold certificates of satisfaction with some of the plant. The defects, however, have not interfered with the regular supply of electricity continuously for 24 hours per day, and my offers to work the concern are, perhaps, the best evidence which I can give of my conviction that in every direction the contracts arranged by me are sufficiently clear and stringent to obtain, at no extra expense to the city, plant in accordance with the best modern practice.

In conclusion, I have to record my thanks for the assistance which I have received from the chairman and members of the Lighting Committee, and from the officials of the Corporation.

PERSONAL.

Mr. A. E. le Rossignol has resigned his position as engineer and general manager of the Newcastle electric tramways for an important and lucrative appointment abroad.

The Aberdeen Council have increased by £25 the salary of Mr. D. Mooney, superintendent of the Corporation tramways.

LEGAL INTELLIGENCE.

THE SPEED OF TRAMCARS.

On Friday last, at Middlesbrough Police Court, a car driver in the employ of the Imperial Tramways Company, Limited, was charged with having driven a tramcar at a speed exceeding eight miles an hour. The town clerk prosecuted on behalf of the Corporation, and Mr. F. Rowlands defended. The case was heard on Aug. 26, and adjourned for the purpose of the Corporation producing other evidence, as reported in these columns.

Inspector Millstone and **Sergeant Blakeborough** (who used stop-watches) declared that defendant was travelling at a speed of over 16 miles an hour.

Defendant went into the box, and denied that he was travelling at an excessive speed.

A fine of £3, including costs, was imposed.

OVERCROWDING.

At Norwich Guildhall last week Robert Beaumont, a tram conductor in the employ of the Norwich Electric Tramways Company, was summoned at the instigation of the chief constable for allowing an excessive number of passengers. He was further summoned for allowing certain persons, not being officers or servants of the company, to ride on the car platform on the same date.

The chief constable appeared in support of the information; Mr. E. Reeve defended. Defendant pleaded not guilty to each offence.

It appeared that the company had communicated with the Corporation as to carring extra passengers upon special occasions, but had not received a reply. The traffic on the day in question was very heavy.

The **Chairman**, after consultation with his colleagues, said they must convict on each charge, but as there were exceptional circum-

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stances, only a nominal fine would be imposed. The company's officers had endeavoured to prevent overcrowding. A fine of 1s. in each case would be imposed and costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Tynemouth.—The Corporation invite tenders for a 600-kw. steam dynamo by Sept. 30. See advertisement.

Oviedo (Spain).—The Municipality require tenders for the public lighting of the town for 20 years. Tenders by Sept. 20.

Salford.—The Electricity Committee invite tenders for paper-insulated cables. Tenders to the Town Clerk by Oct. 6.

Madrid.—Tenders are required by the Municipality for a number of lamp-posts for one, three, and five lamps. Tenders by Sept. 21.

Arenas de San Pedro (Spain).—The Municipality require tenders for the electric lighting of the town for eight years. Tenders by Sept. 25.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

The Hague (Holland).—The Council of the Hague require tenders for the supply of from 8,000 to 9,000 tons of steel rails, including appurtenances, for electric tramways. Tenders by Sept. 2 .

Arenas de S. Pedro (Spain).—The municipality require tenders for electric lighting for eight years. One hundred 10-c.p. lamps are required for public lighting. Tenders by 25th inst. to above.

Edmonton.—The Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. Tenders by Sept. 27. See advertisement.

Ilford.—The Urban District Council invite tenders for the supply and erection of balancer and switchboard panel, and reversible traction booster and switchboard panel. Tenders by Oct. 4. See advertisement.

Belmez (Spain).—The Municipality require tenders for electric lighting of Belmez, Pueblo Nuevo del Terrible, and Pennarroya for seven years by Sept. 17. Particulars from the Alcadia Constitutional, Belmez, Cordoba, Spain.

Aberdeen.—The Tramways Committee invite tenders for the supply and delivery of 20 top-deck car-covers. Drawings and specifications may be had from Mr. J. Alex. Bell, city electrical engineer, Aberdeen. Tenders by Sept. 27. See advertisement.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Sofia.—The District Finance Commissioners require tenders for 50,000 km. 4mm. iron wire, 1 000 km. 2mm. iron wire, 15,000 Parphor insulators (No. 2), and 1,000 iron hooks (No. 2). Five per cent. guarantee required. Estimate. £1,175. Tenders by Sept. 25.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Philippopolis (Roumelia).—The Municipality requires tenders for a concession to construct and work electric lighting and tramways for 50 years. A guarantee of £6,000 is required. Tenders by Oct. 15. On the next day a second adjudication will take place in case there is an offer of £5 per cent. less per kilowatt-hour than the minimum.

Edinburgh.—Tenders will be received for the supply of 600 tons (more or less) of cable ropes, for the Edinburgh and District Tramways Company, Limited. Specification may be obtained of Mr. John E. Pitcairn, general manager, 1, South Charlotte-street, Edinburgh, and tenders must be lodged with him in accordance with specification by Sept. 19.

Tschatschak (Servia).—The Electricity Company Owtschar und Kablar in this town require two turbines of 750 h.p. each, two generators for three-phase currents, and other plant for the erection of a hydro-electric central station. and equipment of lines of distribution within 40 miles, by Oct. 2. Specifications, etc., may be obtained from the Manager of the Company.

Bangour (Scotland).—The Edinburgh District Lunacy Board invite tenders for (1) electric wiring and cables, (2) telephone installations, (3) electric bells, required in connection with certain buildings erected and to be erected at Bangour. Tenders to be lodged with Mr. And. Ferrier, clerk, Edinburgh District Lunacy Board, Castle-terrace, Edinburgh, by 28th inst.

India Office, S.W.—The Secretary of State for India in Council is prepared to receive tenders to supply (1) compressed paper blocks ; (2) carriage and wagon wheels and axles ; (3) electrical plant. The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office by 2 p.m. on 13th inst. for Nos. 1 and 2, and on 20th inst. for No. 3.

Ballinasloe (Ireland).—The Joint Committee of the District Asylum invite tenders for the supply and erection complete, with acid trays, spray arresters, insulators, etc., of a set of accumulators, consisting of 110 cells, having a capacity of not less than 342 ampere-hours, and a maximum discharge rate of not less than 60 amperes. Tenders, addressed to the Resident Medical Superintendent, Ballinasloe Asylum, to be left with Mr. James Young, clerk of asylum, by 17th inst.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

London, N.—The Edmonton Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. They are prepared to consider offers based upon certain alternative arrangements, particulars of which are set out in the form of tender. Particulars and form of tender may be obtained at the office of Mr. William Francis Payne, clerk, Town Hall, Edmonton. Tenders must be addressed to the Clerk, and delivered by 12 noon on Sept. 27.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Barking (Essex).—The Urban District Council invite tenders for the construction of light railways as follows: (Contract No. 1 and 1A) rails, fishplates, and bolts; (2 and 2A) permanent way construction); (3 and 3A) overhead line equipment; (4 and 4A) underground feeder cables, etc. Specification may be obtained of Mr. H. Hargreaves, clerk, Public Offices, Barking, Essex, on depositing a cheque for £5. 5s. Applicants to state the contract for which they propose tendering. Tenders to Chairman of the Electricity and Tramways Committee, Council Offices, Barking Town, by 12 noon on Sept. 20.

Shanghai.—The Board of Trade have received through the Foreign Office copy of a telegram from the British commercial agent in Shanghai to the effect that tenders are invited by the municipality of that city for the construction and working of 24 miles of electric tramways on the trolley system, double or single. Conditions of contract, together with plans, etc., may be seen on application to Messrs. Pook and Co., agents for the municipality of Shanghai, 63, Leadenhall-street, E.C., and such modifications of the conditions as may be necessary may be made by tenderers. Tenders must be sent in by March 31, 1905.

Australian Commonwealth.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart (Tasmania). until noon on Sept. 30, 1904, for the supply and delivery at the General Post Office, Hobart, of one multiple metallic branching switchboard. Specifications may be seen at, and tender forms and conditions obtained from, the General Post Offices at Hobart, Melbourne, Sydney, Adelaide, Brisbane, and Perth. Tenders should be endorsed "Tender for Switchboard," and addressed to the Deputy Postmaster-General, Hobart. Tenders may be deposited in the tender-box at the General Post Office, Hobart, or, if sent by post, must be prepaid and registered. Tenderers must state the name of the country in which the switchboard will be manufactured.

London, S.W.—The London County Council require tenders for the manufacture, delivery, and erection at the Council's tramways electricity generating station at Greenwich of two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in artesian well pump, fixed and rotary strainers, etc. Persons desiring to submit tenders may inspect the drawings and obtain the specifications, bills of quantities, form of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the Cashier to the Council of £2 deposit. Tenders to be addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Pumping Plant." No tender will be received after 10 a.m. on Oct. 4.

Madrid.—The call for tenders for the service of the electric lighting of Pueblo Nueva del Terrible and Penarroya was without result. The conditions of tender have therefore been modified in certain respects, and a new adjudication is announced to take place on Sept. 18. Tenders are also required for the supply of 25,000 porcelain telegraph insulators, No. 1 of the Spanish type. Tenders, which must be accompanied by a proof that 5 per cent. of the amount has been deposited, will be received at the office of the Direction General of Posts and Telegraphs, No. 10, Carretas, 2° Madrid, up to Sept. 16. The *Gacetas* containing the above notices may be seen by persons interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

RESULTS OF TENDERS.

Hove.—The Council have accepted the tender of the St Helens Cable Company for the supply, delivery, and laying of low-tension cables, conduits, boards, and meters for £7,113. 8s. 8d.

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Burnley.—The Electricity Committee have accepted the tender of Messrs. Korting Bros., at £145, for supply and erection of pipes and valves required in connection with the extension at the electricity works.

Llandilo.—Tenders for carrying on the electric lighting of the town have been received from Messrs. B. Thomas, whose present tender is about to expire; A. Mayberry, Llanelly; and J. Bowen, Llandrindod.

Ipswich.—The Guardians have received the following tenders for an extension of the electric light installation at the offices:

Collum and Co.	£13	10	0
Hall and Hackblock	17	17	0
Chapman	24	0	0
Tamplin and Makovski	16	16	0
Martin and Newby (accepted)	13	15	6

BUSINESS NOTES.

TRACTION.

Reading.—An electric water-car is in use on the Corporation's tramways.

Liverpool.—The Corporation have adopted a proposal for the use of top covers.

Halifax.—The Corporation have sanctioned the extension of the tramway from Sowerby Bridge to Style Bank at an estimated cost of £4,200.

Wakefield.—The company expect that the Thwaite-gate section, forming a connection with Leeds, will be completed in the course of a few weeks.

Jarrow.—The Town Council have decided to write to the British Electric Traction Company asking them to proceed with the laying of the rails at once.

Pemberton.—The track within the District Council's area is finished, and only awaits the completion of the overhead equipment by the Wigan Corporation.

York.—The proposal to purchase the tramways was considered at a meeting of the Streets and Buildings Committee on Tuesday night, and deferred to a future meeting.

Sunderland.—The Corporation have adopted a recommendation of the Tramways Committee that top covers be used, and that the work be done by the tramway staff.

Colne.—The Corporation have agreed to the Colne and Trawden Light Railway Company's application for an extension of time to complete the Laneshawbridge section.

Bolton.—A proposal that the computation of depreciation on the permanent way should be altered from 8 per cent. on the gross capital to a fixed annual amount of £360 per mile is to be further considered before the next balance-sheet is prepared.

Cheltenham.—The working and extending the light railway, for which Messrs. R. W. Blackwell and Co., Limited, are the contractors, is expected to be put in hand in the course of the next two or three weeks. Operations will commence outside the town, probably at the Charlton Kings end, but almost simultaneously the Leckhampton section will also be proceeded with.

Southport.—The Southport Tramways Company have intimated to the Corporation that they are prepared to sell their undertaking, as they consider that separate ownership militates against efficient working. A part of the company's system, however, extends into Birkdale, where they have leased the lines of the Urban Council, who decline to assent to the proposed change.

Dulverton-Minehead.—In reference to the proposed light railway, the Watchet Urban District Council have received a letter from a London solicitor stating that some clients for whom he is acting are prepared to promote such a scheme. A similar intimation has also been received on behalf of another promoter. The Council have decided to do everything in their power to assist the project.

Derby.—Now that the first contract has been completed, and having regard to the great success of the two routes, which have been opened for the past fortnight, it is expected that at the next meeting of the Corporation the Tramways Committee will bring forward some proposals in relation to the remaining routes, the chief of which are those along Duffield-road, Ashbourne-road, and the Uttoxeter New-road.

Durham.—At the meeting of the Town Council last week a proposal was put forward that the Board of Trade should be communicated with by way of objection to the extension of time desired by the British Electric Traction Company for completing the tramway. Ultimately it was agreed that if the company gave a definite undertaking to proceed with the work, under penalty for non-fulfilment, the Council would raise no objection.

Stockport.—The Corporation having submitted to the Bredbury and Romiley District Council a letter from the County Council as to the conditions upon which the last-named were prepared to assent to the doubling of the tramline in London-road, Hazel Grove, and to the working of the same by electric traction, the District Council have decided to acquiesce in the conditions, except upon one or two minor points. The Corporation have authorised a sub-committee to continue negotiations for the purchase of the company's system.

Aston.—Within the next few days electric trams will, it is expected, be running between Birmingham and the Holte Hotel, Aston. A delay has occurred in the laying of the rails into the depôt in Witton-lane, and consequently the cars cannot be run into that place. In the circumstances, the Aston Corporation will make an arrangement with Birmingham either to store the Aston cars at Miller-street or to work their own cars to the Holte Hotel for about three weeks, by which time the connection with the depôt will have been finished.

Yarmouth.—The Board of Trade has provisionally approved the extension from Blackfriars-road to Queen's-road. Preliminary proceedings have been taken for the acquisition of the Southtown and Gorleston tramways. The surveyor stated that the cost of constructing electric tramways from Southtown Bridge through Gorleston, including car-shed and 10 cars, would be £46,762, to which must be added the cost of purchasing the present undertaking. This scheme will be brought before the whole Council at a meeting on the 30th inst.

Torquay.—The Dolter Company having written asking the Council to state an approximate date when they would be ready to supply the company with electric current, the town clerk was instructed to reply that if the secretary would give some idea when the company would require the current, the Council would use their best endeavours to supply it. The company's reply to this was that they would naturally like to make a start as early as possible, but felt that it would be useless to do so until they could get some definite information as to when the supply of electric energy would be available. The Town Council have written suggesting a conference.

Bury.—Through running to Whitefield was instituted last week. After a successful trial trip representatives of the different authorities met at the Whitefield Council chamber, where courtesies were exchanged. The question of fares remains in abeyance pending the completion of arrangements with Salford. Communication is now opened up between Bury and Manchester, but at present passengers have to change at Whitefield. Through running will, however, probably take place before long. The Tollington section will probably be ready for inspection in a day or two. The construction of the Radcliffe-road section has been commenced. The Heywood Town Council have intimated that they will submit further proposals.

Plymouth.—A lengthy discussion ensued at the meeting of the Town Council in regard to track renewals, which, it is stated, will be necessary before long. The question of forming a depreciation fund was alluded to, and the Town Clerk expressed the opinion that if the Council were in favour of such a step it would be well to get direct authority for the purpose, as he doubted whether the provisions of the Legislature sanctioned such a course. Mr. Everson, the tramway manager, assured the meeting that the overhead equipment, about which misgivings had been uttered, was inspected weekly, and was in splendid condition. It was stated that certain formalities lay in the way of the immediate construction of the Garden-street extension.

Bradford.—Considerable progress has been made with the extensions of the tramways from Undercliffe to Greengates and from Allerton towards Sandy-lane. The former line will probably be opened in a week or two. The short length of about a third of a mile which is being added to the Allerton line is expected to be ready in about six weeks. A petition is being extensively signed at Oakenshaw praying the Corporation to extend the tramway from Odsal Top to the city boundary in the direction of Cleckheaton. It is pointed out that the locality has not the same facilities in this respect as almost every other part of the city, and it is suggested that if an extension were made as suggested the Cleckheaton and Dewsbury line might eventually be continued to Oakenshaw.

Newcastle.—The latest traffic returns show that in the five weeks ending Sept. 3 there were 4,085,759 passengers, as against 3 807,284 in the corresponding period of last year. The mileage run was 420,248, as compared with 387,615, and the takings were £18,369, as against £17,596. The number of cars in use was 112, as compared with 104, and the mileage works out at 10·49d. per car mile, against 10·89 in the same period of 12 months ago. Alderman Ellis remarked that it was the most unfavourable report yet presented. The Tramways Committee have decided to supply to every member of the Corporation the detailed information in regard to the depreciation question asked for by a councillor a few weeks back. It has also been decided to build no more cars at present. Owing to the through running arrangement, the Corporation is said to be overstocked.

Perth.—At a meeting of the Tramway Reconstruction Committee last week the report by the engineers, Messrs. Kincaid, Manville, Waller, and Dawson, on the offers for the reconstruction of the tramways, was submitted to the meeting. Mr. Dawson gave explanations regarding the various contracts, and was questioned by members of the committee on various points, especially on the proposal to introduce petrol cars. Treasurer Lawrie maintained that the petrol car had been a success in Perth, and it was a very much lighter car than the cars which Mr. Dawson proposed to put on the route. In reply to Treasurer Lawrie, Mr. Dawson condemned the introduction of the petrol car at the present time, contending that a 10 minutes' car service could only be obtained by electricity, but petrol 'buses would be suitable for an hourly service. Were they to introduce petrol or electricity, the Town Council would require to relay the rails, and this being so, the introduction of the former would mean a considerable expenditure, whereas if they decided on electricity, the relaying of the rails would be about half of the total cost. Again, the petrol car was too light, and the engine which they had been using was not of sufficient horse-power, and the engine which the company proposed to introduce would still be insufficient, and with such a heavy engine after five months' trial the car would be destroyed. It is understood that the Committee will hold another meeting at an early date to make recommendations to the Council.

Rochdale.—At last week's meeting of the Tramways Committee it was agreed to accept Heywood's proposal to supply power for the running of trams in their borough. Bury, it is thought, are likely to consent to this. New alternative terms are to be submitted to Hey-

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wood, but in each case the demand of the Heywood Corporation to supply current for the cars as they run through their district is acceded to by Rochdale. One set of proposals provides that Rochdale shall construct and maintain the lines on their side of Heywood market place, and also put up the overhead equipment; that Heywood shall pay their share of the purchase price of the old undertaking; and that Rochdale shall have possession of the new system for 21 years, at the end of which time it shall be handed over to Heywood. The other proposal involves reconstruction by Rochdale, who will pay twenty-one-thirtieths of the purchase price of that part of the company's system in Heywood, and pay it at the rate of one-thirtieth per year. At the end of 21 years Heywood will, under this scheme, take over the property at a valuation. Arrangements have now been completed with the Whitworth District Council for the electric cars from Rochdale to run to Ending, a couple of hundred yards beyond the borough boundary. The reconstruction of this short length will be undertaken at the beginning of next week. The fixing of the overhead equipment on the Royton section has now been carried nearly the whole distance to Summit, and efforts are to be made to get the Milnrow-road section ready for running at an early date. The laying of the electric cables is being pushed forward rapidly. A later report states that the impression that Rochdale has acceded to Heywood's demand that the latter should supply power for the cars after they pass the Heywood boundary is incorrect, Rochdale being desirous of supplying the energy for running the trams through to the Market-place. At the meeting of the Electricity Committee last week there was some discussion as to the supply of current now available for tramway traction. Mr. Atchison, the electrical engineer, stated that the existing plant was capable of producing the power sufficient to run 27 cars, and that when the Tramway Committee was ready with ducts, cables, and overhead equipment on the Healey and Milnrow-road sections there would be no difficulty in regard to the power.

Handsworth.—The District Council evidently intend to stand upon their rights. The South Staffordshire Company, it will be remembered, has secured the concession for working the line from Handsworth to West Bromwich. The lease from the former authority has not, however, been executed at present. With a view, it was reported, to benefiting by the big football match on Saturday, the company set to work during the small hours to connect the wire, so that their cars could continue the journey after passing the West Bromwich boundary. But, alas! the best-laid schemes, etc. No sooner had a car entered upon the Handsworth section than the Council's officials appeared upon the scene and protested. Not only this, but, on finding the company persistent, they backed their arguments by placing a heavy steam-roller across the line at the border. To make assurance doubly sure, the engineer proceed to fix up an arrangement by which the current was short-circuited and the connection between the two portions of line was broken in three places. The company could not combat such tactics, and so they were unable to accomplish their purpose. Some correspondence on the subject has since passed between the parties. The Handsworth Council had previously intimated to the company that no cars must be run until the Board of Trade had inspected the tramways and the lease completed. The lines had not been passed by the Council's engineers because the work could not be tested until certain differences between the company and West Bromwich had been settled, West Bromwich having declined to allow any temporary or other connection to be made. The Council threatened an application for an injunction unless the company undertook not to repeat the attempt without special consent. The company has replied that as the junction of the electrical equipment is outside the boundary of the Council, it was not possible for the connecting up to be carried out by employés of the Council and that the only car run was for test purposes, and as a preliminary to the application for the Board of Trade inspection. The company had no intention of running a service of cars for public traffic until permission had been obtained from the Board of Trade. The company demand that the Council shall make good the severance of the equipment, but express their desire to co-operate with a view to the opening of the complete service at an early date. The dispute between the West Bromwich Corporation and the company has, it appears, just been settled. Terms were arranged between representatives of the Corporation and the company at a private conference, and the lease has now been signed, the company handing to the Corporation a cheque for several thousand pounds, the amount due for rent and electricity charges up to June 30 last. The agreement is said to be for five years certain.

LIGHTING AND GENERAL.

Rhyl.—Sanction has been obtained to borrow £2,610 for electric lighting purposes.

Motherwell.—The town was in partial darkness on Saturday owing to the bursting of a cable in the power-house.

Walsall.—The Town Council have decided to reduce the charge for electricity to a uniform one of 4d. per unit.

Swinton and Pendlebury.—Negotiations are proceeding with the Lancashire Electric Power Company for electric lighting.

Longton.—The output of electricity during August was 4,094 units, being an increase as compared with last year of 23 per cent.

Shalimar.—The Government of India have approved of the expenditure of half a lakh of rupees for the supply of electric transporters at Shalimar.

Caerphilly.—A committee has been appointed to consider the appointment of an electrical engineer to superintend the Council's installation.

Aspull.—The Board of Trade have agreed to defer consideration of the question of revoking the electric lighting order for one year from the 22nd inst.

Andover.—The Town Council intend to apply for a provisional electric lighting order, which they do not intend to work themselves, but to transfer.

Bury.—The electrical engineer in his last report states that during the past month applications have been received for 107 8-c.p. lamps and a 5-h.p. motor.

Birkenhead.—Sanction has been obtained to the borrowing of £20,000 for the Upton and Prenton supply extension without an enquiry being held.

Maidenhead.—An enquiry will be held shortly into the application by the Town Council for sanction to borrow a further sum of £3,000 for electricity purposes.

Bexhill.—The Electric Light Committee are about to extend the electricity cable to supply houses on the Woodsgate Park Estate at an estimated cost of £170.

Bristol.—An enquiry is to be held to-day into the Council's application for sanction to borrow £126,000 for the Avonmouth and Temple Back station extensions.

Sale of Plant.—The Corporation of Leicester are prepared to receive offers for tramway temporary track, with turn-outs, etc. Particulars in advertisement columns.

Transvaal.—The *Transvaal Government Gazette* of Aug. 12 contains the text of an ordinance sanctioning the expenditure of £13,000 on telephone materials.

Bredbury and Romiley.—The Urban District Council are considering a report by Mr. Charles Richardson, of Romiley, setting forth alternative schemes for lighting the compulsory area.

Govan.—Application is to be made to the Secretary for Scotland for increased borrowing powers to the extent of £47,000, which sum is to embrace all extensions of the electricity plant up to 1906-7.

Keswick.—The Urban District Council have accepted the terms of the Windermere and District Electricity Supply Company for lighting three arc lamps. We understand that the price to be paid for 2,000 c.p. is £40.

Twickenham.—The Council have agreed not to sanction the erection of the proposed cooling tower at the electricity station, or enter into any agreement with reference thereto, unless the consent of the owners of the adjoining property is first obtained.

Stock Exchange.—Application has been made to the Stock Exchange Committee to grant a quotation to the United River Plate Telephone Company's further issue of 12,000 ordinary shares of £5 each, fully and partly paid, Nos. 58,001 to 70,000.

Sunderland.—The Town Council have agreed that for the purpose of meeting the increased demand for power at Messrs. Doxford's shipyard, alterations and extensions of plant should be made at the Hylton-road electric supply station at an estimated cost of £3,000.

Lien Registered.—The Fladbury Electric Light and Power Company had a lien registered on Sept. 3 for £150 5 per cent. debentures, part of £300; amount previously issued, £150; no trustees; charged on the undertaking and all the property and assets, including the uncalled capital.

Lowestoft.—There are now connected to the mains 536 consumers, representing 27,099 8-c.p. lamps. During the last month two new consumers were connected, representing 64 8-c.p. lamps. The engineer has fixed two temporary cables under the harbour at a cost of £58. 10s., which are working satisfactorily.

A Library of Technology.—Particulars will be found in another column of an international library of technology, of which 45 volumes are now ready. They are sold in any combination of five or more volumes by the International Text-Book Company (British agency), 57-58, Chancery-lane, London, W.C.

Perth.—The last report of Mr. Lambert, the electrical engineer, shows that the number of units generated during August was 36,428, an increase of 2,402 units in the month. The lamps connected were equivalent to 150, making the number connected up to date 26,982. The coal used per unit of electricity generated was 7·81lb.

British Engines for New York.—The *Daily News* understands, from an official source, that the General Electric Company, of Schenectady, New York, have placed an initial order with the Wolseley Tool and Motor Company, of Birmingham, for one of their powerful six-cylinder petrol engines, to develop, at normal revolutions, 140 b.h.p.

Hove.—The Council have now consented to the Brighton Corporation carrying telephone wires over the town hall provided they entered into an agreement to remove the wires on receiving three calendar months' previous notice, and to make good any damage done to the premises caused by or arising out of the wires or the carrying over or removal of the same.

Dudley.—The gross profit in connection with the electricity supply account for last year is considerably more than for the previous year, being £5,012, on which there is a net profit of £655. The capital expenditure has been £70,000, and a gross profit of £5,012 gives a return of 5 per cent., which would absorb £3,500, and leave a balance of £1,500 to put to a depreciation fund.

Pudsey.—An enquiry has been held into an application for sanction to borrow £5,000 for electric lighting. Of this sum £3,000 is wanted for cable-laying and £2,000 for extensions when required. Current will be obtained in bulk from the Yorkshire Electric Power Company, and the Council will erect a transforming station on a suitable central site recently acquired for street improvement.

Radcliffe.—The generating station for the Lancashire Electric Power Company is rapidly approaching completion, and negotiations for the supply of energy in bulk are far advanced with Rawtenstall, Bacup, Haslingden, Swinton and Pendlebury, and various other local

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authorities. The supply of electrical energy in bulk to collieries promises to be a feature in the working of the company.

Croydon.—A pamphlet has just been issued by the electricity department of the Corporation. The Electricity Committee now charge 2½d. per unit to consumers who require power at all hours, and 1½d. per unit to those who do not require power between dusk and 11 o'clock. The advantages of this system, the methods and machinery used for producing the current at the Croydon stations, etc., are detailed in the pamphlet.

Board of Trade Regulations.—A special meeting of the Power Bills Parliamentary Committee of the London Chamber of Commerce will be held at Oxford-court, Cannon-street, E.C., on Sept. 21, at 3 p.m., to consider the draft regulations issued by the Board of Trade for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy, to the contents of which we have already referred in previous issues.

Reading.—On Friday the new electric water-cart, which has been built for the Corporation by Messrs. Dick, Kerr, and Co., of Preston, was removed from the Reading Station goods yard and placed on the tramrails, fitted all ready for the application of electric power, under the superintendence of Mr. Hodgson (Messrs. Dick, Kerr, and Co.'s representative). The car has since been used to water the permanent way and sides of the roads abutting on it.

Portsmouth Telephones.—The municipal telephone system has now been extended to Rowland's Castle. The price to country subscribers is exactly the same as that charged to those of the town. The charge at the Corporation call offices is 1d., and the municipal system now covers Portsmouth, Gosport, Cosham, Portchester, Fareham, Pubrook, Waterlooville, Havant, Emsworth, and Rowland's Castle, the total number of subscribers being over 1,800.

Electrical Testing.—The Westminster Electrical Testing Laboratory, York-street, Westminster, have just issued a neat booklet containing their scale of fees. The object of the laboratory is to assist manufacturers, contractors, consulting and resident engineers in the carrying out of tests which they are unable to undertake for themselves from either lack of suitable apparatus or a sufficiently skilled staff. Experimental and research work is also undertaken on behalf of inventors and others.

Dewsbury.—The electrical engineer, in his report upon the recent breakdown of the cables, states that for a long time Dewsbury had had remarkable immunity from accidents of this nature, and a continuous supply of energy. The fault on this occasion had arisen from the smaller mains in the distributing boxes. The bulk of the difficulty has been got over, and Mr. Campion has advised certain measures which would obviate a recurrence of this trouble, and enable him to locate the faults more readily when occasion arose.

Elland.—The last report of the electrical engineer states that during the five weeks ending July 31 the engines ran a total of 144½ hours, generating 6,131 units, and that the output was 2,084 units. The total output from July 1 to 31 was 1,984 units, an increase of 300 on the previous month. At the end of this period the total number of consumers was 69, and the total number of 8-c.p. lamps connected 4,156. During the five weeks ending July 31 the destructor ran 299½ hours, detroying 265 loads of refuse and 150 loads of sludge.

Aberdeen.—On Monday the Council asked the Lighting Committee to consider the advisability of a more general extension throughout the city of the improved street-lighting recently adopted by the Council for the tramway routes, and to report. It was explained that at the present time the committee had incandescent lights throughout that part of the city, and the result of that had been that there had been a constant demand for improved lighting in other parts. If that were generally done, it would put an end to the present patchwork system.

Electricity in Collieries.—Messrs. Bolckow, Vaughan, and Co. are extending the utilisation of electrical energy for motive and lighting purposes to their Shildon Lodge pit. Arrangements have been completed for the putting down of cables to convey the power from the Auckland Park Colliery pit to Shildon, two miles distant. New engines will be fixed, and from the power-house at Auckland Park energy will be derived for haulage and lighting purposes at Shildon Lodge. At Shildon, also, cables are being put down for the supply of electric light for public use.

Electrical Ore Finding.—The operations on the Barrow Hæmatite Steel Company's property, under an agreement whereby the Electrical Ore-Finding Company will receive royalties on the ore raised, have been successful in the location of hematite ore. The instruments having located certain spots that contained hematite in ground that had not been previously worked in any way whatever, bores were put down by the steel company, and hematite ore has been struck at a depth of 88ft.—*i.e.*, within a few feet of the depth previously indicated by the Ore-Finding Company's operators.

Newport (Mon.).—The borough electrical engineer has reported that Messrs. Cordes (Dos Works) have been making enquiries as to obtaining a supply of electrical energy for power purposes at their works, and they estimate that they will require 1,400,000 units per annum. They, however, suggest that they should be supplied at less than the scale rate for power adopted by the Corporation. The matter having been considered, the committee resolved that the company be offered the supply of current required by them at the scale rate, which the committee consider is the lowest they can charge and obtain some remuneration.

New Company.—The Simplex Arc Lamp Syndicate, Limited, has been registered with a capital of £16,000. Objects: to adopt agreements (1) with A. Heller, (2) with F. W. Stevens, and (3) with C. J. Scott, and to carry on the business of manufacturers of and dealers in arc and other lamps, brackets, globes, films, shades, glasses, burners, meters, galvanometers, ammeters, voltmeters, carbons, cut-outs, switches, motors, batteries, stoves, turbines, pipes, wires, and all appliances and things used in connection with electricity or any other illuminant or generator of light, heat, or power; suppliers of electricity and other light; electrical and general engineers, etc.

Ayr.—The annual report of the burgh electrical engineer, Mr. Roland Marshall, states that the units generated reached a total of 1,119,629, an increase as compared with the previous year of 102,593 units. The prices charged for current were: private lighting, 5d.; public lighting, 2d.; traction, 1·5d. and 1d.; power, 2d; and the revenue was as follows: private lighting, £5,627; public lighting, £3,590; traction, £1,753; other sources, £286—being a total income of £11,257. The expenditure, including £4,822 interest and sinking fund, was £10,629, leaving a net surplus of £627, or £326 in excess of last year. Sanction has been obtained to a loan of £15,000.

East Barnet Valley.—The Urban District Council are considering an offer from the National Electric Construction Company for carrying out the complete central-station equipment. Including the extensions to Hadley Wood, the cost will be £15,500. This includes a sum of £1,250 for buildings, £250 for land (half an acre), and a provisional sum of £500 for street-lighting. The plant will consist of gas producer and gas-engines with direct-coupled machines, storage battery, balancer and boosters, switchboard, mains, and all the necessary accessories for a complete equipment. The engines will be capable of dealing with a load of 60 kw., and the battery will consist of 256 cells, having a capacity of 80 amperes for five hours.

Dundee.—The partial breakdown in the electricity supply on Monday night was, it is stated, caused by a service cable giving way. This occasioned a heavy current to flow through the copper strip feeders, which were already weak, and they, too, collapsed. The weakness of the copper strip and many of the services and boxes put in about two or four years ago was brought to the notice of the Council by the engineer some months ago. The current had to reach the centre of the city by way of the outlying cable feeders at the west, north, and east ends of the city. This threw very heavy work on to these feeders and the Perth-road distributor, but they might have stood the strain if the latter had not been damaged where it runs in front of the premises recently erected.

St. Marylebone.—The Borough Council intend to apply to the London County Council for approval to an alteration of the standard pressure of supply to consumers in the area of supply comprised in their order. At the present time current is supplied at pressures varying from 50 to 200 volts on the alternating and continuous current systems. It is now desired to alter this into a continuous-current supply at 240 volts on the low-tension system. The London County Council have sanctioned the borrowing for 42 years by the Marylebone Borough Council of £340,045 for electric lighting works, subject to the latter body's providing out of a sinking fund, or from maintenance account, for all renewals and replacements during the currency of the loan of plant, machinery, and works, and a loan for 38 years of £48,545, the estimated cost of bringing existing plant into working order, and a loan for 10 years of £44,850 for meters or alterations to existing meters consequent on change of pressure. These loans are in addition to the loan of £1,212,000 already incurred to pay the Metropolitan Electric Supply Company for their Marylebone property and goodwill under arbitration award.

Southwark.—At the Borough Council on Wednesday evening, on the first meeting after the recess, some remarkable opinions on electrical engineers were expressed by Alderman Boyd. It will be remembered that the services of the late electrical engineer to Southwark Borough Council—Mr. Blaikie—were dispensed with by this Borough Council in a manner which caused much comment in the electrical world. On Wednesday evening the Electric Light Committee recommended that advertisements be issued for a chief engineer and manager of the electric light undertaking at a salary of £300 per annum, rising by annual increments of £20 to a maximum of £400 per annum. A long discussion arose on this recommendation. Councillor Chell moved that the matter be referred back for further consideration. He argued that they did not want an electrical engineer to manage the concern, but a commercial man who would go out and canvass for customers, whilst a mechanical man should manage the electric light station. Alderman Boyd warmly supported the proposition of Councillor Chell. They did not want an electrical engineer, he said, with a lot of letters after his name, but a good business man to manage the concern outside the station and a smart mechanical engineer to manage the station itself. Properly speaking, he said, there was no such thing as an electrical engineer. Any person of ordinary intelligence could read up in a month all that an electrical engineer knew. There was nothing in it. It was all a lot of theory. What they wanted was a good mechanic to supervise the station. Councillor Attenborough said he did not think it was any good for the Council to issue advertisements for a qualified electrical engineer. The Council had treated the late chief of their electric lighting department so disgracefully, that no member of the Institution of Electrical Engineers would be likely to apply for a post under such a council. Councillor Hill advised the representatives of St. George's, Christchurch, and St. Saviour's, in which parishes the Newington electric lighting order does not run, not to take any part in the voting, but to leave Newington to "stew in its own juice." After a long debate, the committee's recommendation to advertise for a chief engineer and manager was carried by a large majority.

Colchester.—Electric lights are to be substituted for 13 oil lamps in Mile End-road. The Electric Light Committee in their last report give the output of electricity in July as 23,174 units, number of consumers as 515, and the number of 8-c.p. lamps connected as 26,505. It is proposed to charge the Tramways Committee for the first year of working 2½d. per unit, and 10s. 6d. a week for making the daily tests required by the Board of Trade. The Lighting Committee has been informed that if the number of public electrically lighted lamps can

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be increased to 400 equivalent half-ampere lamps, this committee will be prepared to made a charge of 2½d. per unit till the ending of the financial year.

Devonport.—The demand for current for motive power and lighting has increased 50 per cent. in the last 12 months, and as more favourable terms have recently been offered to consumers there is a prospect of the increase continuing. The Electric Power Committee consider that the need for extending the plant is urgent, and the chairman (Mr. H. Banbury) and the electrical engineer (Mr. J. W. Spark) have been deputed to inspect a number of engines and report to the committee, with a view to one being purchased and laid down in time to augment the supply for the coming winter. Although the necessity for extending the plant has arisen earlier than was expected when the works were built, it was anticipated, and the bed for the new engine is already provided.

London Gazette.—An adjudication order has been made *re* Henry Bock Binko, electrical engineer, carrying on business at 34, Leadenhall-street, E.C., and residing at 4, Highbury-crescent, Highbury, Middlesex. The partnership between George Frederick Matthews and Aubrey Hunter Spalton, carrying on business as electrical and mechanical engineers at 64, and 80, West-street, Sheffield, has been dissolved by mutual consent; also that between William James and William S'. Just Clarke, carrying on business as electrical engineers and instrument makers at 174, Pentonville-road, Clerkenwell, E.C., and 16, Camden-road, N.W., under the style of "W. S. Clarke and Co." Mr. William Henry Platts, 1, Oxford-row, Leeds, chartered accountant, has been appointed trustee in the estate of the Yorkshire Motorcar and Electrical Engineering Company, carried on at 101, Kirkstall-road, Leeds.

Barrow.—The Council at their last meeting discussed at length a petition from shopkeepers who objected to paying 6d. per unit for electricity while householders were charged 4½d. Finally it was decided to reply that they could not see their way to reduce the charge at present. It was pointed out that the system of charging had been based on the principle of charging each consumer in proportion to what it costs to supply him with current, and that this cost is much greater in the case of shops than in that of private houses; that their letter assumed that the tradesmen paid 6d. per unit, whereas the average price for the last year worked out at about 5½d., and that the committee much regretted they were unable to make a general reduction last March, but were confident, with the improved state of things now existing at the works, to be able to reduce the hours for which the maximum price was charged, from 1½ hours to one hour.

Macclesfield.—At the last Town Council meeting, the town clerk read notices from the Empire Electric Light and Power Company, London, Messrs. Foote and Milne, London, and Mr. G. Vaughan Fowler, Warwick, of their intention to apply for a provisional order to supply electricity within the borough. There was also a letter from the Industrial Engineering Company, of Newton, near Hyde, submitting a generalised arrangement of their scheme for lighting the borough, and enquiring, in the event of the Corporation deciding not to go in for a scheme of their own, if they would give the company the option of purchasing the provisional order, or their help in securing the same from the Local Government Board. Finally, the chairman was asked to procure further details of his scheme for a 200-kw. plant with feeders, distributing mains, etc., at a cost of about £12,000, excluding buildings and site. The Chairman, Messrs. Councillors Brown, Cross, Clayton, and Isherwood were appointed a sub-committee to further consider the route along which the cables shall be laid in the first instance.

Clydebank.—Recently the Clyde Valley Electrical Power Company enquired whether the Council would take a supply of electricity for public purposes, and explained that, as the alternating current at 50 cycles per second would be more suitable for the burgh and district, they were prepared to bear the expense of altering the wiring in the municipal buildings from the direct-current system to the alternating-current. The Electric Lighting Committee at first agreed to adhere to the direct-current system, as stipulated in the agreement with the Clyde Valley Company, but to allow a rotary transformer to be placed within the buildings alongside the present dynamos, provided the company would take over the dynamos at a valuation. The company afterwards suggested the introduction of concentric wires, which could be drawn through the present tubes without breaking out any of the plaster or woodwork of the building. The committee then agreed to allow the alteration of the wiring of the buildings on certain conditions, one of which was that the company undertake to have the new current installed in the buildings not later than Feb. 15 next, so as to enable the Council to give delivery of their machinery and plant to a purchaser on that date. This course has been agreed to by the Council.

Wisbech.—An enquiry has been held by Colonel Meade-King into the application of the Town Council for sanction to borrow £35,000 for purposes of establishing an electric lighting undertaking. As already noted, a provisional agreement has been entered into between the Council and the National Electrical Construction Company, under which the latter will carry out all the work in connection with the scheme and run the undertaking themselves for at least a period of years, and under which the money for the scheme is to be borrowed by the Council and repaid by the contractors. The Corporation was represented by Mr. J. Ellis Griffiths, M.P. (instructed by the town clerk, Mr. Geo. Carrick). The ratepayers opposing the scheme were represented by Mr. Arthur H. Poyser (instructed by Mr. T. R. Dawbarn), and Mr. H. St. John Raikes (instructed by Mr. Robert Dawbarn) opposed the scheme on behalf of the Wisbech Lighting Company. The electrical engineers employed by the Corporation, Messrs. Hammond and Sons, were represented by Mr. Spencer Hawes, whilst the managing secretary of the National Electrical Construction Company, Mr. W. B. Cownie, was also present. Amongst those who gave evidence were the Mayor (Mr. H. C. Elgood), the chairman of the Electric Lighting Committee (Mr. A. Southwell), the borough surveyor (Mr. A. H. Plowright), and the manager of the lighting company (Mr. J. G. Hawkins).

Sheffield.—The electric supply department have issued a large illustrated postcard, in which the general manager and engineer (Mr. S. E. Fedden) points out that it is in the consumers' interests to overhaul their incandescent lamps from time to time and remove any which may have become blackened with use, resulting in loss of light and efficiency. He says: "To secure the greatest economy in electric lighting only first-class lamps should be used, the small extra cost over inferior grade being saved many times over during the life of the lamp by the reduced consumption of energy per candle-power. For example, a low-class 16-c.p. lamp, costing, say, 8d., may consume one unit in 12 hours, whereas lamps of the same candle-power such as are sold at about 1s. each, will frequently burn for 16 hours with the same consumption of energy, in addition to which the good lamps need not be changed so frequently as the poor ones. Assuming, however, their life to be equal, say 650 hours, the relative cost will be approximately as follows: Low-grade 16-c.p. lamps—first cost, 8d.; energy consumed at five watts per candle-power = 52 units at 4d., 17s. 4d.—total cost, 18s. High-grade 16-c.p. lamps—first cost, 1s.; energy consumed at four watts per candle-power = 41·6 units at 4d., 13s. 10½d.—total cost, 14s. 10½d., or, approximately, a saving of 15 per cent. in favour of the high-grade lamp. Attention to these details at the commencement of the winter season will secure a maximum of comfort and satisfaction, and assist in economising energy and reducing consumers' accounts."

Battersea.—The London County Council have consented to the erection of the coal-conveying plant at the central electric generating station. Various mains are to be extended at an estimated cost of £119, and also additional cable is to be provided in stoneware casing already laid at an estimated cost of £317. The committee have been considering the charges made for the supply of electrical energy to, and maintenance of, arc lamps within the borough. They state that they have ascertained that the charges made by other metropolitan borough councils supplying electricity are as follows: Bermondsey, 3d. per unit (about £25 per lamp per annum); Fulham, £25 per lamp per annum; Hackney, £18 per lamp per annum; Hammersmith, £22. 10s. per lamp per annum; Hampstead, £28 per lamp per annum (500-watt arc lamp); Shoreditch, £31 per lamp per annum (nearly); Southwark, £28. 7s. per lamp per annum (3½d. per unit); St. Pancras, 3d. per unit (about £25 per lamp per annum). The electrical engineer has prepared a report showing the cost to the electricity department of the street-lighting for the year 1903 4 and the estimated cost for the year 1904-5. Taking into consideration the charges for generation and distribution of electricity, rents, rates and taxes, management expenses, and special charges during the year 1903-4, a loss of about £779 has been incurred. Having regard to the whole of the circumstances, the committee recommend that the charge for the supply of electrical energy to, and maintenance of, arc lamps be increased from £16 to £18 per lamp per annum. There are at the present time 356 arc lamps fixed in the borough, and in the event of the recommendation of the committee being adopted, an increase of £712 will have to be provided for in the estimates for the accounts of the Council as lighting authority, but a corresponding increase in the revenue in the accounts of the electrical undertakings will be effected.

Salford.—An enquiry has been held into an application by the Town Council for sanction to borrow £5,000 for purposes of electric lighting for the district included in the Prestwich electric lighting order of 1900. Mr. J. Purrett, deputy electrical engineer, said in his evidence that the money was required for the purpose of enabling a supply of electricity to be given in the district of Prestwich, covering an area of 2,435 acres, with a population of 12,839. With reference to the system of supply, the single-phase alternating-current system was to be adopted similar in all respects to the system of supply which had been in use in the district of Higher Broughton, Salford, for the past eight years. Duplicate high-tension cables conveying electricity at 3,000 volts pressure would be laid to a sub-station situated centrally in the area, a branch being taken off one of the cables in order to supply Hilton-lane. From the sub-station low-tension cables would be laid. Transformers would be used in the sub-station to transform the pressure from 3,000 volts to 200 volts, and this pressure would be supplied wherever low-tension cables were laid. A pilot cable for indicating the pressure of supply at the sub-station would be laid with the other cables. High-tension cables would also be laid down Rectory-lane and Whittaker-lane, and persons requiring a supply of electricity in these two roads, and also in those parts where low-tension cables were not laid, would be provided with individual transformers for transforming the pressure down to 200 volts. In these cases the high-tension alternating current would be taken direct into the houses; in every case the transformers would be enclosed in a cast-iron box. No cables had been provided for in Bury Old-road by agreement with the Prestwich Urban District Council, the arrangement being that should any applications be made from this road the cables were then to be laid. Were cables required to be laid the capital expenditure would be £626, upon which an adequate return could not be expected at present. Lead-covered and concentric cables would be used, with the exception of the pilot cable, which would be twin lead covered. The high-tension cables and the pilot cable would be drawn into pipes, but the low-tension cables would be armoured and laid direct in the ground, the soil being of a satisfactory nature. A sum of £962 had been included for service cables, meters, etc., necessary for connecting up consumers. Allowing £20 per consumer approximately, 50 consumers would be connected with this expenditure. The current to be used in the area would be conveyed by cables already in use from the Frederick-road works to the boundary of the borough of Salford. Those cables would then be connected to the

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cables proposed to be purchased under this loan. The transformers which would be used in the area were already in the possession of the Salford Corporation, having been used in Salford prior to the system in the centre of the town being changed from alternating to direct current. No new expenditure under this heading would, therefore, be required for some time. They had sufficient power at the Frederick-road station to supply this extra demand.

Londonderry.—The Corporation obtained a provisional order in 1891, and in 1894 the public lighting installation was commenced. Specifications and plans for private lighting and power purposes were prepared jointly by Messrs. Preece and Cardew and Mr. Macrory in 1901, and contracts entered into in May, 1903, amounting to about £20,000. A contract was afterwards accepted for the new buildings for £5,500. Owing to the site of the station being reclaimed land, great care had to be taken in putting in foundations for the new buildings, which are sunk to hard ground, in some cases 14ft. deep. A foundation of cement concrete, from 2ft. to 4ft. deep by 6ft. wide, has been provided under all walls. The engine-house extension is 75ft. long, 50ft. wide, and about 40ft. high, and is finished with open iron roof and lantern light. The switchboard platform occupies one side, at a level of 5ft. above the floor, and is approached by a double flight of cast-iron steps, and protected by polished steel rails and standards. The floors of platform and engine-house have been laid with encaustic tiling. The new boiler-house is parallel to the engine-house, and is 90ft. long, 48ft. wide, and 30ft. high, with open iron roof and louvre ventilation along the whole length of ridge. There are at present five boilers and space for two additional ones. Between the boiler-house and quay a store provides room for 1,000 to 1,500 tons of coal. At the end of boiler-house a new pump-house has been erected, with a large tank overhead providing water supply to the condensers. The supply for this tank is drawn from the river by two electric motor-driven pumps, while the old tank is used for supply to steam-boilers. The whole of the buildings, etc., including batteries and test-rooms, stores, etc., have been carried out by Mr. R. Colhoun, of Londonderry. The sub-contractors were Messrs. Wm. Nelson and Alexander Brown and Co. for decoration and iron stairs and railing respectively. The plans and specification for the works were prepared by Mr. Daniel Conroy, architect, under whose superintendence they were executed, Mr. W. M'Elwee acting as clerk of works on behalf of the Corporation. The total outlay on buildings, etc., is about £7,175. The boilers, pumps, condensing plant, and pipe connections have been supplied by Messrs. Victor Coates and Co., of Belfast. There are three new Lancashire boilers, each 7ft. 6in. diameter by 26ft. long, suitable for a working pressure of 125lb. per square inch, constructed throughout of Siemens-Martin mild steel. The feed pumps are of the Weir vertical direct-acting type in duplicates, each capable of delivering 2,500 gallons of water per hour, and are placed in the pump room, which also contains two Pulsometer centrifugal pumps coupled direct to Brush shunt-wound continuous-current motors provided with no-load and overload automatic releases. There are three condensers of the ejector type, by Messrs. Korting Bros. The contract for the generating plant was carried out by the British Thomson-Houston Company, of Rugby, who built the electrical apparatus and sub-contracted the engines to Messrs. W. H. Allan and Sons, of Bedford. There are four direct-coupled steam sets, two capable of developing 250 kw. each. These dynamos are shunt-wound six-pole machines. The compound engines which drive them are of 375 i.h.p., each with high-pressure cylinders of 14½in. and low-pressure cylinders of 24in. diameter and having a stroke of 10in. The two smaller sets are six-pole 100-kw. machines, compound wound with a view to being eventually used to supply power to the future electric tramways. The British Thomson-Houston Company also supplied the balancer-booster set. The battery was manufactured by the Electrical Power Storage Company, of 4, Great Winchester-street, London, E.C., and consists of 268 cells. The contractors for the switchboard were Messrs. Cox-Walkers, of Darlington and Edinburgh, who have also carried out the cable work connecting the machines with the board through the various energy-recording meters, etc. The overhead five-ton travelling crane was supplied by Messrs. Porte and Co., of Dublin. Travelling rails are laid along the whole length of the new engine-room. The whole of the private lighting cables have been manufactured and laid by the Western Electric Company, of North Woolwich, and are insulated with impregnated paper and lead-covered. The feeder cables are of the triple-concentric type, lead-covered, jute-served, and drawn into conduits, spare ducts being provided for additional cables when required. Three-core, lead-covered, jute-served pilot cables are also drawn into the conduits from the works to the various feeding points. The distribution cables are of the three-core lead-covered pattern, laid in earthenware troughs which are filled with bitumen and covered with bricks. The distribution cables are split up into sections by means of 110 intersection boxes and seven fuse and feeder pillars. A few Nernst lamps have been placed in the streets. The outside work included in the cables contract has been supervised by the assistant electrical engineer, Mr. B. Mertens, A.I.E E., and carried out under the superintendence of Mr. H. J. Holder, A.M.I.E.E., of the Western Electric Company.

PROVISIONAL PATENTS, 1904.

SEPT. 5.

19109. Improvements in single-phase commutator motors. Franklin Punga, Oswaldstre House, Norfolk-street, Strand, London.

19113. Wireless telephony. John Alexander Steven Arnold, 55, Chancery-lane, London.

19125. Improvements in brush-holders for electrical machines. Benjamin Garver Lamme, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 16, 1903, being date of application in United States. (Complete specification.)

19126. Improvements in or relating to dynamo-electric machines. William Horace Foot, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 16, 1903, being date of application in United States.) (Complete specification.)

19139. Improvements in electric arc lamps for medical purposes. Wilhelm Sedlbauer, 46, Lincoln's-inn-fields, London.

19160. Improvements in telephone cord. Ernst Gustaf Sievert, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19168. Improvements in and relating to alternating-current and electrical machinery. William Phillips Thompson, 322, High Holborn, London. (Berliner Maschinenbau Act.-Ges. vorm. L. Schwartzkopff, Germany.) (Complete specification.)

SEPT. 6.

19189. Improvements relating to signal lights for tramway or street cars and for similar services. Sydney Weiss Mitchell, 18, Southampton-buildings, Chancery-lane, London.

19198. Improvements in the construction of lifeguards applicable to electric tramcars and the like. John Nathan Fidler and Samuel Woolley Fidler, 4, St. Ann's-square, Manchester.

19232. Improvements in or relating to electric arc lamps. André Blondel, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Sept. 9, 1903, being date of application in Belgium.) (Complete specification.)

19242. Improvements in and relating to electric light fittings. Henry Lea and Sydney Mitchell, 18, Southampton-buildings, Chancery-lane, London.

19243. Improvements in and relating to electric generator locomotives and the like. Alfred Dickenson and John Mannheim, 18, Southampton-buildings, Chancery-lane, London.

19245. Improvements in automatic signalling for electric railways or tramways. Reginald Page Wilson and Arthur Grotjan Marshall, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

19265. Improvements in indicating devices for electrical fire-alarms. Reinhold Hoenicke, 18, Buckingham-street, Strand, London. (Complete specification.)

19266. An new or improved galvanic cell. Rudolf Ziegenberg, 18, Buckingham-street, Strand, London. (Complete specification.)

SEPT. 7.

19305. Improved electric interlocking apparatus for operating electrically-worked signals and points. Edmond Meyer Tudor Boddam, 55, Chancery-lane, London.

19326. Improvements connected with electric hand-switches for motor cycles and other like purposes. James Frederick Janes, 40, Chancery-lane, London.

19333. Improvements in means for eliminating the effects of induction in telephone systems and the like. John Young, 322, High Holborn, London.

19334. Improvements in electric motors. The Firm of Reiss and Klemm, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Oct. 12, 1903, being date of application in France.) (Complete specification.)

SEPT. 8.

19341. An improved bearing for use on motors, dynamos, or other machines. Thomas Haynes, 114, Fentham-road, Erdington, near Birmingham.

19343. Regulating trolley head for electric cars. John Murphy, James Murphy, and Philip Goodier, 321, Cleveland-street, Birkenhead.

19364. Combined driving gear and brake for electric cranes. John William Branston, 30, Forester-avenue, Bathwick, Bath.

19365. Improvements in and connected with metallic conduits for electric wires and cables. William Herbert Isherwood, Carlton Mills, Leeds.

19422. Improvements in regulating mechanism for arc lamps. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Allgemeine Beleuchtungs und Heizindustrie Act.-Ges., Germany.) (Complete specification.)

SEPT. 9.

19423. Improvements in the internal insulation of tubes and fittings for electric conduits. Thomas Taylor, Electric-avenue, Witton, near Birmingham.

19465. Improvements in and relating to crossings of tramway rails. Barnim Kombst, 81, High Holborn, London. (Complete specification.)

19475. Improvements relating to electric cranes or the like. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens Schuckertwerke G.m.b.H., Germany.)

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19478. Improvements in regulators for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19479. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19482. Improvements in electric automatic block signal and safety systems. George P. Finnigan, 53, Chancery-lane, London. (Complete specification.)

19560. Improvements in electric meters of the mercury electrolytic type. Arthur Wright, Norfolk House, Norfolk-street, Strand, London.

19562. Improvements in electrolytic meters for alternating currents. Arthur Wright and Herbert Flaxman Reason, Norfolk House, Norfolk-street, Strand, London.

SEPT. 10.

19506. Improvements in connection with wall sockets and switches for electric circuits. George Edwin Fletcher, 17, St. Ann's-square, Manchester.

19525. Improvements in and relating to electromotors. Adrian Baumann, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 12, 1903, being date of application in Germany.) (Complete specification.)

19540. An improved combined rail and road electric tramway system and vehicles therefor. John Dixon and Thomas Oliver Dixon, Lloyds' Bank Buildings, Canute-road, Southampton.

19561. Improvements in and relating to trolleys for electric tramways. Josef Honnette and Heinrich Gebhardi, 81, High Holborn, London. (Complete specification.)

19572. Improvements in means for controlling circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19573. Improvements in train control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19574. Improvements in motor-control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19580. Improvements in electric meters. Thomas Duncan, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 29, 1903, being date of application in United States.) (Complete specification.)

19590. An improved casing or conduit for electric conductors. Malcolm Macdonald McHardy, 40, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 29, 1904.

1903.

19251. Electric telegraphy. Brown.

19341. Apparatus for use in laying pipes for sewers, drains, electric light, gas and water mains, and such like. Hayes.

21227. Lifeguards for electric tramcars and other road vehicles. Turner and Turner.

21315. Steps for electric and other tramway cars, vehicles, and the like. Cable.

21930. Electric arc lamps. Hulsart and Adams.

23359. Sparking plugs and the like for electric ignition. Veulle.

23540. Electric resistance boxes. Adams and Curtis.

23636. Raising and lowering electric arc lamps. Brown.

25022. Couplings for electrical conduits. McMurtrie. (Date applied for under International Convention, Nov. 21, 1902.)

1904.

8540. Printing telegraph receivers. Swift.

10688. Device for grinding commutators. Bohm.

12368. Installation and apparatus for automatically putting alternating-current transformers into or out of circuit. Mariage.

17190. Manufacture of electric glow lamps to represent candles. Gimingham.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	–	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	5⅞-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	99-101
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	–	2¾-3¼
—— 4 per cent. Mortgage Debenture Stock	100	–	85-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	½-¾
—— Non. Cum., 5 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	94-97 xd
—— 4½ per cent. 2nd Debenture Stock	100	–	70-75
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9½-10¼
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	5	–	1½-2
—— 5 per cent. Debentures	100	–	90 96
Edison and Swan United, "A" Shares, 1-99,261	5	–	¾-1
—— "A" Shares, 01-017,139	5	–	1-2
—— 5 per cent. Debentures	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9-9½
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	10½-11½
—— 4½ per cent. Preference	5	–	5-5½
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18½-19½
—— 4 per cent. Debentures	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10½
Telegraph Construction and Maintenance	12	–	34-37
—— 5 per cent. Bonds	100	–	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11½-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9½-10½
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	–	10½-11½
—— 4½ per cent. Debenture Stock. Red.	100	–	103-106
Bromley (Kent) Electric Light and Power Co.	5	..	5½-6
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary	5	–	10¾-11½
—— 7 per cent. Preference	5	–	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	–	7½-7¾
—— Nos. 20,001-30,000	5	–	7-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12½-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	107-110
Charing Cross and Strand, Nos. 1-70,000	5	–	7⅞-8¼
—— 70,001-80,000	5	..	7¼-7⅝
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4¾-5
—— 40,001-80,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	105-109
City of London, Ordinary	10	–	10½-10¾
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	102-105
County of London Electric Supply, Ordinary	10	–	8-9
—— 6 per cent. Cum. Pref.	10	–	11½-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	100	–	103-104
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	6 6½
—— 6 per cent. Cum. Pref.	5	–	6-6½
—— 4½ per cent. First Mort. Deb.	100	–	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1½-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	99-102
Havana Electricity, Limited, 1-15,000	10	–	9½-10¼
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	..	101-103
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-81,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1½-2
—— 6 per cent. Pref.	5	–	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	96-99
Metropolitan Ordinary	10	–	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-115
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	–	96-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	100-103
Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,510	5	–	5¾-6¼
—— 4 per cent. Debenture Stock	100	..	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2¾-3¼
—— 4 per cent. Debenture Stock	100	–	85-88
South London, Ordinary	–	–	4 4½
South Metropolitan Electric Light and Power Co., Ord.	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	..	104-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-30,080	5	–	14½-15½
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¾-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¾-5¼
Westminster, Ordinary	5	–	12¾-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	5-5¼
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅛-5⅜
—— Ord.	5	..	5½-5¾
—— Permanent 5 per cent. Debenture Stock, 1888	100	–	137-141
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	100-102
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	..	11/16-13/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	½-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.	100	–	97-100
—— Ord Pref.	100	..	100-103
—— Non. Cum. 5 per cent. Pref.	10	–	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	£40	–	104-106 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-500,000 & 60,001-80,000	10	–	8¾-9¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10¾-11
—— 5 per cent. Perpetual Debenture Stock	100		117-120
—— 4½ per cent. 2nd Deb. Stock	100		94-97

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	—	3½-3⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5⅛-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	5-5½
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
—— Prov. Cert., all paid	100	—	102 105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	94-99
Calcutta Tramways, Limited, 1-102,268	5	..	7¼-7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways, Nos. 1-480,000	1	—	1⅛-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4½-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	—	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	—	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	—	9½-10
—— 5 per cent. Cum. Pref.	10	—	11-12
—— 4 per cent. Debentures	100	—	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 5½ per cent. Mort. Debs., 1-5,000, Red.	100	—	94-97
Imperial Tramways Ordinary	all	—	18 19
—— 6 per cent. Cum. Pref.	all	—	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	3½-4
—— 4 per cent. Debenture Stock	100	—	88-91
Kidderminster and District Lighting and Traction, Pref.	5	—	8-84
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	10½-11
—— 4 per cent. 1st Mt. Deb. Stock, Red.	100	—	10⅝-11⅝
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-106
Metropolitan Elec. Trams., Ld., Defd., 1 000,001-1,314,016.	1	..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¾-1
—— 4½ per cent. Deb. Stock, Red.	100	..	98-100
Milwaukee Electric Rail and Light. 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	5	—	½
—— 6 per cent. Cum. Pref.	5	—	1-2
—— 5 per cent. Mortgage Debentures, 1-1,715 (Egd.)	100	—	88-93

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	12-12½
—— 5 per cent. Cum. Pref.	10	—	9½ 9⅝
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	—	101-104
Potteries Electric Traction, Ordinary 20,001-40,000	10	—	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	—	8¼-8½
—— 4½ per cent. Debenture Stock	100	—	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	—	1
—— £101,152 5 per cent. Preference	1	—	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	—	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	86-88
—— 4 per cent. Pref.	100	—	100-102
—— ,, ,, deferred	100	—	79-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	106-109
City and South London, Consolidated Ordinary	100	—	44-46
—— 4 per cent. Debenture Stock	100	—	105-108
—— 5 per cent. Pref. Stock '91	100	—	121-124
—— ,, ,, ,, '96	100	—	117-120
—— ,, ,, ,, '01	100	—	115-118
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
—— Ordinary, 1-50,000	10	—	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	..	97-98
Waterloo and City, Ordinary	100	—	86-89
Telephones.—			
National Telephone, Preferred	100	—	104-106
—— Deferred Stock	100	—	92-95
—— 5 per cent. Cum. First Pref.	10	—	12-14
—— 6 per cent. Cum. Second Pref.	10	—	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	—	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	—	97-99
—— 4 per cent. Deb. Stock, Red.	100	—	104-106
—— £ 4 per cent. Prov. Cert.	—	..	65-68
Oriental Telephone and Electric Company	1	—	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1-1⅛

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 10	1,458	1,235	+ 202	+24,671h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Sep. 10	42	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 11	1,094	1,115	- 21	+ 114	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 10	5,231	5,137	+ 94	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 2	1,035	788	+ 238	+ 2,335	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 8	2,011	1,681	+ 330	+ 4,430	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 5	1,463	1,368	+ 95	- 40	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 11	1.918	1,827	+ 91	+ 352	38	38	March 31g	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 7	1,461	1,391	+ 70	+ 1,544	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 10	4,904	4,021	+ 883	+19 854	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 11	1,218	1,011	+ 207	+ 2,686h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 9	5,295	5,140	+ 155	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 10	1,137	956	+ 181	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 11	372	—	—	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	Aug. 20	2,189	2,088	+ 101	+ 1,376	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	Sep. 10	211	214	- 3	—	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 10	5,880	5,537	+ 343	— h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City & South London Railway	,, 11	2.555	2,632	- 77	— h	6⅜	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 8	509	653	- 143	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 9	229	248	- 19	- 92	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 3	285	310	- 25	- 247	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 2	58	166	- 8	- 24h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 9	4,032	4,081	- 49	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 9	1,039	1,041	- 2											
Dundee City Tramways	,, 9	971	869	+ 102	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 10	748	710	+ 38	+ 1,409	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 10	14,870	14,129	+ 641	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 7	378	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 7	3,357	2,784	+ 573	+ 3,034	31¾	30¼	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 10	1,326	1,289	+ 37	+ 2,653	34	34	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 10	2,200	1,914	+ 286	+ 6,938	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 10	483	481	+ 7	+ 656	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Aug. 31	170	192	- 22	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 30	256	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Sep. 10	6,242	5,659	+ 583	+ 9,400	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 3	10,949	10.427	+ 522	+12,307	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 11	1,521	1,672	- 151	- 422h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 10	13,778	10.269	+3,508	+61,534	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 10	353	332	+ 21	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 10	12.889	12,439	+ 450	+11,924	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 9	2.088	1,384	+ 706	+ 4,384h	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 10	130	121	+ 9	+ 1,000	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 10	3,590	3,512	+ 78	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 10	520	453	+ 62	+ 2,221	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,025	+ 466	+ 3,051	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Sep. 8	495	511	- 16	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	Sep. 10	343	—	—	—	7½	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 11	4,690	4,412	+ 278	+ 2,951h	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 8	1,317	1,205	+ 112	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 7	512	506	+ 6	+ 1,123	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 9	592	397	+ 195	+ 6,033	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 11	1,392	1,192	+ 200	+ 926	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C.	,, 10	801	747	+ 53	— *	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 8	1,133	—	—	—	1¾	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	Aug. 24	748	465	+ 283	+ 9,508	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

The Mont Blanc Electric Railway.—A few weeks ago we gave the terms finally decided upon for this concession, and we are now able to supplement that information by the following details in regard to construction. The curves must not have a smaller radius than 164ft. Steel rails, weighing at least 58lb. to the yard, are to be placed on metal sleepers, which will be situated at a minimum interval of 2·95ft. The gradient is 1 in 4. The trains will be composed of two or more carriages, but the total length must not exceed 65·6ft.

An Itinerant Post Office.—Milan has just witnessed an innovation in the form of an itinerant post office. A car divided into two compartments is used for this purpose. In the foremost compartment the motors and accumulators for driving the vehicle are stored, and in the after division the Post Office employés carry out the work of sorting. The car performs a tour of some 14 miles and collects the letters from the various pillar boxes, the time occupied approximating an hour and a half. The men sort and stamp the letters *en route*, and deposit them, ready for delivery by the local postman, at the different branch offices. The cars are the work of Messrs. Camona, Giussani, Turinelli, and Co.

Long-Distance Wireless Telegraphy. — It is reported that communication has been established between St. Louis and Chicago, a distance of 300 miles, by the De Forest wireless telegraph, the apparatus working with perfect accuracy. In an interview at New York, Mr. Marconi stated that he will start for Italy on a voyage eastward shortly, keeping in touch with the station at Poldhu as long as possible, with the object of determining the strength of his new transmitters and receivers. Mr. Marconi is not a pessimist, and he is credited with the prediction that he will be able to communicate with Poldhu when half way round the globe.

Rebertson Electric Lamp Works' Concert.—The football club attached to this establishment is holding a concert to-morrow night at 7.30 in aid of the club funds. Proceedings will commence at 7.30 prompt, Mr. C. Wilson, who fulfils the office of president, being in the chair. A lengthy and engaging programme has been organised, and the artistes will be reinforced by a professional contingent Mr. A. Heden, assisted by Mr. P. Pring, will be in charge of the stage arrangements, and Mr. Brown will officiate at the piano. The "turns" comprise songs humorous and sentimental, instrumental music, and a comic performance, so that the audience will be provided with a capital evening's entertainment.

Tramcar Obstruction.—No one desires to see an arbitrary assertion of their rights on the part of tramway proprietors, but when the driver of another vehicle wilfully impedes progress by continuing to crawl along the lines after the gong has sounded he becomes a public nuisance, and merits all the penalties which the law can inflict upon him. A conspicuous case of this kind occurred last week in the New Cross-road, where the driver of a vehicle, despite frequent warnings to clear the lines, kept in front of the car for half a mile, and aggravated the offence by returning to the lines when the car resumed its journey after pulling up at a stopping point. The man's conduct was obviously of a most deliberate character, and fully warranted the fine of £3, with 23s. costs, imposed by the magistrate at Greenwich Police Court. It is a rather favourite method with some defending advocates to make a bid for public sympathy by satirising upon tramway "monopoly" of the highways. Such practices are really puerile. Tramway proprietors merely claim protection against such acts as the above, and, even apart from the rights of the owners, the interests of the public demand that such protection shall be afforded.

Sources of Tramway Revenue.—The Heywood Corporation has not yet come to terms with Bury and Rochdale in regard to its trams, but some of the ratepayers are considering how the service can be utilised to the greatest advantage, and one of them writes to a local paper suggesting that it might be employed for the conveyance of agricultural produce, in addition to coal and ordinary parcels. Goods traffic has been dealt with by the South Lancashire Tramways Company for some years, and two or three of our tramway systems have introduced the carriage of parcels with considerable success, whilst Huddersfield has now matured its coal-haulage scheme. The subject has been dealt with at length in the technical Press, Mr. J. E. Waller contributing a large quantity of original matter. There is a wide field for such traffic, and where powers can be obtained it is a good way of improving a tramway's load factor.

Municipal and Company Relations.—There is a sense of the ludicrous about the incident, reported in these columns last week, connected with the tramways at Handsworth, but it also has a more serious side. The company's action looked remarkably like an attempt to steal a march upon the Council; and even if, as the company state, the junction of the electrical equipment is outside the Handsworth boundary, and the company merely intended to run a car for test purposes, they might at least have notified the authorities. Incidentally, it may be wondered—the company's object being so innocent—why the small hours were selected for the connecting-up operations. Probably no great harm would have been done if the cars had run over the whole system, but the conduct of the company was certainly irregular, and such episodes are apt to accentuate the friction between municipalities and companies. Happily, in this case the salutary lesson of the steam-roller is likely to lead to a better understanding in the future.

The Electro-Harmonic Society.—The nineteenth season of this institute is approaching, and arrangements have been concluded for again holding the concerts in the King's Hall of the Holborn Restaurant. For smoking concerts Oct. 14, Dec. 9, Jan. 20, and March 24 next have been fixed; the ladies' nights being Nov. 11 and March 24. Members are reminded that the annual subscription of 10s. 6d. is payable before the first concert. Extra tickets, price 2s. 6d. for the smoking concerts and 1s. for ladies' nights, may be obtained from the hon. secretary, Mr. W. E. Lane, whose address is now 123, Cannon-street, E.C. Mr. R. K. Gray has kindly accepted the position of hon. treasurer, rendered vacant by the resignation, on account of advancing years, of Mr. Augustus Stroh, who occupied the office since the society's formation. The committee trust that the heavy expense involved in engaging the King's Hall will be justified by a corresponding increase of membership. May harmony continue to reign supreme at these entertaining functions!

Single-Phase Electric Traction.—We understand that the consulting engineers of the London and North-Western Railway and also of the London, Brighton, and South Coast Railway are investigating the advantages of the single-phase alternate-current motor for heavy traction work This motor, if the advantages claimed for it can be realised, will greatly simplify and cheapen the cost of converting main-line railways. In the first place, the current is conveyed from the power station to the train without

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the interposition of any transforming apparatus. The transformers needed to bring the voltage down to working limits will be carried on the train itself. The cost of construction with overhead wires is thus reduced very largely as compared with the cost of the third-rail system at medium pressures. We understand that the British Westinghouse Company are experimenting in this country on the single-phase system, and that they are laying down experimentally a short length of track at their Trafford Park works, the equipment for working which will be completed within the next two months. This will enable English engineers to judge for themselves the progress made in America with the single-phase commutator motor.

Cambridge Tramways.—As will be seen from our business columns, the Cambridge Corporation have decided on the advice of their consulting engineers, Messrs. Kincaid, Waller, Manville, and Dawson, to allow the Cambridge Electric Tramways Syndicate, Limited, to electrify the Corporation tramways subject to the following conditions, which are of much interest. The Corporation, having waived their right to acquire the tramways in 1907, may acquire them in 1914, upon a valuation as a going concern, provided the sum the Corporation shall pay shall not be less than the amount the company have *bonâ fide* expended on the undertaking, including the purchase of the existing tramways and the cost of obtaining the Bill; in 1925, upon a valuation as a going concern without any further proviso; or in 1947, and after, under the terms specified in Section 42 of the Tramways Act, 1870, or any modification thereof as may be made by Parliament. The Corporation also shares in one-third of the net profits after 5 per cent. on the capital has been distributed amongst the shareholders, and an amount to be agreed has been provided for depreciation and reserve. These terms seem reasonable to all concerned, and they give the company a fair opportunity of seeing a return for their outlay. As will be seen from our business columns, the tramways are to be considerably extended on electrification.

Northampton Institute.—With September on the wane signs of activity among the technical institutions are very noticeable. The Northampton Institute has just issued its syllabus, which promises well for a continuation of the valuable work performed by this foundation. Under the direction of Dr. R. Mullineux Walmsley and his able assistants, the evening courses in electrical and mechanical engineering will be resumed on Monday next, as also will the courses in artistic crafts and other technological subjects. The evening courses in electrical engineering have been remodelled, the complete course now covering five years. The day studies in engineering, extending over four years, will begin on the 3rd prox. In the electrical section special attention is devoted to traction and electrochemistry, in addition to the ordinary work in lighting and power distribution. The institute's system of combining the theoretical and practical sides is well known. It is believed that the complete day courses in technical optics, included in the institute's programme for the first time, are the first attempted in any country. The evening classes in this section are separated from the applied physics department, and have been remodelled under Mr. S. D. Chalmers. Day courses for artistic crafts also appear for the first time. The admirable methods in vogue at the Northampton Institute will doubtless commend it to those contemplating a technical career.

An Automatic Telephone Exchange.—In the Berlin Imperial Postal Museum has been installed a model of an automatic telephone central station. In order to allow of the working being watched readily, the exchange has been placed in a glass case. It is actuated by putting at the speaking station a finger into a disc perforated with numbered holes and turning the disc up to a certain point, when a group distributing switch will first be moved in the exchange, the connections being divided into groups according to the decimal system. As soon as the adjustment by means of the finger is repeated, for the next small number a secondary group and, finally, a line distributing switch (*linienwähler*) will be actuated. In the central station installed in the museum four groups of two-line distributing switches have been connected together, being of the same size as in the exchange existing in Berlin. The telephonic apparatus themselves have also been adapted to German practice. As soon as a call is made the apparatus is seen to work rapidly and safely, any connections being effected at a surprising rate. In fact, the exchange will at any time be ready and prepared to serve any subscriber. In the case of the number called for not being disengaged, this is signalled by a cracking noise in the receiver. By placing the receiver on its hook, the connection is instantly broken, all being ready for a new connection. There is practically no noise in the working of the exchange, and instead of conversations there is only heard the slight humming of the interrupter for the working current.

The Birkbeck College.—This institution, which is located at Bream's-buildings, Chancery-lane, and has now completed 81 years of educational work in the Metropolis, commences the new session on Monday, Oct. 3, when Dr. J. E. Mackenzie will give the opening address at 7.30 p.m. The day and evening courses of study comprise the various branches of natural science (chemistry, physics, botany, zoology, geology, etc.), mathematics, Latin, Greek, modern languages, economics, commercial subjects, law, logic, and psychology. Courses, conducted by recognised teachers of the university, provide for the examinations of the University of London in the faculties of arts, science, and commerce. The report for the last session shows that during the year 71 students passed some university examination, while a large number gained successes at various public examinations. Special classes prepare for the conjoint Board and Civil Service examinations. The college has added considerably to it appliances in recent years, and the physical, chemical, biological, and metallurgical laboratories are very thoroughly equipped. Courses in mining, metallurgy, and assaying are given both in the day and evening. The modern language classes include Russian, Spanish, Italian, and Dutch, as well as French and German. The college has a school of art, open both day and evening. Good reading and magazine rooms are provided. The calendar supplies much detailed information respecting the courses of study, examinations, studentships, etc. A popular lecture or entertainment is given in the theatre every Wednesday evening during the session.

Theatre Lighting in America.—The terrible fire at the Iroquois Theatre in Chicago last December has led to a general overhauling of the theatres in that town in an attempt to "close the stable door after the horse has escaped." Our contemporary, the *Western Electrician*, describes the new equipment for electric lighting at the Alhambra Theatre, and some of the provisions clearly show that the authorities have a knowledge of the London County Council's regulations governing such work. For instance, there are two centres of distribution in the building, one on the stage and the other in the box office. In the event of a fire on the stage, the throwing of a switch in the box office will connect all the lights in the lobbies and exits on to an outside supply system. This renders it practically impossible for the theatre to be left in darkness for any length of time. When lights are needed in the

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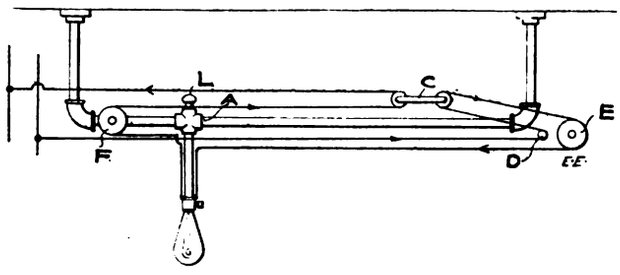
ordinary way, the whole of the theatre lights are supplied from its own plant. The wiring in the building is carried out on the separate-circuit principle, no more than a dozen 16-c.p. lamps being allowed on one circuit. It will be seen that the limit is considerably higher than that recognised as the best work in this country, where six or seven lamps is about the limit. All the wires are installed in loricated iron conduits, and are so arranged that they can be used either on the two or three wire system. The switchboard for controlling the stage-lights and varying the candle-power of the same resembles the usual English type, as it contains provisions for the linking of the dimmers, and a number of circuits so that they may be operated simultaneously. The switchboard is iron-clad, and is said to be waterproof as well as fireproof. Intercommunication telephones, the wires for which also run in iron conduits, are provided, connecting the box office, the fly gallery, and the orchestra with the stage electrician. The electrical work at this theatre, although good, does not seem to be any better than that insisted upon in London for the last five or six years.

Lamp Suspension over Work Bench.—Mr. W. F. Sheaf, of Herkimer, New York, is responsible for the following illustration, for which we are indebted to the *Western Electrician*, of a method of suspending an electric lamp over a desk, work bench, lathe, etc., in such a way that the light may be moved from one end of the work bench to the other, without any loose wire. The contrivance also allows the lamp to be placed out of the way when not in use. The frame is made of ¼in. or ⅜in. pipe, attached to the ceiling by floor plates. A represents a pipe-cross drilled out so that it will slide upon the pipe,



with a thumb-screw (L) threaded through a pipe plug and used to fasten the lamp up out of the way when not in use, and also to fasten it at any angle when in use. The arrows indicate the direction of the current in the lamp cord. Two movable pulleys linked together are shown at C. D is a porcelain knob to which the lamp cord is tied, and E and F are fixed pulleys. The lamp and movable pulleys, C, move in opposite directions. As one cord lengthens, the other shortens, and *vice versâ*. The device is ingenious, but the number of wires and pulleys employed makes one doubt the practicability of the same for a work-shop. We are afraid that in England, at any rate, the hooking up of a flexible cord will still hold the field for this purpose.

The Lynchburg Trolley Ear.—For the last eight months the Lynchburg (Va.) Traction and Light Company have been using with very satisfactory results the new type of trolley ear devised by Messrs. S. H. Cochran and A. E. Anderson, of which a description is given in the *Street Railway Journal* of New York. The ear is adapted for both round and grooved wire. The cap of the ear is provided with a depending post, having a wedge-shaped slot cut through it near its lower end. The lower end of this post is cut away and provided with a rounded shoulder, and the extreme lower end is also cut away to provide a shoulder and a downwardly projecting lip. The ear is substantially U-shaped in cross-section, and upon its lower face is straight from end to end, but the inner bottom face of the ear is convex. The ear is provided with an arm extending upward and terminating in a tubular-shaped portion, which is provided with a bevelled bearing face. The bottom of the bore of the tubular division is rounded to form a seat. Both the tubular extension and the post are furnished with slots arranged to coincide and permit the insertion of a key. This key is provided with a set of perforations, through any of which the key can be locked by the insertion of a cotter-pin. A wedging piece is formed in substantially the same arc as the convex face of the ear. This wedging piece is provided in its upper edge with a notch in which the shoulder of the post is adapted so as to be seated when the parts are assembled for locking. In using the ear the trolley wire is deflected and placed within the ear. After the wire is in the ear, the wedging piece is placed in it, with its curved face resting upon the upper face of the wire. The ear is then pushed upward, and the tubular extension passes over the post until the shoulder of the latter engages with the notch in the wedging piece, the lip of the post bearing upon the outer face of the wedging piece, and thereby holding it firmly in position. The key is then inserted and locked. Should the key for any reason come out of the post, the ear would fall to the ground and leave the trolley wire free from any obstruction. Actual tests have shown that the ear can be removed from and replaced on the wire in two minutes. A modified form of construction is adapted to grooved or figure 8 wire.

The Electrical Production of Steel in Sweden. Those furnaces in which the direct heat of an arc formed between an electrode and the iron in the furnace is employed are handicapped by the fact that the temperature of the arc is in the neighbourhood of 3,700deg. C., which is much more than is necessary to melt steel, consequently the metal close to the arc becomes burnt before that further off is melted. Another type of furnace that has occasionally been tried depends on the heat developed in the steel itself by the passage of a heavy current. The low resistance of the metal in the molten state, however, necessitates the use of enormous currents with such furnaces, and this leads to trouble at the electrodes and great expense in the copper supply mains. According to the *Elektrotechnische Rundschau*, an improved furnace, depending on the induction principle, has been at work for some time past at Gysinge, in Sweden, with very satisfactory results. The smelting chamber consists of an annular cavity, coated inside with firebrick and closed at the top by lids which are preferably on the floor level. Through the centre of this ring one limb of a rectangular transformer core passes, the remainder of the core being completed beyond the ring. The core is, in fact, linked with the annular cavity like one link of a chain is looped with the next. The primary winding of the transformer is placed immediately round that limb of the core which is surrounded by the annular chamber. A single-phase alternating current is passed round this primary winding, and induces a flux in the iron core, which, in turn, sets up a current in the material to be melted, the value of this secondary current depending on its primary voltage and the primary turns. The first of these furnaces was set up in 1900, and produced steel excellent in quality, but at a slow and expensive rate, the output being only 595lb. of steel in 24 hours with a power expenditure of 78 kw. A few months later a second improved furnace was erected which gave 1,320lb. to 1,540lb. per 24 hours with 58 kw. In 1902 the matter was taken up on an enlarged scale, and has been working satisfactorily ever since. The capacity of the new furnace is 3,960lb., and out of this only about 2,200lb. to 2,420lb. is drawn off at a time, so

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that the secondary circuit is never quite broken. The rate of production is 9,050lb. of steel per 24 hours with a a power of 165 kw. The supply is obtained from a 3,000-volt single-phase generator, and the secondary current through the steel is about 30,000 amperes. The steel produced is of exceptionally good quality, and unusually dense and homogeneous. It can be readily worked cold, and is less liable than ordinary steels to spring or become distorted when hardened.

New Publications.—Messrs. Cassell and Co. have forwarded us a copy of "Electricity in the Service of Man," upon which Dr. Walmsley has been engaged for some three years past. This is the fourth edition, which, owing to the advance of electrical science since the previous issue was published in 1893, has been practically re-written from cover to cover. It has already circulated in serial form, the first number making its appearance in October, 1901. In issuing the present volume the author was confronted with the problem of inadequate space, for, though the extent of the work has been increased by nearly 200 pages, bringing the total up to 1,200, the recent rapid progress of the science presented an extensive and diversified field. Dr. Walmsley was therefore compelled to choose between treating the various branches in an abbreviated form and dealing fully with a portion only of the work originally contemplated. Finally, he decided upon the latter plan, thinking that if the reception of the present treatise be favourable, a supplementary volume, dealing with the omitted branches, might be issued in the near future. The work is divided into two sections. In the first, the author deals with the history and principles of electrical science; and the lucid manner in which it has been compiled, supplemented by copious and graphic diagrams, will render it eminently comprehensible to the student, or even to the lay mind. The second part, dealing with the technology of electricity, will be vested with interest for members of the profession, comprising, as it does, an account of recent developments on the practical side, accompanied by full discussions of the underlying principles involved and the methods available for utilising them. After treating in detail generators and motors for both continuous and alternate currents, the volume concludes with a chapter on electrical measurements, in which most types of modern instruments are included. This section, too, is splendidly illustrated, and purchasers of Dr. Walmsley's admirable production will obtain a good return for their 10s. 6d. The author records his indebtedness to many friends and manufacturers, and also to the technical Press, for the assistance accorded him.—"Carpentry Workshop Practice," by C. F. and G. A. Mitchell. (London: Cassell and Co.). 1s. 6d. An excellent little manual—one of the Polytechnic series—specially prepared for students following recognised courses, and also adapted to the needs of the large body of votaries unable to pursue organised instruction. The Year Book of the Michigan College of Mines has just come to hand. This foundation was established under statutory authority in 1885, and provides specialised courses in the different branches of mining engineering. It is particularly happy in its location, being situated in the midst of the great mining region of Lake Superior, and practical work is a dominant feature in the programme of the college, which during the past year received an accession of 231 students. Many of the high schools are affiliated to the college, admission to which is gained by passing a preliminary examination or producing a diploma from an accredited institution, while special arrangements are made for the reception of students who have not undergone an academic preparation. Highly interesting descriptions of the college buildings and equipment, the library, text-books, and degrees are contained in the volume, and the detailed syllabus for the ensuing session augurs well for the continued success of the college. While it does not guarantee appointments, the college takes a close interest in the future welfare of its graduates, and the Year Book is supplemented by a register containing a complete list of their qualifications.—"Journal of the Western Society of Engineers (Chicago)." The issue for August contains a paper by Mr. G. S. Rice on "The Use of Steel for Coal Mine Tipples, and a Classification of Same," and one on "Railroad Signalling," by Mr. G. E. Ellis, with the discussions thereon. Mr. A. N. Talbot deals with "Flexure of Reinforced Concrete Beams," and Mr. E. B. Elliott describes some of the electrical features of the St. Louis Exhibition.

Electric Waves.—At the recent Cambridge meeting of the British Association Dr. J. A. Fleming presented to Section A his paper on "The Propagation of Electric Waves along Spiral Wires and on an Appliancé for Measuring the Length of Waves used in Wireless Telegraphy." This paper is concerned with an experimental and theoretical treatment of the propagation of electric waves along spiral wires. The subject has engaged the attention of several physicists. Hertz has described an experiment in which he established stationary electric waves on a spiral wire and compared the distance of the nodes with the corresponding distances when the wire was stretched out straight. Theoretical treatment has been given by H. C. Pocklington, and G. Siebt has devised lecture apparatus for exhibiting the propagation of stationary waves on spiral wires. The first experiments described by the author were made with a long helix of insulated copper wire, wound in one layer on a wooden rod. The helix consisted of 5,000 turns, the length being 200cm. If such a helix is placed in connection with an oscillating circuit consisting of a condenser or Leyden jar, a spark gap, and a variable inductance, stationary waves could be set up on the helix by adjusting the inductance in the oscillating circuit. In order to detect the nodes and antinodes of these stationary oscillations, the author makes use of a vacuum tube, similar to that used in spectrum analysis, preferably one filled with the rare gas, neon, which was kindly supplied to him by Sir William Ramsay. Rarefied neon seems to be extremely sensitive to the presence of variable electric force through it; hence, if such a tube is held perpendicular to the helix and moved parallel to itself along it, it glows brightly at the antinodes but not at the nodes. In this manner the internodal distances can be measured with considerable accuracy, and the wave-length of the stationary oscillation measured. The paper also contains a theoretical analysis of the phenomena leading to the conclusion that the velocity with which the wave is propagated along the spiral is inversely proportional to the square root of the product of the capacity and inductance of the helix per unit of length. The author has perfected of late years methods for measuring very small capacities and inductances, and in the case of the above-named helix the inductance is equal to 100,000cm. per centimetre, whilst a capacity of the helix is $\frac{7}{40}$ of a micro-microfarad (one micro-microfarad $=10^{-6}$ microfarad) From these data the velocity of propagation of electric waves along the helix can be shown to be 235,000,000cm. per second. This figure is confirmed in the following manner: The capacity and the inductance in the oscillating circuit are both measured when the first harmonic oscillation is formed on the helix, and under those conditions the half wave-length was found to be 140cm., whilst the frequency in the oscillating circuit, as calculated

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from the capacity and inductance, was found to be $0\,847 \times 10^6$. Having, therefore, the wave-length and frequency, we find their product gives a velocity of 235,000,000cm. per second, which agrees with the figure determined from the constants of the helix. It is shown in the paper that the best form of inductance to be employed in connection with the oscillating circuit is a square of one turn of wire, and that the employment of spiral coils leads to errors due to passage of a dielectric current from coil to coil. On the above lines an apparatus has been devised by the author for measuring wave-lengths in connection with Hertzian wave wireless telegraphy. It is a matter of considerable importance to be able to determine the frequency and wave-length of the waves sent out by any given transmitting arrangement. The author calls this instrument a "kummeter." It is constructed as follows: A long ebonite rod is wound over closely with silk-covered wire in one layer, and this is supported on insulating stands. On this long helix slides a metal saddle having some layers of tinfoil interposed to make good contact between the saddle and the helix. This saddle is connected by a flexible wire with the earth. One end of the helix is furnished with an insulated metal plate, which is placed in apposition to another metal plate connected to the oscillating circuit of the transmitter. The process of measuring the wave consists in sliding the saddle along until a Neon vacuum tube indicates the presence of one note half-way between the saddle and the plate. When this is the case, the distance from saddle to plate is one wave-length of the stationary wave on the helix. From the constants of the helix the velocity of the wave along it can be calculated as above shown, and hence the frequency of the oscillating circuit becomes known. If this frequency is divided into the velocity of light, reckoned in feet, it gives the wave-length in feet of the wave radiated from the associated aerial, provided that the aerial radiating wire has been tuned to be in resonance with this oscillating circuit. This instrument also provides the means of measuring small inductances, and also the frequencies in oscillating circuits, which are much higher than those which can be determined by photographing the spark.

Testing a 2,750-kw. High-Tension Alternator and Transformer.—The *Schweizerische Elektrotechnische Zeitschrift* gives a detailed account of some interesting tests carried out on three 10,500-volt, 2,750-kw., three-phase alternators and three three-phase 10,500-46,000-volt transformers of the same output, built by the Maschinenfabrik Oerlikon for the Caffara water-power installation in Brescia. The generators are of the standard stationary armature type, and are wound for 9,000-10,500 volts, 150 amperes, 315 revolutions per minute, 42 periods. Though the maximum volts by the maximum amperes correspond with a load of 2,760 kilovolt-amperes, the normal load is actually only 9,000 volts at 150 amperes, or 2,340 kilovolt-amperes, with a power factor of ·75. The armatures have three open slots per pole per phase, and the coils are former-wound. The pole-shoes are of the slanting form adopted by the firm in order to ensure a sine wave of E.M.F., and the whole pole is thoroughly laminated. Each complete machine weighs some 81,550lb., and the rotating part alone about 29,750lb. With the power available it was not possible to test the machines under load, so the following method of determining the drop, efficiency, and heating was adopted: One alternator was directly coupled to a direct-current motor of about 400 h.p., and the no-load losses and open-circuit characteristics were obtained. This motor-driven alternator was then made to drive the second alternator as an unloaded synchronous motor, and the no-load losses of this synchronous motor were measured by means of a wattmeter placed between the two machines, after adjusting the synchronous motor excitation until the minimum armature current was reached. These motor no-load losses by wattmeter were found to check very closely with the light-load losses of the generator, measured by the aid of the direct-current motor. In order to get an idea of the increase in the core and eddy-current losses with load, the excitation on the generator was next increased and that on the synchronous motor decreased, until the full-load current (150 amperes) was flowing in both armatures, the power factor being practically zero, and the wattmeter measurement was then repeated. It is interesting to note that in order to produce this state of affairs the generator excitation had to be increased to 220 amperes and that of the motor reduced to 72 amperes, the normal full-load excitation with ·75 power factor being 160 amperes. The additional load losses, after subtracting the known $C^2 R$ losses in the armatures, were found to amount to only 4 kw. per machine (the ordinary no-load losses, excluding excitation, being 63 kw. per machine), so that they may be neglected. The commercial efficiency, including exciting losses, of each generator was specified as 95 per cent. at a load of 1,760 kw. with $\cos \phi = 1$, and, using the measured no-load losses, this efficiency works out at 95·8 per cent. The voltage drop was specified as 6 per cent. with $\cos \phi = 1$ and a load of 1,760 kw., and 16 per cent. with $\cos \phi = ·75$ and a load of 2,340 kilovolt-amperes, and the amounts estimated from the observed open-circuit and short-circuit characteristics of the machine were 3·5 and 13 per cent. respectively. The 24-hour temperature test taken at 10,500 volts 120 amperes, with the generator over-excited and the synchronous motor under-excited as above, gave equally good results, the maximum rise on the generator armature being only 28·5deg. C., and on its magnets 14·5deg. C., whilst the specified rise was 35deg. C. The transformers are of the standard Oerlikon oil and water cooled type, the water cooling being, however, carried out in a somewhat novel manner by making the upper part of the cast-iron case double walled, and fitting a number of ribs in the space between the walls, so as to cause the water to circulate up and down between them all round the case. In this way a good cooling effect is obtained without the risk of the water leakage which sometimes occurs with the usual circulating pipes suspended in the oil. The cores consists of three rectangular limbs side by side. The low-tension winding consists of bare flat copper strips insulated with presspahn, and is wound next the core, the high-tension winding being outside. The core losses at 9,000 volts were found to be 20½ kw., and the copper losses at 150 amperes were 12 000 watts, giving an efficiency of 98·5 per cent. at 1,760 kw. $\cos \phi = 1$, or 98·2 per cent. at 2,340 kilovolt-amperes $\cos \phi = ·75$. By means of a short-circuit test the drop was found to be 4·25 per cent. at 2,340 kilovolt-ampere $\cos \phi = ·75$, or ·5 per cent. at 1,760 kw. $\cos \phi = 1$. The wattmeter measurement on the short-circuit test, with 150 amperes passing, showed only 14,000 watts, their comparatively small addition for eddy currents being probably due to the small section of the copper wires. The transformers were tested for heating on open circuit, but with the voltage increased to over 12,000, so that the core loss alone amounted to 32 kw.—*i.e.*, as much as the sum of the core loss and copper loss under normal full-load conditions. In this way it was found that at 2,340 kilovolt-amperes the temperature would be within the specified 45deg. C., with a water circulation of about 23 pints per minute in each transformer. The gross weight of each transformer with oil is 26,500lb., or 22,040lb. without oil.

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HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE.*

BY ALEXANDER SIEMENS, PAST-PRESIDENT.

(*Concluded from page 409.*)

Of great importance are the results obtained while accelerating and during the retardation of the cars. The

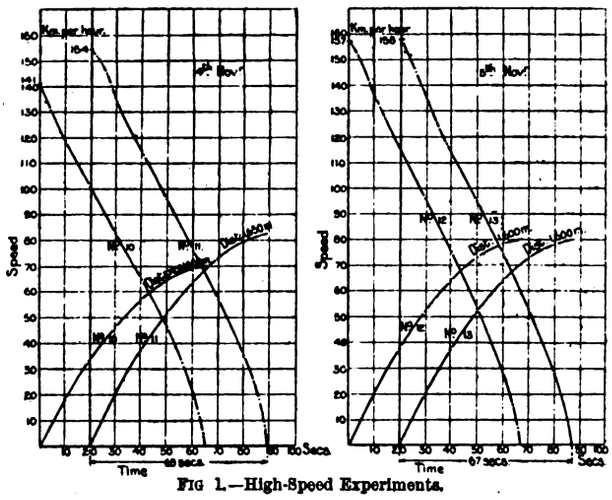


FIG 1.—High-Speed Experiments.

acceleration varied with the demand on the generating station and the motors, as was to be expected. To obtain a speed of 100 km. per hour the distances travelled varied from 2,000m. to 3,200m., and the times from 138 to 220 seconds. These figures correspond to an average acceleration of 0·13m. to 0·2m. per second, and correspond to

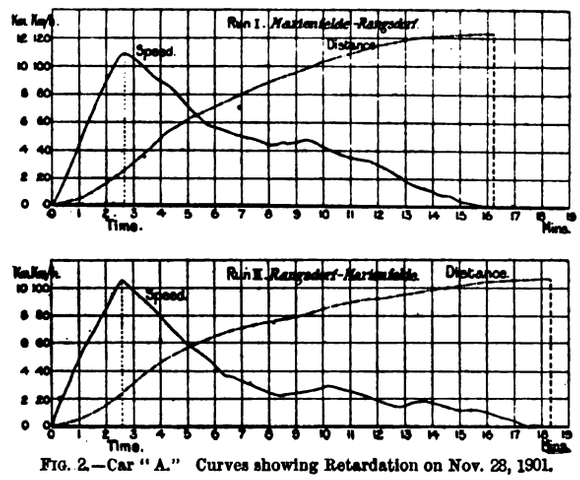
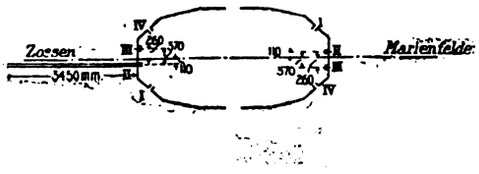


FIG. 2.—Car "A." Curves showing Retardation on Nov. 28, 1901.

trains intended to travel long distances without stops the rate of acceleration is, however, of less importance than the action of the brakes on which the safety of the service depends. Both cars were fitted with a Westinghouse quick-acting brake, hand brakes, and an electric brake acting by reversing the currents through the motors. The "A" car had, in addition, an accumulator battery, the current from which could be sent through the three-phase motors. A great many trials with these brakes are reported, which are not important enough for recording in detail as the brakes were not satisfactory, but a few curves are reproduced in Fig. 1 showing the results. In Fig. 2 the decrease of speed is shown when the "A" car was left to itself after attaining a speed of about 106 km. per hour respectively. The wind at the time was W.N.W., and had



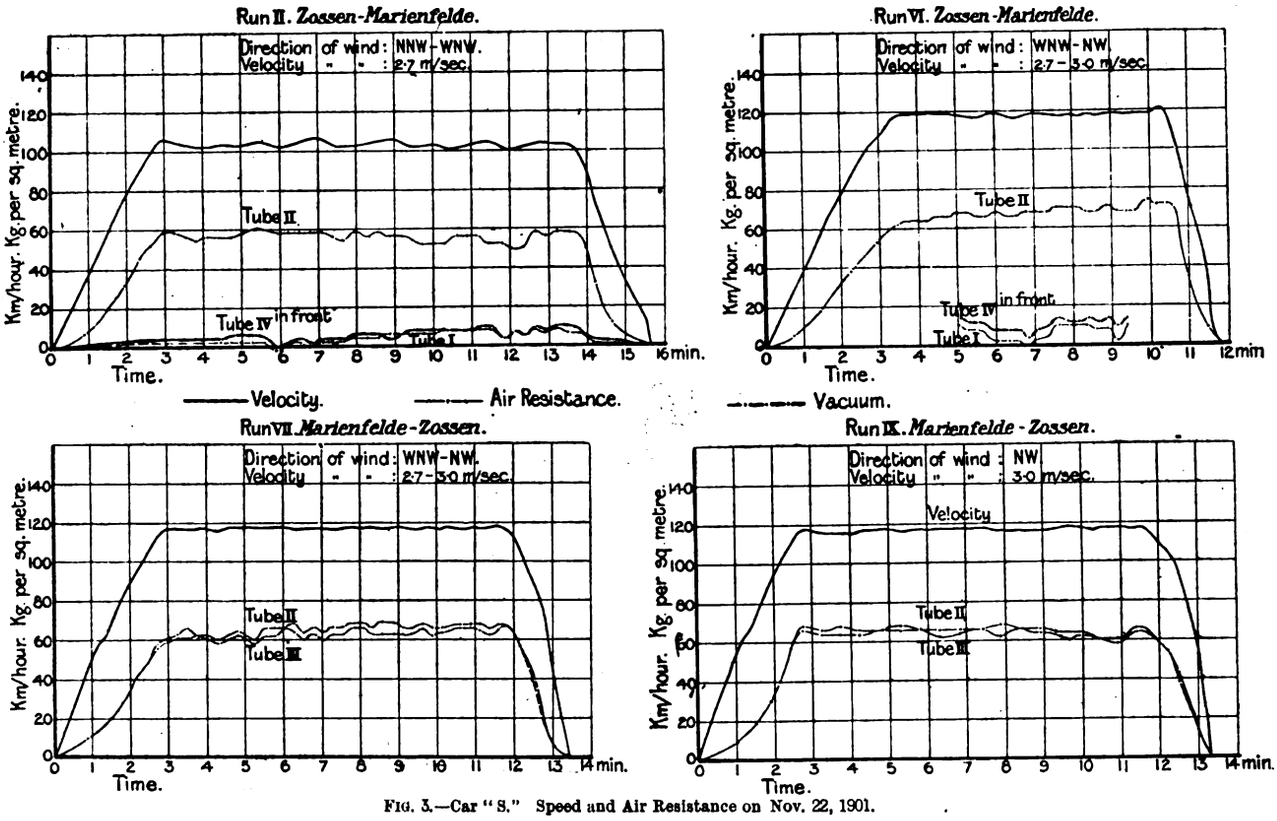


FIG. 3.—Car "S." Speed and Air Resistance on Nov. 22, 1901.

700 h.p. to 100 h.p. As the motors are capable of exerting up to 3,000 h.p. during acceleration, this might have been increased correspondingly, but the generating set was not powerful enough to supply the necessary current. For a speed of 11·4m. per second; it offered, therefore, less resistance during the run from Marienfelde to Rangsdorf than in the opposite direction.

Very numerous observations were made about the consumption of energy, both in the generating station and on

* Paper read before the Institution of Electrical Engineers.

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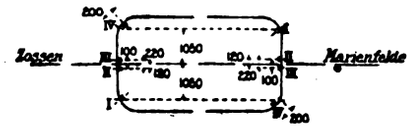
the cars, especially during the last set of runs. For this purpose readings were taken at the switchboard in the generating station every 10 seconds of the volts, amperes, and watts, and the periodicity of the current was checked by the number of revolutions of the generating set. On the cars amperes and volts were read at intervals of from



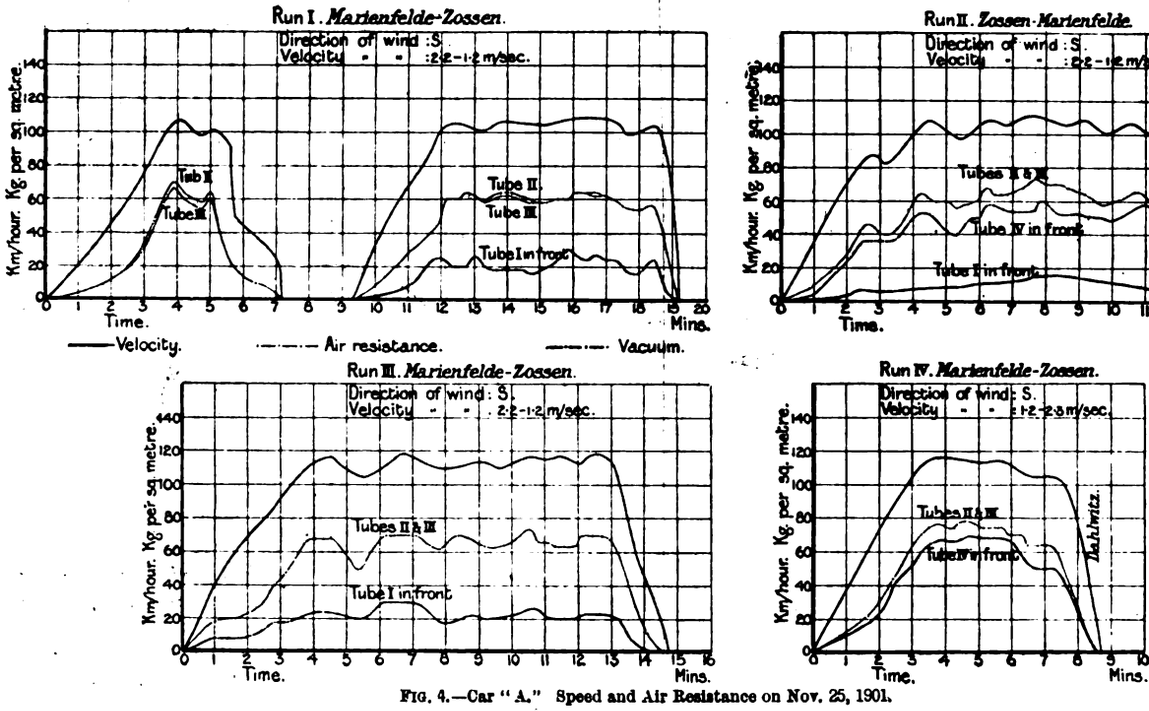
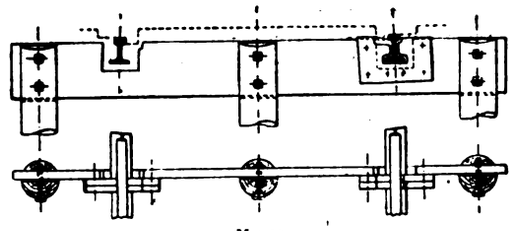


FIG. 4.—Car "A." Speed and Air Resistance on Nov. 25, 1901.

15 to 30 seconds. The measurements at the station were the most accurate, as the instruments there were not exposed to the vibrations unavoidable on the cars. After making the observations they had to be corrected, as the instruments were only correct at a certain periodicity. Numerous further measurements were taken, and the following table gives the average result of the power required at a constant speed.

The report does not consider these figures reliable enough for commercial deductions, partly because the instruments were not properly calibrated for the varying periodicity of the current, partly because the motors in both cars were working very much below their rated output.



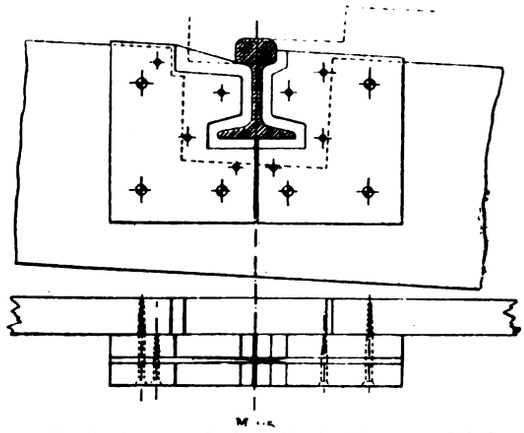


FIG. 5.—Apparatus for indicating the Movement of Rails.

Car.	Speed. Km. per hour.	B.H.P. Measured at feeding point.	B.H.P. Measured at car collector.	B.H.P. Calculated from speed.	Efficiency of electrical outfit. Car by itself.	Efficiency of electrical outfit. Car and conductors.	Consumption of steam. Kg. per B.H.P. per hour. At car wheels.	Consumption of steam. Kg. per B.H.P. per hour. At flywheel of steam-engine.
"A"	118	478	455	397	87 %	83 %	5·84	4·6
"B"	115	431	405	341	84 %	79 %	6·12	

For the purpose of observing the air resistance at the various speeds, openings were made in various parts of the car bodies and short brass tubes inserted. These tubes were connected by indiarubber tubes to a row of pressure indicators, consisting of pairs of communicating glass tubes about 5mm. in diameter partly filled with water. An adjustable scale was fitted to each indicator, divided into millimetres, so that the difference in the water-level of the two tubes could be observed at the various speeds. Four such openings were made at each end of either car, two of which were near the centre and the other two at the sides, as indicated in the diagrams of Figs. 3 and 4. Preliminary

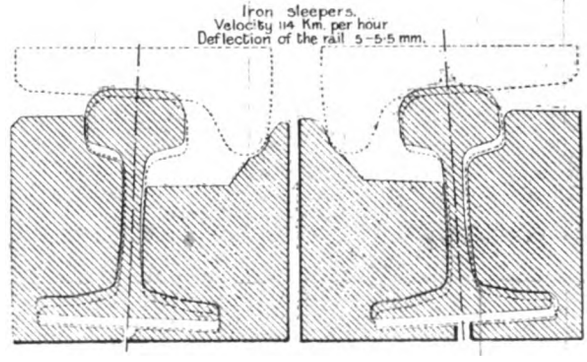


FIG. 6.—Diagram of the Displacement of the Rails on Nov. 30, 1901, at 15·8 kilometres.

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trials proved that the position and the form of the opening of the brass tubes have no influence on the result, and this made it possible to compare the pressure all over the front of the car with the pressure in the centre, independent of the varying speed of the car. In addition, straight tubes, up to 3·4m. long, were fitted to explore the pressure of the air in front of the car, and these observations showed that a cone of uniform pressure exists in front and at the back

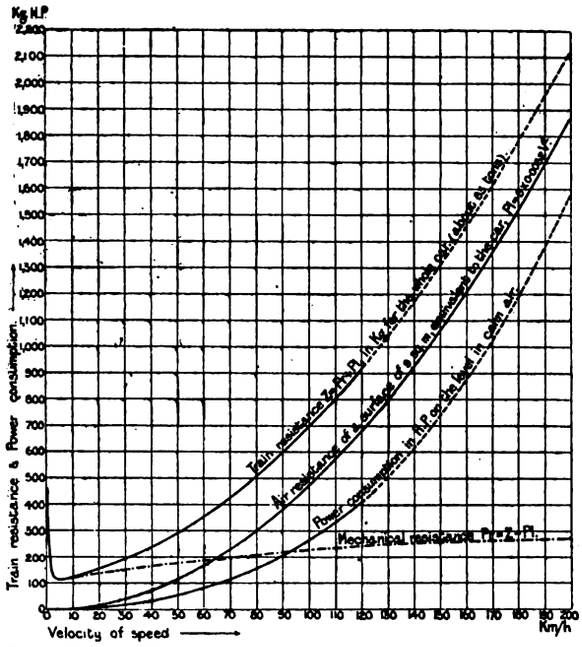

FIG. 7.—Train Resistance and Power Consumption of the High-Speed Cars.

of the car, the apex of which was about 3m. distant from the car. The "A" car, as the diagram shows, has well-rounded corners, while the "S" car has its ends in the shape of truncated cones. The pressure on these was very much smaller than in the centre, and sometimes even negative owing to the influence of the wind. Some openings were also made along the sides of the car, and occasional observations showed that speed had very little influence on the pressure indicated, when the brass tubes ended flush with the sides of the car, and that the direction of the wind has much more effect. The Tables VI. and VII. show the results of observations made during several runs of both cars.

Combining all the results, the report considers that up to a speed of 150 km. per hour the pressure may be calculated by the equation $p = 0{\cdot}07\ v^2$, when v is the velocity in metres per second and p is the pressure on a surface of one square metre at right angles to the direction of the motion. The number of observations were, however, insufficient to determine the best form for the end of the cars. Another set of observations was made to determine the extent of the movement of the rails when the cars

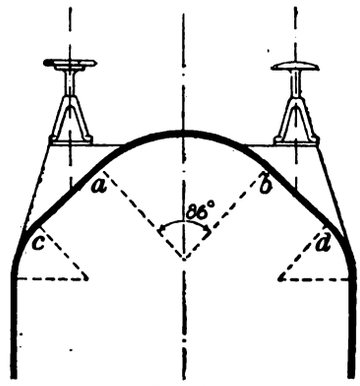

FIG. 8.

were passing at various speeds. For this purpose measuring apparatus were set up at various points of the line, which are shown in Fig. 5. Each of these consists of three strong posts, about 1½m. long, rammed into the ground, one in the centre and one on each side of the rails, to which a strong board is fastened with its upper edge a little below rail-level, and with suitable openings cut to permit the rails to pass through. Near each rail two short boards are bolted to the plank, between which a lead plate is supported. This is cut in two and fitted accurately against the rail, the edges touching the rail being sharpened. It is evident that any movement of the rail will bend these edges back, and thus leave a permanent record of the greatest movement of the rail. The result on one set of lead plates is shown in

FIG. 9.—TABLE A: AVERAGE VALUE OF THE ELECTRICAL AND MECHANICAL MEASUREMENTS TAKEN DURING ACCELERATION.

No. of runs.	No. of motors working.	Total weight of train in tons.	Distance in metres.	Falling gradient, average per cent.	Average acceleration, m/sec.	Final speed, km./hour.	No. of periods per sec.	At feeding point			At collector of car			
								Amp.	Volts.	Kw.	Amp.	Volts.	Kw.	H.P.
5	2	89·5	4,430	0·30	0·08	88·6	20·6	51·2	5,662	—	50·0	5,376	358	487
2	4	89·5	3,950	0·84	0·12	97·5	20·8	—	5,165	—	74·2	4,835	446	606
6	2	89·5	7,930	0·54	0·07	106·0	24·0	51·1	6,383	—	50·1	6,024	407	553
2	4	89·5	4,550	0·57	0·11	102·5	25·0	—	6,740	—	76·0	6,360	535	727
3	4	188·4	8,700	0·61	0·07	113·3	25·0	101·0	6,253	880	—	—	813	1,105
9	2	77·9	2,744	1·11	0·13	91·2	20·8	52·6	5,472	—	51·8	5,257	394	535
9	2	77·9	4,294	0·68	0·12	105·6	24·0	51·1	6,290	—	50·5	5,950	434	590
6	4	159·6	5,583	0·60	0·11	116·7	25·0	108·2	6,237	1,010	105·6	5,938	928	1,261
1	4	193·4	8,300	—	0·07	115·0	25·0	110·0	6,140	988	107·0	5,450	855	1,160

REMARKS.—Car A: Runs 5, 2, 6, 2, car alone; 3, car drawing three passenger cars. Car S: 9, 9, car alone; 6, car and two passenger cars; 1, car and three passenger cars. Observations taken in autumn, 1902.

TABLE B.—AVERAGE VALUE OF THE ELECTRICAL AND MECHANICAL MEASUREMENTS TAKEN DURING PERIODS OF RUNNING AT CONSTANT SPEED.

No. of runs.	No. of motors working	Total weight of train in tons.	Average speed, km./hour	No. of periods per second.	At feeding point.			At collectors of car.				Efficiency of electrical output, %.	Power exerted on wheels.	
					Amp.	Volts.	Kw.	Amp.	Volts.	Kw.	H.P.		H.P.	Pull in kg.
4	2	89·5	95	20·6	43·4	5,835	—	42·1	5,543	246	335	82·7	277	788
2	4	89·5	96	20·8	—	5,450	—	64·0	5,190	247	336	69·7	234	660
5	2	89·5	107	24·0	45·6	6,460	—	43·8	6,089	302	410	86·4	354	892
2	4	89·5	113	25·0	—	6,830	—	71·5	6,390	365	496	79·1	392	938
2	4	188·4	117	25·0	84·7	6,647	694	—	—	644	875	87·1	762	1,760
8	2	77·9	92	20·8	36·7	5,781	—	34·5	5,619	197	268	84·0	225	660
8	2	77·9	106	24·0	39·2	6,447	—	36·8	6,162	283	385	86·5	333	850
4	4	159·6	117	25·0	69·2	6,937	566	65·0	6,685	499	679	85·5	580	1,330
1	4	193·4	118	25·0	81·5	6,700	713	75·0	6,425	680	925	87·7	810	1,840

REMARKS.—Car A: Runs 4, 2, 5, 2, car alone; 2, car and three passenger cars. Car S: 8, 8, 4, 1. Observations taken in autumn, 1902.

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Fig. 6, and a summary of the principal observations is the following:

Distance between sleepers.	Material of sleepers.	Ballast.	Speed km. p.h.	Depression of rails in mm.
850mm.	wood	sand*	108	2·0–2·5
850mm.	wood	sand*	114	3·5–5·0
780mm.	wood	stones*	145	6·0–6·5
780mm.	iron	sand*	114	5·0–5·5
780mm.	iron	sand*	135	6·0–6·5
730mm.	iron	sand*	123	6·0–7·0
850mm.	wood	sand†	70–80	1·5–2·0
730mm.	iron	sand†	70–80	4·0

* Motor cars. † Military trains.

was also experienced in seeing sufficiently far ahead in rainy weather. It is, therefore, suggested to repeat the signals on the car by visual and by audible means, which should also indicate when the apparatus is out of order. In addition, it is recommended to cut the current off in the sections which a car has just left.

In conclusion, the first report states that, thanks to the care exercised by the firms supplying the cars and outfit, to the cautious and reliable execution of all the electrical work, to the careful maintenance of the permanent way and its appurtenances, and to the conscientious observation of all the precautionary measures, no mishap or damage of any kind has occurred during the trials. No psychological effects on the drivers or

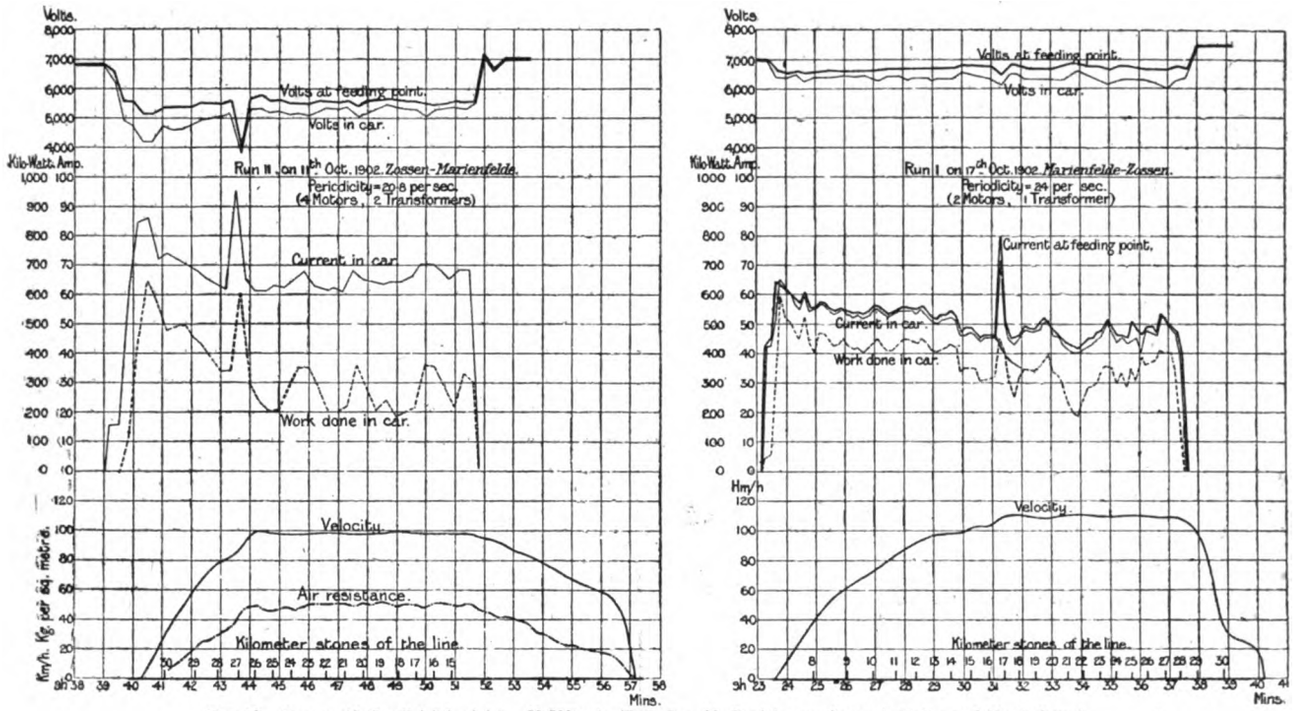

FIG. 10.—Runs with Car "A" (weight = 89,500kg.) (Velocity, Air Resistance, Current, Volts, and Work done)

From these experiences the conclusion was drawn that the permanent way had to be thoroughly reconstructed before speeds exceeding 120 km. per hour could be safely

passengers, attributable to the high speeds, have been noticed. Although it has not been possible to obtain reliable data for judging the economical aspect of this

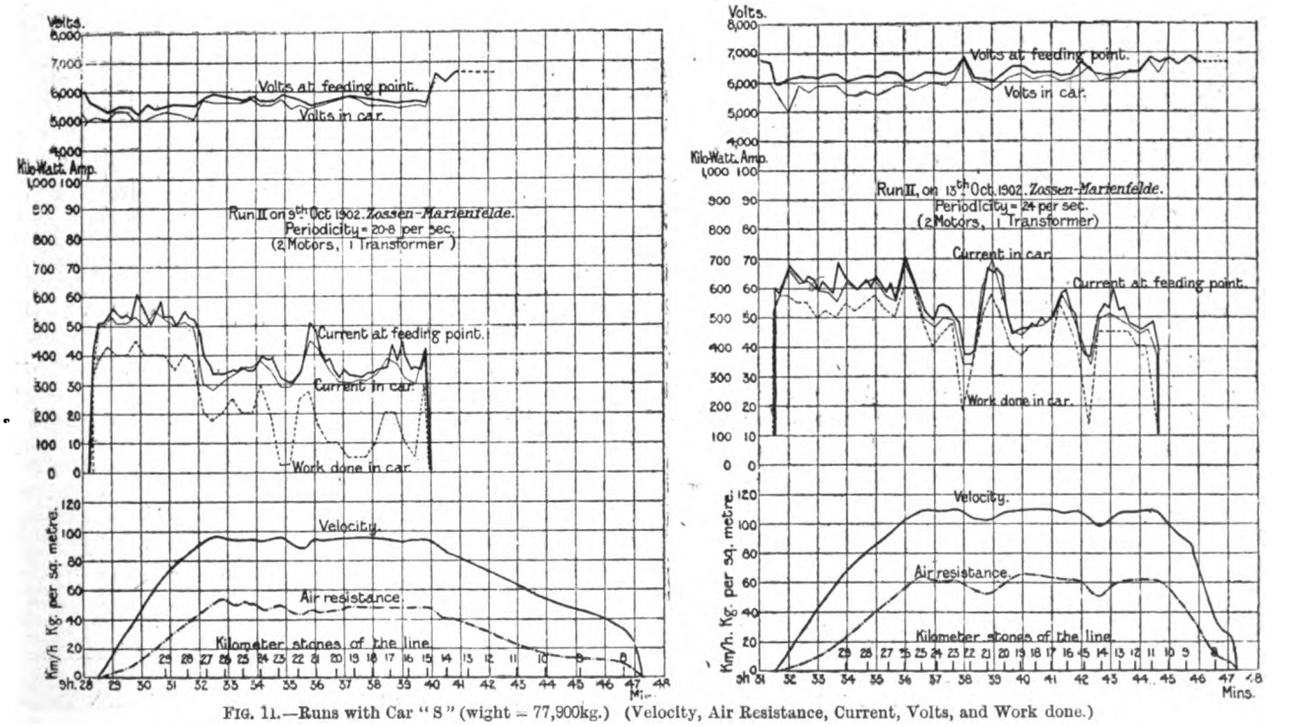

FIG. 11.—Runs with Car "S" (wight = 77,900kg.) (Velocity, Air Resistance, Current, Volts, and Work done.)

investigated. As the military trains run only at considerable intervals, at a comparatively low speed, the existing signalling apparatus had to be supplemented by distant signals about 2 km. from the stations, and some difficulty

question, some valuable technical information has been gained. In the first place, the experiments have shown that it is possible to collect high-tension currents even in unfavourable weather from overhead conductors at double

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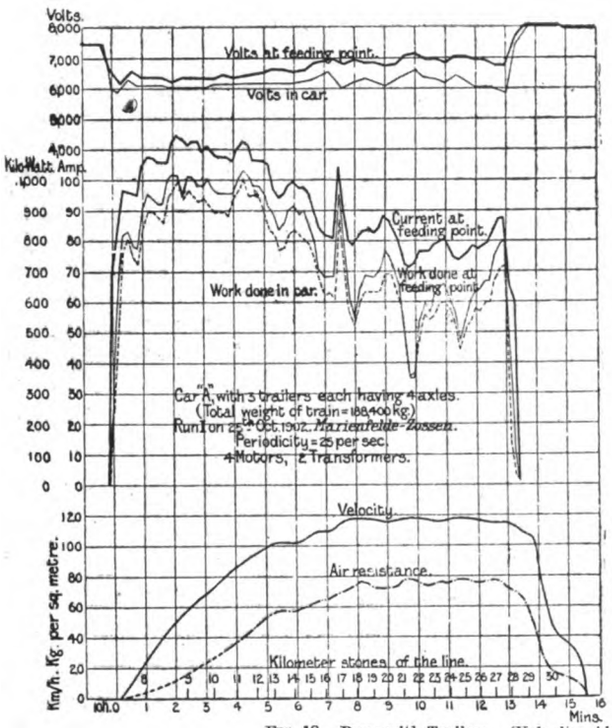
the speed of the present express trains. Both the conductors and the collectors have worked so satisfactorily up to the present that their efficiency at higher speeds may be safely assumed. Three-phase motors have shown themselves reliable, and their overheating has been prevented by suitable ventilation. It has, however, not been possible to decide whether it is preferable to fix the motor on the axle or support it wholly by springs; nor can it be safely said whether fluid or metallic resistances are the more suitable.



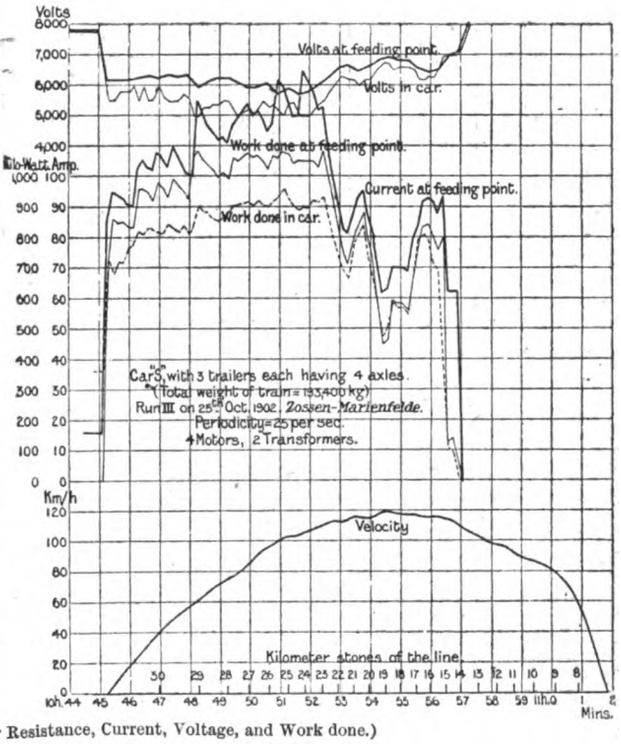


FIG. 12.—Runs with Trailers. (Velocity, Air Resistance, Current, Voltage, and Work done.)

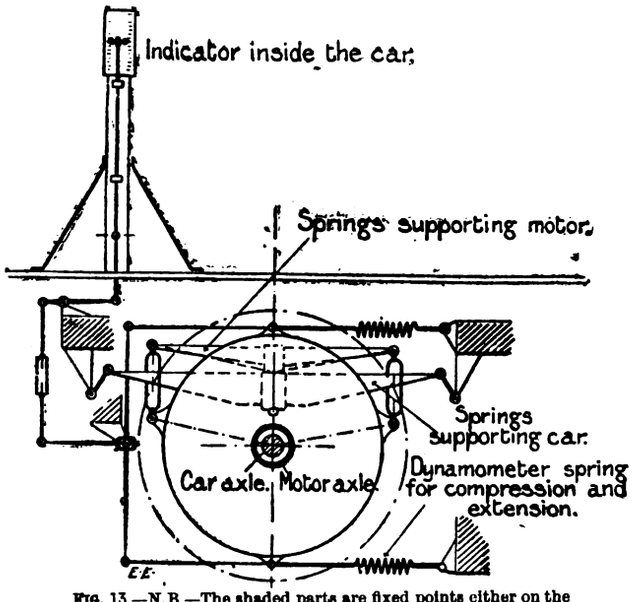


FIG. 13.—N.B.—The shaded parts are fixed points either on the car frame or on the bogie.

Generally speaking, the first year's trials have served principally to find out the best methods of making observations, and to determine which are the most suitable instruments for obtaining trustworthy information. Basing further experiments on the knowledge thus gained, it is certain that it can be ascertained whether the cars, their equipment, and all other outfit are suitable for regular traffic on main lines at a speed of 160 km. per hour, and whether still higher speeds are practicable, especially from an economic standpoint.

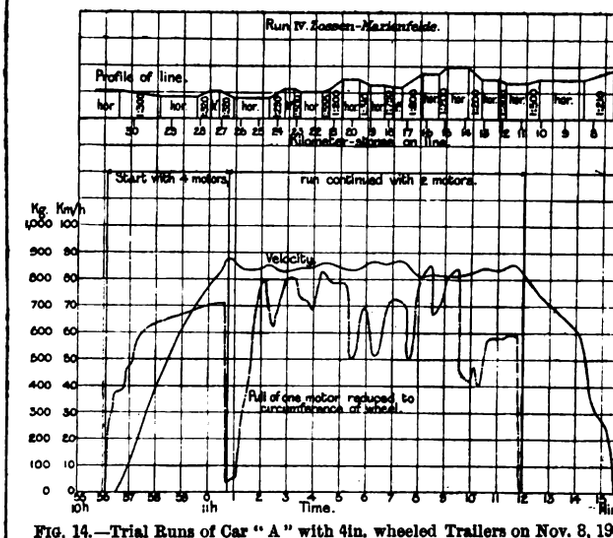


FIG. 14.—Trial Runs of Car "A" with 4in. wheeled Trailers on Nov. 8, 1902. Pull, Velocity, and Profile of Line.

Originally it had been the intention to resume the experiments in 1902 on the lines laid down at the commencement, and to increase gradually the speed of the cars until a speed of 200 km. per hour had been attained. It was, however, not possible to relay the permanent way in time, and in

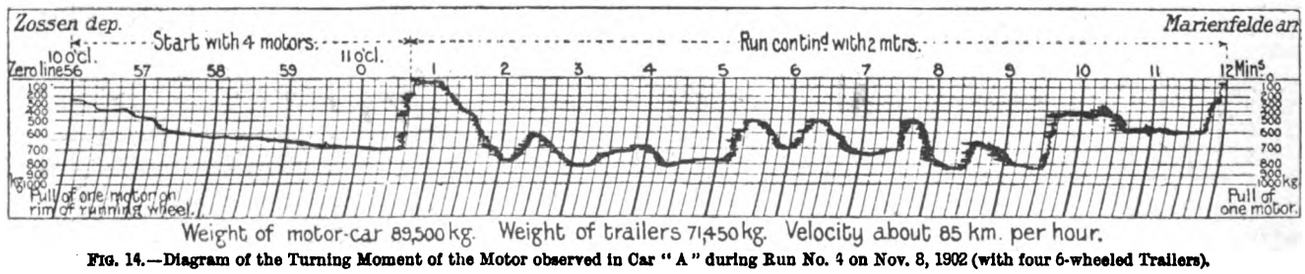


FIG. 14.—Diagram of the Turning Moment of the Motor observed in Car "A" during Run No. 4 on Nov. 8, 1902 (with four 6-wheeled Trailers).

The brakes have not been powerful enough for the high speeds. An alteration of the existing arrangements and the adoption of an efficient electric brake appears to be imperative.

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FIG. 17.—RUNS, AT CONSTANT SPEED, OF THREE-PHASE LOCOMOTIVE WITH ONE TRAILER.

Date. June, 1902.	Run No.	No of periods per second.	Weight of train in tons.	Time of measurements in seconds.	Speed in km. per hour.	Average at feeding-point. Amp.	Volts.	Kw.	Average value of cos ϕ calculated.	Average power at feeding point.	Weight of trailer in kg.
23	I.	30	52 25	810	70	10	7,250	76	0·60	at 70 km.-hour 91 kw. = 124 h.p.	12,250
	II.	30	52·25	240	70	11	7.200	105	0·75		
24	I.	30	57·68	390	65·70	9·5	7,200	71	0·59		17,680
	II.	30	57·68	350	65 70	15	7,150	137	0·74		
25	I.	40	52 25	790	86	12	8,200	136	0·79	at 86 km.-hour 184 kw. = 250 h.p.	12,250
	II.	40	52·25	800	86	18	8,100	222	0 86		
	III.	40	52 25	760	86 88	13	8 250	150	0·81		
	IV.	40	52·25	820	86	18·6	8,150	226	0·86		
26	I.	47	70·75	410	101-102	20·5	10.650	322	0·84	at 102 km.-hour 293 kw. = 398 h.p.	30,750
	II.	47	70·75	390	102	18·5	10 850	286	0·285		
	III.	47	70 75	340	101·5 102	18	10,770	270	0·81		
	IV.	47	70·75	360	101 5 103	19	10,770	290	0 82		

consequence of this the authorities would not allow a greater speed than 125 km. per hour. The time was therefore utilised for determining more accurately the resistance of the cars at various speeds, the power required for propelling them, and the losses of energy in the feeder and the conductors. In addition to this, further experiments were made with the brakes, and alterations in the structure of the cars were considered, to ensure steady running at high speeds; the movement of the rails was also observed during the trials.

The second report describes the experiments in great detail, and the following are the principal results ascertained by their help: At first attempts were made to determine the resistance of the cars direct by pulling them at moderate speeds by a locomotive, to which they were attached by a dynamometer. It was found, however, that owing to the great weight of the cars, and owing to the irregular pull of the locomotives, no steady curves could be obtained, nor was the success greater when the cars were attached to a goods train. Somewhat better results were achieved by the employment of a three-phase locomotive, but the curves were still too irregular to be accepted. Nothing

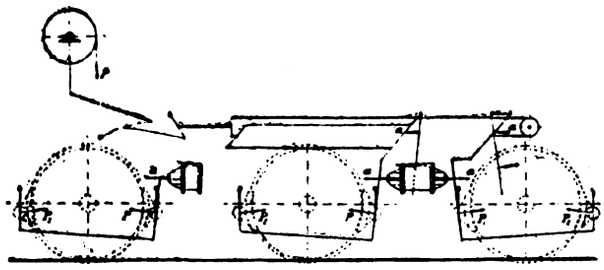

FIG. 15.

remained but to revert to observing the time each car took to come to a standstill after attaining a certain speed, and the distance it covered during that time, due account being taken of all differences in level. The smallest curve on the line has a radius of 2,000m.; it was therefore not necessary to consider the curvature in the calculations, but very careful measurements of the air resistance were made by means of tubes projected from the cars in the way already described, and in the end a small correction was found necessary in the formula for air resistance, which was altered to $P = \cdot 0052\ V^2$, and the resistance of the cars was found to be equal to the resistance of nine square metres.

In Fig. 7 the final results of the traction resistance of the cars are represented by four curves showing the total resistance for a car weighing 83 tons, the air resistance of a surface of nine square metres being the equivalent of the air resistance of a car, the horse-power required on the level with no wind, and, by the difference of the first and second curves, the resistance due to mechanical friction. It is at once apparent, from this diagram, that at high speeds the air resistance is by far the most important factor, and that the proper shape of the car has to be very carefully determined.

From their experiments the Studiengesellschaft draw the conclusion that the front of the car should be a rather steep paraboloid. Owing to the necessity of arranging the cabin of the driver in front, and providing buffers and drawbars, it is not possible to carry this out in practice, but the nearest approach to the correct form is suggested to be a cylindrical front, extending for 86deg., then plain surfaces which join the sides of the car by easy curves, as represented in Fig. 8. Very careful measurements were made as to the amount of energy required, and a measuring station was established at the feeding point to avoid the calculations of the losses in the feeder. The ammeter and wattmeter at this station were connected direct to the high-tension circuit to avoid the use of transformers, and to make them almost independent of periodicity and of difference in phase. In the cars the instruments were joined to

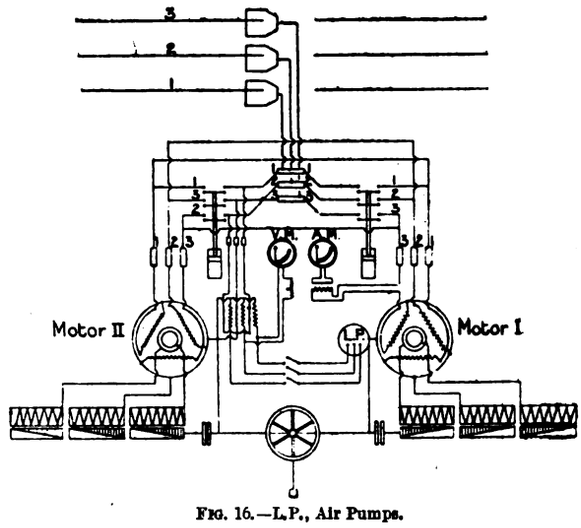

FIG. 16.—L.P., Air Pumps.

the same phase as the feeding point. In spite of all precautions, however, the readings were not all reliable, especially in wet weather. The measurements are divided into two groups: one to determine the energy during acceleration, and the other to measure it at constant speed. In both cases the cars were sometimes running by themselves, and sometimes pulling trailing cars. It will be noticed that the acceleration is not very great, but this was the consequence of the generating set not being powerful enough to supply more energy. Compared with the theoretical amount of energy required to give the cars the same acceleration, the figures of the table show an efficiency of about 45 per cent., due, no doubt, to the losses in the starting resistances; but for long-distance travelling the period of acceleration is almost negligible.

In Tables A and B of Fig. 9 the results of these experiments are summarised, and diagrams in Figs. 10, 11, and 12 give some details of runs and without trailers. An attempt was made to measure the turning moment of a motor direct by fitting on car "A" a special apparatus represented in Fig. 13. Instead of attaching the motor rigidly to the frame, it is held by springs, as shown diagrammatically, and the movement of the springs is transmitted by suitable levers to a registering indicator in the interior of the car. The instrument was calibrated by weights, and gave useful results when a resistance was inserted in the secondary circuit of the motor; but, of course, the direct comparison.

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between the indicated turning moment and the electrical readings is thereby prevented. Diagram V., Fig. 14, shows the turning moment during a run of car "A" on Nov. 8, and the curve below it is drawn in accordance with these indications. About the measurements made to ascertain the loss in feeders and conductors, nothing need be said, as no novel features with regard to them are disclosed in the report. Nor need the brake experiments be described, as they were again unsatisfactory, and eventually it was considered advisable to alter the whole of the braking arrangements. A good opportunity for doing this was afforded by the reconstruction of the bogies, which became necessary to ensure the steady running of the cars during high speeds. In the new bogies the following points were to be observed: (1) the wheel base is to be increased from 3·8m. to 5·0m.; (2) the bogie frames are to be constructed with simple Z girders; (3) the bearing springs are to be connected by balancing levers, and are to be visible and easily accessible throughout their whole length; (4) the car body is to be supported at four points on each bogie; (5) the centre pin of the bogie is to be movable for a distance of 30mm. in every direction; (6) the motors are to be connected to the axles by springs; (7) the brakes are to be reconstructed as shown in outline by Fig. 15, which explains itself.

During the trials the bending of the rails was measured in the same way as in the previous year; but as the speed of the cars had been restricted, no abnormal observations occurred and no extraordinary repairs became necessary.

When the trial runs of the high-speed cars had been completed, some further experiments were made with a three-phase locomotive built by Messrs. Siemens and Halske, and the Studiengesellschaft comments on them in a separate report. In this case they say that the high-speed cars have proved suitable for their work as far as their mechanical and electrical outfit is concerned, but their weight is too great and the proportion of their dead weight to the paying load is not favourable. The trouble with the permanent way and the very high power required during the acceleration period were a consequence of this weight, and for economical high-speed traffic it should, if possible, be diminished so as to load the axles only sufficiently for the necessary adhesion. It would not be possible to effect this object by altering the construction of the car or by lightening its mechanical outfit without endangering its safety. It is therefore necessary to try to diminish the weight of the electrical apparatus. This may be done by removing the transformers from the car and placing them along the line, or by dispensing with them altogether. In the first case a double set of conductors is required, increasing the losses and the capital expenditure. It is, therefore, preferable to employ motors which are capable of utilising high-tension currents.

With a view of trying the possibility of using such motors on the high-speed cars, Messrs. Siemens and Halske built two motors of approximately the same outside dimensions, but suitable for working with 10,000-volt currents, and fitted them each to a four-wheeled bogie with a wheel base of 3·25m. The car body, 12·5m. long, is of the usual shape for electric locomotives, and in its centre is a driver's cabin 4m. long by 2·8m. wide by 2·3m. high. In the iron boxes on either side of it are the starting switches and resistances, and on the top it carries the collecting gear, which is like that of car "S." The motors are suspended from the bogie frames after the manner of tram motors, driving the axles by a gearing of 1 : 2. Between the car body and the wheels are two sets of springs, and provision is made for a slight lateral movement relative to the bogie.

The diagram (in Fig. 16) of the connections shows that there are separate switches, moved by compressed air, for each direction of running, a small transformer to supply low-tension current to the air-pump motor, and mechanical switches for the resistances, which are actuated by a hand-wheel in the driver's cabin, geared to a horizontal shaft. Some difficulties were experienced in obtaining readings of the measuring instruments on the locomotive of sufficient accuracy, so that finally only the measurements at the feeding point were taken into consideration. The trial runs were started on June 23, 1902, with 7,250 volts, and this voltage was gradually raised until the locomotive successfully pulled a trailer on June 26 with just over 10,000 volts.

Some of the details of the measurements taken during these runs are given in the accompanying table (Fig. 17). It is at once apparent that the efficiency of the locomotive is much greater than that of the cars at the trials in 1901, for the reason that its motors were working nearer to their rated output. Another reason is the absence of a transformer, so that a comparison at an output of 400 h.p. shows that the locomotive required for this at 10,800 volts, and cos $\phi = 0\,85$, an average current of 19 amperes, while the cars at 6,300 volts and cos $\phi = 0\,5$ consumed about 53 amperes. The losses in the conductors along the line are, therefore, 2 kw. in the case of the locomotive and 17 kw. in the case of the cars.

In conclusion, the report considers that the trials have proved the possibility of building motors for three-phase currents of 10,000 volts, used direct without transformers. It is mentioned that the motors and the gearing have worked without giving any trouble.

COMMUTATION OF CONTINUOUS-CURRENT GENERATORS AND MOTORS.*

BY G. A. NEILD AND P. E. BANTING, MEMBERS.

Note.—Where the term "leading pole-tip" is used in this paper, it means the tip which is last to leave a given coil as the armature rotates, whereas the leading tip is the one which meets the coil first. Where the term "central point" is used as regards brush position, it means the geometrical centre between the poles, while "neutral point" means the point of neutral field, which may vary with armature reaction.

As this is such a large subject, it has been decided to deal only with machines having slot-wound armatures and carbon brushes. Before going further, it may be well to draw attention to Fig. 1, which shows diagrammatically the

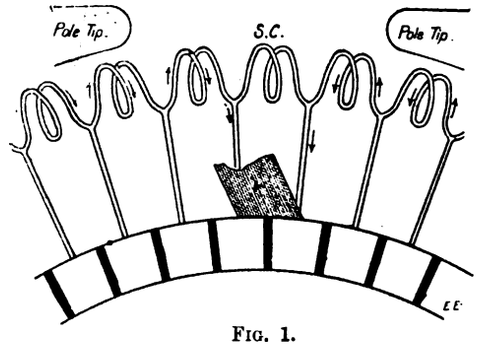

FIG. 1.

actual flow of current in the armature winding of an old-type Gramme-wound machine. This type has been chosen as being the simplest form of armature winding to illustrate the winding. Suppose the positive brush to be the one shown in the figure, the negative being at the bottom of the commutator, it will be seen that the current flows in an upward direction under each pole, out at the top brush, round the circuit, and in through the bottom brush. It will also be observed that the coil shown opposite the brush is short-circuited, having theoretically no current flowing in it. This short-circuited coil, when it leaves the brush, will then be ready to take a current which flows in the opposite direction to that which was last travelling through it.

The principal reason for using carbon brushes on modern machines is that the resistance of these per square inch is from five to ten times that of copper, according to the quality of carbon used. The effect of this high resistance on commutation is as follows: As the commutator bar leaves the brush the area of the contact of the latter grows gradually less, thereby increasing the resistance. With a copper brush the difference in the resistance of a contact, say, $\frac{1}{4}$in. wide by 4in. long and a contact $\frac{1}{16}$in. wide by 4in. long is comparatively little (the resistance is about

* Paper read before the Rugby Engineering Society.

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·003 ohm in the first case and about ·012 ohm in the second case), whereas with a carbon brush the resistance of contacts of the same area as mentioned would be about ·03 ohm in the first case and ·12 ohm in the second; thus it will be seen that the difference between the resistances of the large and small contacts of the copper brush is ·009 ohm, while with a carbon brush it is ·09 ohm—namely, 10 times as great.

From the above it will be seen that when a bar is on the point of breaking contact with the brush, in the case of the copper brush there will be a comparatively low resistance for the current to pass through, allowing a large number of amperes to flow; whereas if the same area of carbon brush were in contact with the plate, the resistance, being very much higher, would choke the current down gradually, inducing it to go through the next coil to get to the brush rather than arc across, forming a spark. The use of carbon brushes also facilitates using reversible motors, as it would be, of course, impossible to run a machine against the brushes if copper gauze or stencil copper were used.

In order to obtain sparkless commutation, one of the most elementary things to consider is the position of the brushes, as it is important that these should always be on the neutral point, so that as a given coil leaves the brush it enters a field of the right direction to reverse the current (see Fig. 1). This neutral point varies with the load on account of the armature reaction, which distorts the magnetic field, as shown in Fig. 2. The neutral point on a generator at full load is somewhat in front of the centre line between the pole-tips in the direction in which the machine rotates, and is slightly behind this line in a motor, the tendency in the first case being to saturate up the trailing tip and in the last case to saturate up the leading tip. The higher the armature reaction and

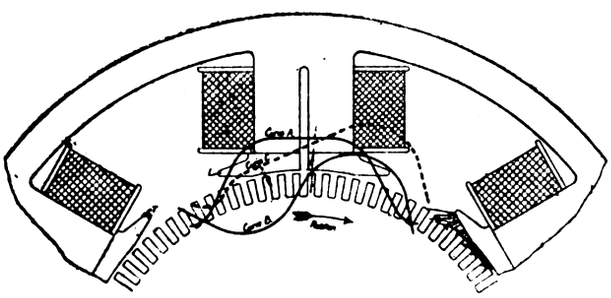

FIG. 2.

the smaller the air-gap in the machine, the greater this effect will be. The correct proportions of armature ampere-turns to field ampere-turns is dealt with under the heading of "Machines with weak fields."

In most modern specifications engineers specify that the machine must be sparkless with the brushes in a fixed position, no matter what the load. In order to obtain this, it is necessary to make the neutral point, as nearly as possible, stationary for all loads. This means that the effect of armature reaction must be reduced. Some makers endeavour to attain this end by means of making a slot from ¾in. to 1in. wide up the centre of the pole, parallel to the armature shaft, the idea being to put a magnetic resistance in the path of the flux due to armature ampere-turns, in the form of an air-gap and saturation of one side of the magnet pole, thereby choking down the effect (see Fig. 2). Another method employed by some makers is to put a divided pole shoe on the bottom of the pole. This shoe is made half of cast steel or wrought iron, the other half being of cast iron, the latter constituting the trailing tip. The cast iron, of course, gets highly saturated very easily, and prevents any more magnetic lines being forced through in that direction when the load comes on the machine. It is also occasionally the practice to make the leading pole-tip of a generator longer than the trailing pole-tip, which gives a good magnetic field as the coil leaves the brush, as well as tending to rectify distortion. Both these last methods prevent the machine from being reversible.

Theoretically, the armature coils, which are being short-circuited by the brush, should be in an absolutely neutral field, and each should enter a field which tends to reverse the direction of the current in it as the bar to which it is connected leaves the brush; therefore, the proportion which the pole arc bears towards the distance between the pole-tips is also of importance. If the pole-tips are too close together, the magnetic lines from one cross over those from the other (see Fig. 2), so that there is no real point of "no field." It has been found from experience that the pole arc should be from 66 to 75 per cent. of the total pole pitch—probably about 70 per cent. is the best figure for machines with small air-gaps, whereas the lower figure (66 per cent.) is best on machines where a wide air-gap and a heavy chamfer are employed, because if the tips were near together in this case the lines would cross one another, as mentioned above. If the distance is too great between the tips, the coil, as it is about to leave the brush, is not in a sufficiently strong reversing field. In the case of a reversible motor, such as a crane motor, which has to run at the same speed in either direction, it is impossible to have the brushes on the neutral point, as they must be in a geometrically central position, and this never coincides with the neutral point (this matter is considered separately under the heading of "Crane motors.")

While speaking of neutral point, it may be well to see how the width of the brush bears on this. If the brush is too wide and the neutral point is fine, it is probable that sparking will be produced owing to coils being short-circuited which are in a strong magnetic field. This has much the same effect as if a narrower brush were used, which was not on the neutral point. On the other hand, if the brush is too narrow, it will not short-circuit sufficient coils, and a given bar will not have a sufficiently long time in which to pass the brush. As a general rule, the brush should cover about 1½ to 2 bars, if an ordinary winding is employed.

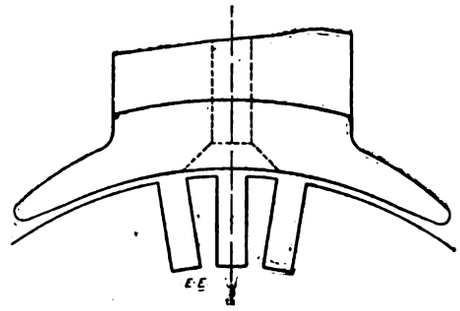

FIG. 3.

In endeavouring to obtain good commutation, care should be taken that the shape of the potential wave is correct. The curve of this wave from the neutral point up to the maximum should not be too sudden. In order to obtain a gradual slope, it is necessary to saturate up the pole-tips, this saturation gradually increasing the nearer you get to the extremity, forming a good fringe of flux, so that the field strength grows as gradually as possible from the neutral point to the maximum. This latter should not be situated too far under the pole face, as the coils should enter a fairly strong field soon after leaving the brush, as has already been explained. Different makers have various methods of saturating up these tips—some of them employing cast steel or laminated wrought iron, and cutting the material down very fine, while others employ cast iron, which, of course, has very much the same effect, owing to its poorer magnetic qualities. When laminated wrought iron is employed, it is sometimes the custom to cut out every other lamination. Not only should the pole-tips be thoroughly saturated, but it is also well to chamfer them back on the face, as shown in Fig. 2. The amount of this chamfering, of course, depends on the width of the air-gap employed, as it is the proportion of chamfer to air-gap which it is necessary to get correct. In actual practice it has been found best to employ long pole-tips, thin at the ends (as shown in Fig. 3), with a slight chamfer at the extremities.

It may be here mentioned that if the iron of the armature core is of an inferior quality—having bad hysteretic qualities—the magnetic lines in the teeth will be apt not to reverse until after passing the central point by some appreciable distance, thereby dragging over the flux from

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the pole-tip still more than armature reaction alone would cause.

Effect of Weakening the Fields of Dynamos and Motors.

Armature reaction plays a very important part in the design of generators which have to work over a large range of voltage and in variable-speed motors. The ratio of armature ampere-turns to air-gap ampere-turns can be as high as 1 : 1 with machines which have an average width of air-gap, but if the reactance voltage is very low by calculation, and the field strength is practically constant—*i.e.*, no variation in voltage—the armature ampere-turns can be about 20 per cent. higher than is given above. With very small air-gaps, it is not advisable to work the armature ampere-turns higher than 80 per cent. of the air-gap ampere-turns, as the distorting effect on the fields is approximately inversely proportional to the width of the gap. Also, on separately-excited boosters which have to carry their full-load output over a range of voltage varying from, say, 100 volts to 10 volts, the armature ampere-turns should be kept as low as possible to avoid sparking on the low volts when the field is very weak. On self-exciting generators, such as are used for battery charging, the same remarks apply, but in this latter case instability limits the range of voltage possible. In almost all specifications of the present day, an overload of 50 per cent. is required momentarily on all dynamos and motors without brush shifting or sparking at the commutator. Consequently with the same strength of field, but with 50 per cent. more armature ampere-turns, the effect of this latter must not be capable of overpowering the former, or even distorting it to such an extent that it will necessitate shifting the lead of the brushes.

In speaking of the above ratio of armature ampere-turns to air-gap ampere-turns, the authors have taken the calculated air-gap ampere-turns necessary to drive the flux across the gap from the pole-face to the top of the armature teeth, assuming that the density at the pole-face is rather higher than that in the air-gap, due to part of the lines spreading out at the sides as shown in Fig. 2, on the right-hand pole-tip. Variable-speed motors are affected in exactly the same way as generators which have to work over a large range of voltage, and consequently, in designing this type of motor, it is necessary to under-rate the horse-power on the high speeds where the field is weakened by inserting resistance in the shunt circuit. Not long ago a testing motor working on a very weak field to increase its speed for driving a high-speed generator was developing an overload of about 30 per cent.; by accident a further increase of load of about 20 per cent. was put on the generator. The result of this was that the motor pulled up dead, due to the field produced by the armature ampere-turns overpowering the normal field, and tending to run the motor in the opposite direction. On the motor pulling up, a very heavy rush of current naturally passed through it due to the back E.M.F. being reduced to nil, and consequently the circuit breaker came out, saving the armature from burning up.

In dealing with this subject, it may be advisable to point out the advantage of using compound-wound motors on circuits in which the load is very intermittent, or where sudden loads come on at regular intervals. A good example of this last case can be found in small printing presses, in which the printing table is rotated backwards and forwards by means of a crank, this latter being driven by a motor. Every revolution of the crank the motor has to get the crank over its dead point, thereby necessitating a considerable overload on the motor. Now, if a shunt motor is used for this work, there is nothing to check the armature reaction distorting the field on the overload, but if a series winding is placed over the shunt winding, in series with the armature, the flux produced by the field will be increased in approximately the same proportion as the armature reaction. In this way the armature reaction is to a great extent cancelled out. Also, on crane motors it is advisable to use compound-wound motors; in fact, this type of motor should be used in all cases where a fluctuating load occurs. Of course, series-wound motors are better than compound for cancelling out armature reaction, but the objection to these motors is that they cannot be run on light loads, due to the excessive speed.

Reactance Voltage.

Before discussing the actual reactance voltage it is necessary to define the terms "inductance" and "reactance." Any wire carrying current is surrounded by a large number of concentric circles of magnetic lines, which rise and fall with the current; consequently, if the latter is suddenly broken, all these lines will fall back, as it were, on to the conductor, thereby producing an E.M.F. in that conductor opposing the E.M.F. driving the original current. The result of this induced E.M.F. will be to retard the original current, whether falling or rising. Inductance may be defined as the total amount of lines produced round the conductor carrying unit current. If anyone wishes to obtain a practical example of the effect of inductance, the authors would recommend him to break the shunt of a large 500-volt bipolar generator when running with the field fully excited, and then note the result by the respective position of his head and feet. Now take one of the coils of the winding shown in Fig. 1, the inductance expressed in henries = lines surrounding one turn × number of amperes × total number of turns × 10^{-8}. In this figure it will be noted that there are two turns in each coil. The inductance produced in a given coil varies as the square of the number of turns, and consequently it is most necessary to keep the turns per section on any motor or generator as low as possible to reduce the inductance round

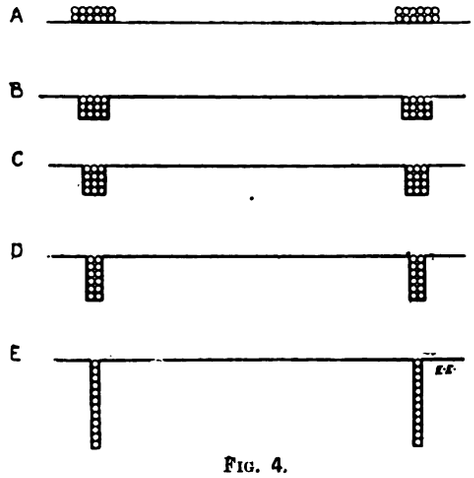

Fig. 4.

the short-circuited coil. On a smooth-core armature the path of the magnetic lines round the conductor lying on the surface of the core consists almost entirely of air, no iron being present except that immediately below the conductor, and even at this point there is usually about $\frac{3}{16}$in. to $\frac{1}{4}$in. of insulation between the iron and the coil; but on a slotted core the path round the conductor consists almost entirely of iron, the insulation between them being only about ·04in. to ·06in. The inductance will depend very considerably on the depth of the slot in the core.

Fig. 4 shows various methods of assembling a given number of conductors, A representing a smooth-core winding, and B to E different types of slot winding. These slot diagrams have been taken from a paper read before the Glasgow Congress in 1901 by Mr. Hobart, in which he refers to some tests made on experimental slots and coils, as shown in this figure. He found that there was a difference in induction between A and E of about 300 per cent., clearly showing the effect of the iron path on the magnetic lines of induction; but with the arrangement shown in B, C, and D there was only a difference of 35 per cent. Between D and E there was a difference of 63 per cent. Although the actual figures of inductance expressed in C.G.S. lines given by Mr. Hobart are very doubtful, the percentage difference in effect is very interesting. The width of slot to depth of slot should not exceed the ratio of 1 : 3. To decrease the lines of inductance circulating round the conductor, it is advisable to work to teeth at as high a density as possible, as the less saturated the iron the better will be the path for the circulation of the magnetic lines. It is not possible to saturate the teeth to

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any great extent, as this would then increase the resistance of the magnetic circuit, thereby necessitating more ampere-turns, and consequently more field copper on the spools. Another objection to working the teeth at a very high density is that it tends to make the machine hum. The density at the bottom of the teeth should be about 125,000 to 135,000 C.G.S. lines per square inch for ordinary machines, but this figure is usually about 150,000 on series-wound crane and railway motors. Reactance = $2\pi \times$ inductance $\times$ periodicity of commutation. It should be noted that "periodicity of commutation" is quite distinct from the periodicity of the machine. Periodicity of commutation = $\frac{P}{2T}$ cycles per second, where P = peripheral speed of commutator in inches per second; T = thickness of brushes in inches; periodicity of the machine = pairs of poles $\times$ revolutions per second.

On a machine with a large number of poles the commutator is usually of a large diameter to take the necessary number of studs (number of studs = number of poles). The large diameter of commutator will increase the peripheral speed, and consequently the periodicity of commutation. This point is one of the limiting features to the number of poles to be used on a given machine, but, on the other hand, with a larger diameter of commutator, a greater number of commutator plates can be used to reduce the conductors per section. On heavy-current machines a large number of poles is advisable, in order to reduce the amperes to be caried in each brush. The current in any conductor of the armature should not exceed 200 amperes.

Reactance voltage = reactance $\times$ current per conductor. The term "reactance voltage" was first used by Messrs. Parshall and Hobart, and as usually calculated is a purely arbitrary term, but it is extremely useful for comparing the sparking properties of different machines. It is very doubtful what the true "reactance voltage" set up in the short-circuited coil really is, as it is always calculated on the assumption that the fall and rise of the current during the short-circuit follows a true sine wave, but up to the present no experiments have been made to prove this assumption. Various methods have been used for calculating this voltage, all based more or less on the principles referred to above. For instance, Mr. Hobart, in calculating the inductance per coil uses 10 C.G.S. lines per inch length of conductor lying in the slot, and 2 C.G.S. lines per inch length of end connection. These figures may be approximately correct, but so long as the same figures are used in all calculations it does not matter very much whether 10 C.G.S. lines per inch length of conductor are used or whether 20 C.G.S. lines are used, because, as stated above, the reactance voltage is only useful for the sake of comparisons. On small machines up to, say, 50 kw., the reactance voltage should not exceed two volts per coil, but on machines of 200 kw. and upwards this figure can be slightly increased to, say, three to four volts. It does not necessarily follow that if the reactance is very low the machine will operate satisfactorily, as the armature reaction plays a very important part as regards the sparking properties of the machine. This has been gone into fully in a previous part of this paper.

As regards reducing the number of turns per coil, the limiting feature is the number of commutator plates that can be used on a given diameter of commutator. A large number of plates naturally increases the cost of the commutator to a considerable extent. An instance of this may be found in the fact that on a commutator of about 20in. in diameter the cost of labour was increased about 250 per cent. by using approximately 320 plates instead of 200. In all machines having more than two poles it is found advantageous to use series-coupled armatures in order to obtain good commutation, but, of course, there may be reasons to prevent this which have no connection with the matter under discussion. This holds good for machines up to 500 kw. or 600 kw. capacity at least. The chief reason that parallel-coupled armatures are not desirable is that if one pole happens to be stronger than another—due to any inequality of iron or air-gap—the coils under that pole will take less load than the coils under the weaker one, due to more back voltage being generated in them. This, of course, applies to motors. In the case of generators the coils under the weak pole will take current from those under the strong pole, and will tend to act as motors; then, the brushes being in the correct position for running as a generator, this weak pole will gradually become strengthened, owing to armature reaction, until it gets stronger than the one which was originally the strong pole. The action will then be reversed, the coils under the latter pole acting as motors. This will continue until very large currents are being generated, and flowing first one way and then the other, causing violent sparking, which is commonly known as "bucking." Another phenomenon which may be observed, and which is due to the same cause, is the violent vibration which is set up in the machine.

The bucking effect mentioned above may be overcome to a great extent by means of fitting equalising rings at one end of the armature, through which these large currents will play (this is somewhat detrimental to the efficiency of the machine). The common practice is to fit one equalising ring per pair of poles—*i.e.*, an eight-pole machine will have four rings, each of which will be tapped in four places, the connections being joined to the armature winding at equidistant points. The cross-section of these equalising rings should be about half that of the armature conductors. In order to use these to advantage, the number of the slots must be divisible by the number of pairs of poles, as if the tappings are unequally spaced, their use will do more harm than good. In actual practice it has been found useless to employ them on machines of less than 60 kw. capacity, except where the current is very heavy, in which case they may be found to have a good effect down to as low as 30 kw. With a series-coupled or wave-wound armature, the slots should never be divisible by the number of poles for good work; whereas with a parallel-coupled or lap-wound armature they should be so divisible, especially if the slots are few in number. This is the more necessary on account of the danger of having to fit equalising rings, as has already been explained. As a general rule, it will be found best to have as many slots in the armature as is compatible with having a wide and shallow slot, as the greater the sub-division, the less will be the difference between the magnetic field in one slot and the next when passing the neutral point.

With regard to the sub-division of the commutator, it is advisable to go to not more than three commutatator bars per slot, as it is obvious that if there are more than, say, three bars per slot, the coils which are connected to these segments will be in the same magnetic field at the same instant, while the segments themselves will not all be in the same position with regard to the brush. Only one combination of coil and segment can be in the theoretically correct position at a given instant, which necessitates the other two being in an incorrect position. On the other hand, if there are a small number of sections, you will have a great number of turns per section, which, as has been shown above, is detrimental from a reactance point of view.

As regards pitch of the winding, it is best to span from the centre of one pole to the centre of the next. Some makers go from the centre of one pole to one or two slots beyond the centre of the next, so that while one half of the coil is in the neutral field, the other half is just entering a reversing field. On the other hand, some machines are wound with a pitch one slot less than the distance between centres of poles. This last method, however, seems to have a detrimental effect on the efficiency of the machine for some reason, which has not as yet been explained by anyone.

Crane Motors.

As the brushes are set centrally on these machines, in order to obtain the same speed in either direction, the armature coil as it leaves the brush cannot well be in a reversing field (it is probably even in a field of the wrong direction), so that the whole of the reversing action overcoming the ohmic resistance of the coil and the reactance voltage must be produced by the contact resistance of the brush. In the following example a 20-ampere machine has been assumed. Referring to Fig. 5, say the contact resistance of one commutator bar to the brush is ·1 ohm, and say each end bar is one-third covered by the brush—

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i.e., the resistance of these will be ·3 ohm—then the voltage tending to reverse section A will be 2·9, that tending to reverse section B will be nothing, and in the case of C it will be ·1. If instead of section A carrying one ampere unreversed it carried 10 amperes reversed, the reversing action, instead of being 2·9, would be minus 1, tending to put the 10 amperes back into the original direction. For sparkless running, the reversing voltage should be arranged so as to give 10 amperes in section A when it leaves the brush, no

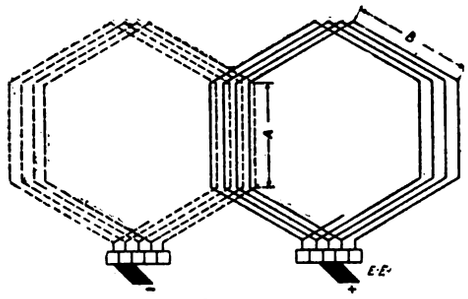

FIG. 5.

more and no less. The fact that one can procure sparkless commutation by giving the brushes a backward lead, shows that the sparking of the brushes when central is due more to too little rather than too much reversing voltage. By curve shown in Fig. 6 it will be seen that most of the reversing appears to take place between the time that the commutator plate begins to leave the brush and the time when it breaks contact altogether. It, therefore, appears to be approximately correct to take half a period as equal

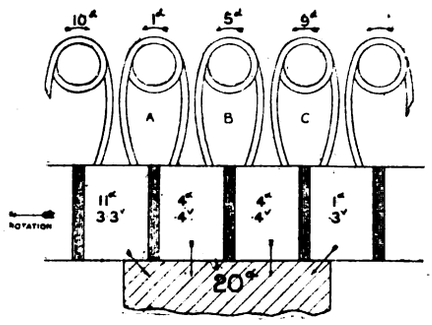

FIG. 6.

to the time taken to pass one section rather than as the time taken to pass the brush.

ERRORS OF CONSTRUCTION.

Under this heading the authors have considered points which do not come directly under design. One of the commonest faults to be met with due to bad construction is the copper and mica sections being of unequal hardness. If the mica happens to be harder than the copper, the latter will wear away more quickly than the former, leaving the mica standing up above the surface of the commutator, which causes the brushes to vibrate violently, therefore causing sparking and pitting of the surface. On the other hand, if the mica

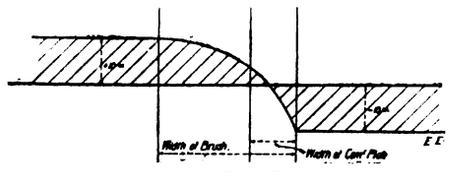

FIG. 7.

is softer than the copper, it will wear away more quickly, leaving grooves which will collect copper dust. This, if allowed to continue for some time, will be apt to short-circuit the segments together. The brush tension to ensure smooth running should not be less than 2lb. per square inch and not more than 3lb., as if it is less than the first figure the brushes will be apt to vibrate, while if it is more than 3lb. per square inch, the friction and wear will be excessive. The best type of brush-holder to use is that in which the carbon is enclosed in a box, being quite free to move up and down, the tension being applied by means of a clock spring pressing on the top of the brush. This clock spring is coiled at the other end, and adjustment is obtained by means of a small handle which passes through the spindle to which the coil is attached. This small handle engages with a ratchet. If the carbon fits the box too tightly, it will be liable to stick, and not follow up the wear properly; whereas if it is too loose, it vibrates and tends to twist over in the direction of rotation of the machine, which prevents its being square to the commutator. As a general rule, radial brushes will be found to give better results than angular ones, especially on reversible machines. If angular brushes are used, the best results will be obtained if the brush-holder is set against the rotation of the machine while the angle of the brush is with the rotation. The brush box should be brought down as near to the surface of the commutator as possible without actually touching it, as it will then hold the brush more firmly if the latter does not fit sufficiently tight. Care should also be taken to see that the brushes are staggered, as otherwise the commutator will very quickly be worn into grooves. Another very common fault in construction to be encountered is the mounting of the brushes on the stud so that they come out of line. When this is the case, it is the same as if a wider brush were employed, as a space is covered equal to the distance from the forward edge of the foremost brush to the back edge of the hindermost.

A few other causes of sparking due to faulty construction may be mentioned as follows—viz.: inequality of air-gap, inequality of iron, unsymmetrical winding, unequal spacing of the brush studs, lack of rigidity in the foundations, engine twisting movement, brushes not being properly bedded. This last is perhaps the commonest of all and the easiest to overcome.

One more point which should be mentioned is a badly-built commutator. If the angle of the clamping rings is not correct, or if the commutator is not bolted up sufficiently tight, the plates will be very apt to rise due to centrifugal force, thereby making the surface very rough. Also, if the commutator is made too long the plates may tend to rise in the middle (even though the ends are tight), and in extreme cases they may fly apart altogether.

In conclusion, the authors thank Mr. Betts for the time and attention that he gave to getting out the sketches and diagrams for this paper.

THE TESTING OF CABLES FOR USE AT VERY HIGH VOLTAGES.

M. Jona, in a paper read before the Milan Electrotechnical Society, considers the question of the testing of high-tension cables. It is usual in low-tension work to test at double the working voltage, but it is questionable whether this rule should hold when dealing with 15,000 or 20,000 volts, for on low-tension work the insulation thicknesses are usually ample, and are decided more on account of mechanical than electrical considerations. Also the break-down voltage rises less quickly than the thickness of insulation. Before breaking down, the dielectric (at least, if it is of an organic nature) is permanently deformed, similarly to a metal strained beyond its elastic limit. The fact that high-tension discharges commence as brush discharges increases the danger of harm to the insulation through the application of excessive test pressures. At very high tensions the dielectric warms up, partly due to dielectric hysteresis, which increases approximately as the square of the voltage, and partly due to the conduction. The conductivity increases rapidly with the temperature—the author states that at 30deg. C. the conductivity of the insulation is some 30 times as great as at 15deg. C.

A conductor of radius r surrounded by a uniform insulation up to a radius R and subjected to an alternating voltage, V, will produce a potential

$$v = V \frac{\log \frac{\rho}{r}}{\log \frac{R}{r}}$$

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at a radius ρ. Differentiating, and employing ordinary logarithms

$$\frac{dv}{d\rho} = \frac{\cdot 434\ V}{\rho \log \frac{R}{r}}.$$

If all dimensions are given in millimetres, this expression gives the variation of potential per 1mm. of insulation material at a radius ρ, and it shows that the insulation near the conductor is subjected to a far greater strain than the outer layers. It also shows that if r is constant, the resistance of the dielectric close to the conductor only increases as $\log \frac{R}{v}$.

The following cases calculated by the above formula show clearly that thickness of insulation is not in itself any guide, as, if r is reduced, the thickness of insulation may be increased and yet the strain at the surface of the conductor may increase:

r. mm.	R. mm.	Thickness of insulation, mm.	V.	v_r. per mm.	v_R. per mm.
4	10	6	20,000	5,450	2,170
1	10	9	20,000	8,680	860
1	7	6	20,000	10,280	—
2·58	7	4·42	20,000	7,700	—

From numerous tests on insulation materials the author concludes that the best insulations are mica and vulcanised caoutchouc, for which the dielectric rigidity may be taken as about 12,000 volts per millimetre. With a 10mm. diameter conductor for 20,000 volts the thickness of insulation should be 7mm., making R = 17, and causing the insulation surrounding the conductor to stand a strain of 3,750 volts per millimetre, which gives a factor of safety of 3·2.

Applying the formula to the case of a conductor ·1mm. diameter, insulated with a substance which will stand as much as 12,000 volts per millimetre, and to work at 100,000 volts, the result for R is the impossible figure of $10{\cdot}75 \times 10^{70}$. Though the formula shows that such a case would be impossible, it is quite possible that such wires could be safely worked in air without an excessive distance between, but only on account of the luminous discharge which would be present, and which virtually increases the diameter of the wire; thus, if the thickness of this discharge around the wire were 1mm., making the virtual diameter 2·1mm., the radius R would work out at only 2,720mm.

The author gives the results of experiments on a line made up of a number of conductors of different diameters connected in series and suspended in air. This line was subjected to a gradually increasing voltage until the luminous discharge commenced in the different wires successively. The voltages at which this occurred are given below:

Diameter of wire. mm.	Voltage.	Diameter of wire. mm.	Voltage.
·12	12,300	6	106,000
·25	18,200	7·6	127,000
·5	28,000	10	152,000
1·0	42,000	12·5	185,000
2·0	57,000	15	196,000
4·0	81,000	—	—

At 196,000 volts the line viewed in the dark showed a luminous discharge of definite diameter varying with the diameter of the wire. The diameter of this discharge corresponded exactly with that deduced from the above formula, with air as the dielectric.

In conclusion, it is pointed out that when the wire is surrounded by insulations of varying quality, it is quite possible for one or more layers to become pierced without the rest of the insulation breaking down, and the author considers that the voltages at which very high-tension apparatus is tested should only slightly exceed the working voltage, as, otherwise, certain regions of the insulating covering may be fatigued or pierced without any external signs of injury.

Society of Engineers.—An interesting visit was made by the president (Mr. D. B. Butler) and members of the Society of Engineers on Wednesday, Sept. 21, 1904, to the pianoforte factory of Messrs. Broadwood and Sons, Limited, at Stour-road, Old Ford. A description of the electrical plant at these works recently appeared in these columns.

THE RELATIVE DISRUPTIVE EFFECTS OF DIRECT AND ALTERNATE CURRENTS.

The *Zeitschrift für Elektrotechnik* gives a short description of tests carried out by the Compagnie de l'Industrie Electrique on the relative disruptive effects of high-tension direct and alternating currents. The alternating current was obtained from a 75-kw. 50-~ external-pole smooth-cored alternator, having a flat-topped curve with a form factor of only 1·255. The direct-current supply was obtained from three 25,000-volt dynamos of the special type made by the firm, with rotating fields, the machines being coupled in series when required. Their current was not absolutely non-periodic as they only had 96 commutator segments, and this fact as well as flatness of the alternator wave are in favour of the alternating current. Nevertheless, the direct current gave the better results in all cases. The tests were made both in the laboratory and in the open air, and the breakdown voltage in the former case was, on the average, about 1·6 times as great as in the latter.

The nature of the electrodes used had a marked effect on the sparking distance in air, and the results obtained are given in the form of curves for the different electrodes, first with direct current, and then with alternating current. The action at 30,000 and 60,000 volts is shown in the following table:

Electrodes.	30,000 volts D.C. distance. mm.	30,000 volts A.C. distance. mm.	Ratio.	60,000 volts D.C. distance. mm.	60,000 volts A.C. distance. mm.	Ratio.
Sphere to sphere	10	16	1·6	30·5	76	2·5
Negative point to positive disc.	16	57	2·2	—	148	1·51
Positive point to negative disc	26			98		
Disc to sphere	14	34	2·4	63	117	1·85

Tests were next made on glass and porcelain insulators, the voltage being increased in each case until a short-circuit occurred between the wire and the iron support, though the insulator was seldom actually pierced:

Type of insulator.	A	B	C	D	E
Breakdown voltage with direct current	24,000	34,000	40,000	45,300	40,800
Ratio of direct-current to alternate-current breakdown voltage	1·6	1·59	1·48	1·35	1·31

Finally, tests were made on 5mm. "carton glacé" (presspahn) and on 20mm. marble, with the following results in the case of the presspahn:

Time of electrification.	Voltage.	Type of current.	Remarks.
90 seconds	9,000	Alternating	—
30 ,,	11,000	,,	Breakdown.
120 ,,	9,000	,,	Strong brush discharge.
15 ,, later	9,000	,,	Breakdown.
120 ,,	10,000	Direct	—
120 ,,	15 000	,,	—
120 ,,	18,000	,,	—
120 ,,	20,000	,,	—
240 ,,	25,000	,,	Breakdown.

The marble plate was broken down after 75 seconds at 20,000 alternating volts, or after 120 seconds at 15,000 alternating volts. With direct current it was only broken down after 15 minutes, when the voltage was increased by 5,000 every two minutes from 10,000 up to 45,000 volts. The only disadvantage in the case of direct current is the fact that certain insulating materials are liable to become electrolysed, but as this can only occur in the presence of water it is not of much importance.

FORTHCOMING EVENTS.

SATURDAY, SEPT. 24.

Municipal and County Engineers (Midland District).—Meeting at Withington, near Manchester.

Robertson Electric Lamp Works.—At 7.30 p.m, football club concert. For programme see other column.

TUESDAY, SEPT. 27.

Municipal Tramways Association.—Annual conference, Liverpool (continued till Sept. 29).

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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AN ANOMALY.

We have called attention to this before, we shall probably call attention to it again, but such is the state of affairs that it is more reasonable to expect the heavens to fall than justice to be done. The Industrial Freedom League is an organisation against which virulent criticisms are launched, many of which may be warranted, but, on the whole, its object is what all must respect. It is "to free private enterprise from undue interference and from rate-aided competition." Its annual report has just been issued, and is interesting reading. The text for our sermon is found on p. 25 of that report, and reads as follows: "I (Hon. Charles H. Lawrence) would like to call your attention to how this enormous (municipal) expenditure affects private enterprise. I am connected with an important industrial concern, the London and North-Western Railway, and I may say that we are almost the largest ratepayers in this country. The unfortunate shareholders of that undertaking are now providing the sum of £600,000 for rates and taxes, or 1½ per cent. on the ordinary dividend due to them. Those who impose the burden of these rates really pay nothing but a very small fraction towards them, and they have very little practical experience of the management of the great undertakings which they are taxing, etc." This part of the indictment will suffice for our purpose. It is true, and it is mildly put. Of late years Englishmen have grown to be talkers, and most decidedly procrastinators, as well as children of Eve, ready to put the evil they do upon the shoulders of someone else. According to our cynicism, there was in olden times a reality in the cry of "fair play." Is there any such reality now, or is not the characteristic degenerated into "God for us all, and the devil take the hindermost"? We also had a maxim mouthed freely, that he who called the tune should be permitted to pay the piper; but who recognises such a thing now? The present style is for one to call the tune and make someone else pay the piper. Surely it is time an industrial freedom league was founded when a railway concern, a factory, or other similar industrial concern is mulcted to the tune of thousands of pounds annually without having a vote or say in the matter. It is perfectly conceivable, and, in fact, occurs in a number of instances, that companies' undertakings pay the major portion of the rates, and has absolutely no power to say a word as to the expenditure. In some cases companies, and especially railway companies, have been heavily hit by the opening of tramways. If these latter were under the same obligations as the railways, there would, perhaps, be little to say in the matter; but they are not. A fundamental difference is that the one has to purchase ofttimes at a heavy price the ground over which its rails go, as well as to construct; the other uses the public road, and has not the liability to purchase the ground over which its rails are placed. When the tramways are controlled by the local authority we may have something of this kind happening. The district may be dependent on the railway enterprise for its original rise and continuance. The railway enterprise was undertaken under the belief that there would be a remunerative local traffic. Had such traffic not been expected, the railway would not have been there. It is rather hard, then, that when the railway has done what it started out to do, the very people whom it started to cater for, and who have benefited by its action, are those who deliberately try to take away the local traffic, not usually by something better than the railway can give, but for other reasons altogether. What with the compounder, the lodger vote, the impotence of companies to have an adequate voice as regards expenditure, the lot of some of these companies is becoming a hard one. Sooner or later

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retaliation will become a cry, and it will then be seen how inadequate tramways are to replace railways. There is much of the argument put forward by the Industrial Freedom League with which we do not agree, but we are fully in accord with all it does in calling attention to these phases of the anomalous state of the law. We Englishmen pride ourselves upon being a practical nation. The man who invented—or applied, perhaps, is the better way of putting it—the adjective "practical" to this nation must have stretched his imagination to the utmost. It is a nation whose legislative enactments are of the crudest and flimsiest pattern, nine-tenths being a dead letter—a nation where expediency is the unuttered watchword, wherein votes rule, and the old cry of "No taxation without representation" is forgotten.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTOR STARTERS.

SIR,—I should like you, if you can, to put a note in your next issue to correct a slight error which I notice has occurred in the printing of my first diagram, p. 41. For three-phase working the two outside leads of the auto-transformer should be connected together at both generator and motor ends.—Yours, etc., POWER FACTOR.

SIR,—In my answer to Question 715, which appeared last week, the frequency of motor was given as 50. The example was calculated for a frequency of 25.—Yours, etc.,
Sept. 20. X. Y. Z.

SIR,—In your "Questions and Answers" column last week the diagram on p. 42 at the top of the first column is obviously lettered incorrectly. It should read A, C, B, and not A, B, C.—Yours, etc., Y. SAKER.

ARMATURE WINDING.

SIR,—Could any of your readers recommend me a good book, at a reasonable price, for dealing systematically and completely with armature windings for both direct and alternating current generators?—Yours, etc.,

A. B. DUNCALFE.

55, Allen's-road, Ponder's End, Sept. 20, 1904.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

VIII.—ON GETTING A JOB.

My Dear Young 'Un,—So you are trying for a job! As you say in your letter, "The glories of Collegiate Life have passed away, and left me stranded on the naked earth like Tannhäuser returning from the Halls of Venus. I want a situation!" What a rolling style we have got to be sure. Chuck it

Engineering is a very prosaic thing—though it has its inner music—and if you will accept some practical advice from a matter-of-fact engineer, you will now eliminate any suspicion of highty-flightiness from your character and soberly settle down to about 48 years of hard work. And the first thing you must do is to compose a neat little letter to possible employers stating what you know and leaving out what you only think you know; you will then copy this out in your best handwriting. Your fist has become fearfully bad since you went into College—too much quick note-taking. I don't know why young fellows nowadays think it is beneath them to take writing lessons. They need it—a readable letter sometimes means a job. Typewriting hints at *haut ton*, which is all right for a £300-a-year job, but a little consequential below it. Printed testimonials, for an ordinary job, indicate the professional wanderer. Write a good round hand—not one of those fancy caligraphies that look as if a tipsy spider had been trying to cake-walk and had tripped over itself.

Next, disabuse yourself of the idea that every employer in the electrical industry is gasping to get you. It is well to soak this in at once, as many a young College graduate has begun the weary search for a job with too high an opinion of his market value, the result being a correspondingly heavy disappointment and loss of nerve. Better have a modest idea of yourself, and find it justified. As your position improves, you can improve your self-conceit if you find it necessary.

Now, what are you going in for? Have you the nerve and the stamina to go through the hurly-burly in the shops? Mind you, it is no use playing at work if you are going to be any good. Six o'clock is your hour, not 6.5. Then, hammer and chisel, and, perhaps, a smashed thumb-nail; work in a draughty shop on a shivery cold morning with nothing to warm you but your own exertions and the dismal gas-flare over your bench; work at three o'clock on a broiling summer's afternoon under a glass roof with not a dash of whitewash on it. Breakfast coffee served in a smoky beer-can; rasher of bacon cooked on a piece of scrap iron. One hour for dinner, and then the hot, greasy crush to get through the works gates before the whistle stops blowing. Bovine, mechanical slogging until six o'clock, and then—more work! Work in the evening arranging what you have learnt in the day, reading the technical papers, keeping yourself up to date. Can you stand it?

If you funk it—or, to put it nicely, if your discretionary instincts become predominant—there is still the clerkly career open to you. As you are a smart man, you might, for example, try the Patent Office. It is almost as simple as your pressing the far-famed button, Messrs. Kodak doing the rest. You pass the initial examination (which, by the way, is fairly stiff and competitive), and you have an assured and progressive salary for a lifetime. And a Government job is usually very, very nice, and very, very select. Only sometimes it is very, very slow.

Or a consulting engineer might take you in. I only mean that he might give you employment in his office. Such gentlemen are usually keen on young fellows, effervescing with theory and willing to be badly paid, to take subordinate positions in the office. Only the outlook is not very cheery after four or five years, for there is a great gulf fixed between the underpaid theorist and the practical man who looks after the putting-up of the jobs outside.

Or you may get into the estimating department or drawing office of a manufacturing firm. You will gain useful business experience in the former, and may possibly develop into a designer in the latter department. But you will all the time be handicapped, enfeebled, by the lack of practical experience. An estimator must know the cranks and kinks of the plant he is estimating for. It is no good nowadays putting down £100 extra in your estimate for "contingencies"; things are cut too fine for that. A draughtsman should have the instinct of mass, of strength, that can only be obtained by chipping and filing the stuff. There is always a point in the design which must be settled by rule-of-thumb, and it is the practical man's thumb that is applied—experience is the only sure teacher.

There is one sphere of usefulness which I have purposely not referred to. An Electric Generating station appears to be the Mecca of young technical men. I suppose that nine College electrical men out of ten try for a berth in a lighting station when they graduate; and just that proportion make a big mistake. They are all right in the meter-testing department, and, to a certain extent, on the mains. But in the station they are aliens. They are purely electrical theorists. The electrical machinery entrusted to a shift engineer has about a third of the total value of the running plant. Any part of the remaining two-thirds is just as likely as not going to go wrong at any moment. What will the electrical theorist do then? As a matter of fact, the movement of thought among the station engineers is at present in the direction of putting a marine man, or next to him a glorified fitter, in charge of the plant. This is just because, in an emergency, he can slip off his coat and scrape a main bearing, and because he can go out into the stokehold with an experimental

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knowledge of the inner working of both the mechanical and human types of stoker. Even if you are going to be a station man, go into the shops first. It will pay you in the end.

I just want to give you a word of warning. Carefully avoid those places which advertise: "A vacancy occurs in an engineering firm for the son of a gentleman as a premium pupil. Thorough knowledge of engineering in all its branches will be obtained. Premium £50." It *may* be all right. I don't like sporting chances myself. There are a lot of twopenny-halfpenny firms run on this kind of cheap labour which are vulgarly known as "pup shops." A moderate quantity of miscellaneous bad work is turned out, and a superannuated foreman, one decent fitter, and one odd-job turner are supposed to do all the fine work and teach a pack of hobbledehoys how not to hurt themselves. Keep off it!

And—I am almost ashamed to mention the matter to a decent fellow—don't try to bribe your way into a post. Of all the things in engineering which are calculated to give one the utter pip I know of nothing worse than the importation into an honourable profession of weak-kneed wasters, who, not having the ability to earn a living fairly, try to wriggle into a place by degrading the honour of people in positions of trust. I cannot conceive that you would do such a dirty thing. But I promise you this—that if ever I were to discover that you had been such a cad as I have described, I would do my level best to ruin you, for your own good and that of the profession.—Yours,

THE OLD 'UN.

MIDDLESBROUGH DOCK ELECTRIC AND HYDRAULIC POWER PLANT.*

BY VINCENT L. RAVEN, MEMBER, CHIEF ASSISTANT MECHANICAL ENGINEER, NORTH-EASTERN RAILWAY.

Now that the question of electric appliances for dock purposes is so generally considered, the author thinks that it may be of interest to record and place before the members of the institution the particulars of the installation and the tests which have been made at Middlesbrough Dock, on the North-Eastern Railway, comparing hydraulic with electric. These are working side by side, and are all thoroughly up to date, giving an excellent opportunity for judging the value of the one against the other, so far as economy in working is concerned. He proposes, therefore, first to describe the machinery at this dock, and then to give the very careful tests which have been carried out. When the dock (Fig. 1) was constructed, it was equipped with steam cranes, and had a small hydraulic power station for working the bridge and gate machinery. Twelve years later, a further extension was made, and hydraulic cranes were then supplied to the new extension. A separate electric lighting station was also put down for dock lighting. With this plant, in the year 1900, the following tonnage was dealt with:

	Tons.
Coal and coke exported	222 616
Merchandise exported	197,933
Merchandise imported	36,941
Ballast worked	1,751
Or a total of	459,241

To do this work

	Coal. Tons	cwt.
The steam cranes burnt	1,989	0
The hydraulic station burnt	994	15
The electric station burnt	932	11
Or a total of	3,916	6

The total merchandise worked per ton of coal burnt was, therefore, 117 tons. When the present extension was proposed, after careful consideration, it was decided to abandon the steam cranes, and to supply their places with electric cranes, and, at the same time, make one large power station, which would supply both the electric power for the cranes and for the lighting, and the hydraulic power water for the hydraulic plant. The work in connection with the power station was divided into two contracts, Messrs. Siemens Bros. and Co, of Woolwich, being responsible for the electrical portion, and Messrs. Carrick and Wardale, of Gateshead-on-Tyne, for the hydraulic installation.

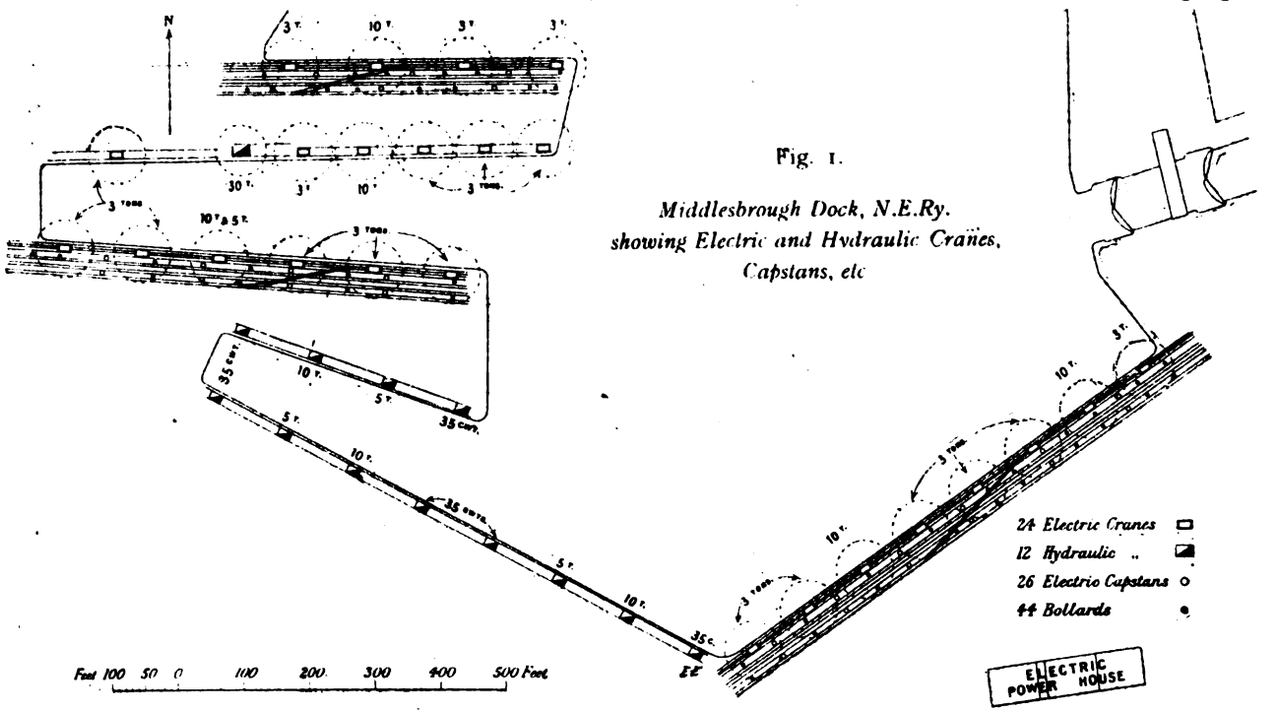

Fig. 1.

Middlesbrough Dock, N.E.Ry. showing Electric and Hydraulic Cranes, Capstans, etc

The power station contains three sets of Messrs. Bellis and Morcom's compound, three-crank, self-lubricating, quick-revolution, vertical engines, discharging with independent condensing plants, each developing 360 b.h.p. at a steam pressure of 150lb. per square inch at a speed of 380 revolutions per minute. These engines are direct coupled to three Siemens dynamos, which have an output of 240 kw. at 430 volts when running at a speed of 380 revolutions per minute. The engines on a six hours' test run gave the following results:

Steam pressure on range	154lb. per square inch.
Steam pressure in steam chest	128lb. per square inch.
Vacuum	24in.
Revolutions per minute	380.
Volts	430.
Amperes	552·5
Exciting amperes	6·75
Kilowatts	237·5
Water consumption	21·1lb. per electric horse-power*
Efficiency	$\frac{318{\cdot}3 \text{ e.h.p.}}{359{\cdot}321 \text{ i.h.p.}\ \dagger} = 88{\cdot}6$ per cent.

* Exclusive of steam used by the condensing plant.
† Exclusive of power abstracted by the condensing plant.

* Paper read before the Institution of Mechanical Engineers, Chicago meeting, 1904.

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The switchboard is of marble, and consists of four machine and one feeder panel, in addition to the lighting panel. The instruments are of the moving-coil type. The shunt winding of each dynamo is brought to a switch on the board, and these shunt switches are interlocked with their respective main switches, so that it is impossible to break the exciting circuit of any machine until the armature has been cut out of circuit, nor can the armature be thrown in until the shunt circuit is made. The three machines are run in parallel upon the 'bus bars, and the shunt circuits are excited from the bars. The three hydraulic engines are of the triple-expansion surface-condensing inverted vertical marine type. The pressure pumps, three in number, are of the ordinary ram type, worked directly off the piston rods, and each set is capable of delivering 300 gallons per minute at a maximum speed of 240ft., against an accumulator pressure of 800lb. per square inch. Both the hydraulic and electric engines can also be worked non-condensing, and the piping and valves are so arranged that either engine can be changed over

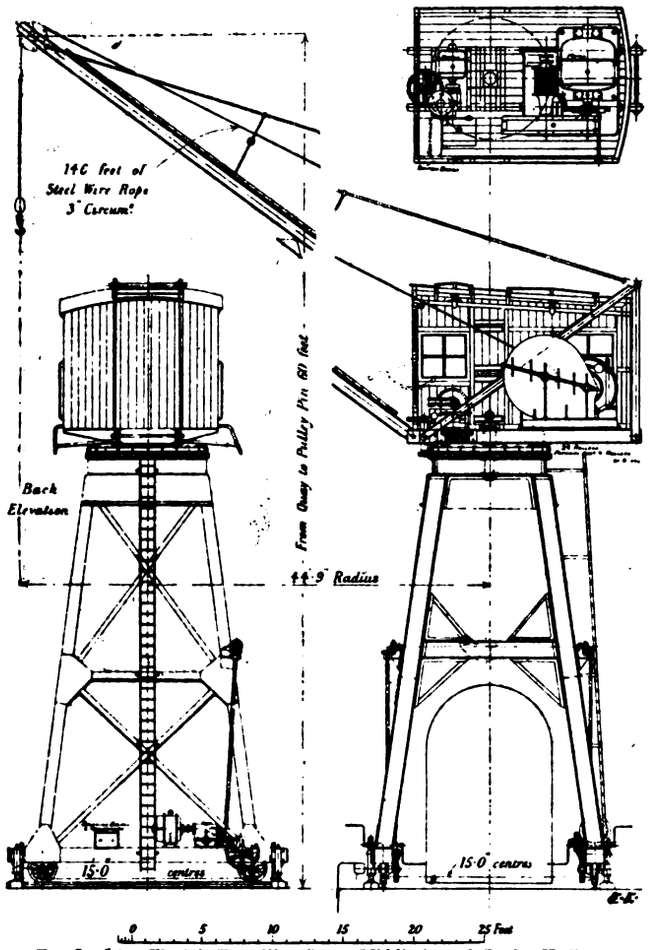

FIG. 2.—3-ton Electric Travelling Crane, Middlesbrough Docks, N. E. Ry.

from condensing to non-condensing, or *vice versâ*, without any stoppage whatever. There are two hydraulic accumulators, 20in. diameter by 23ft. stroke, and situated betwixt these is a large water-tank, which holds 12,000 gallons for supply to the pressure pumps. The hydraulic engines on a six hours' test run gave the following results:

Water pumped at a piston speed of 240ft. per minute		311 gallons.
Water pumped per cwt. of coal burnt		5,090 gallons.
Steam consumption per i.h.p. per hour		14·1lb.*
Total i.h.p.		181·5†
Steam pressure per square inch		150lb.
Vacuum		28·5in.
Efficiency	Pump h.p. / i.h.p. = 162·5 / 181·2	89·5 per cent.
Accumulator pressure		750lb. per square inch.

* Exclusive of the steam used by the circulating pump.
† Exclusive of the power absorbed by the circulating pump.

There are two sets of condensing plant in connection with the electric steam-engines, each capable of dealing with 15,000lb. of steam per hour; these were supplied by Messrs. Carrick and Wardale, of Gateshead-on-Tyne. Each set comprises a compound steam-driven air and circulating pump, together with a surface condenser combined on one bed-plate. The circulating water is passed zigzag through the condenser, and the quantity used is 30 times the amount of steam dealt with, and the vacuum maintained from 27in. to 29in. The circulating water is drawn from the dock, a distance of 300ft., through an 18in. suction pipe, and at low water these pumps have a lift of 15ft., but no difficulty has been experienced in getting the water even at such a great distance. There is also a circulating pump, fitted by the same makers, for supplying water to the condensers of the hydraulic engines, and it is similar in design to the electric plant. The three feed pumps and filters were supplied by Messrs. Henry Watson and Sons, High Bridge Works, Newcastle-on-Tyne.

The boilers for both plants are of the ordinary Lancashire type, six in number, 30ft. long, 8ft. 6in. diameter,

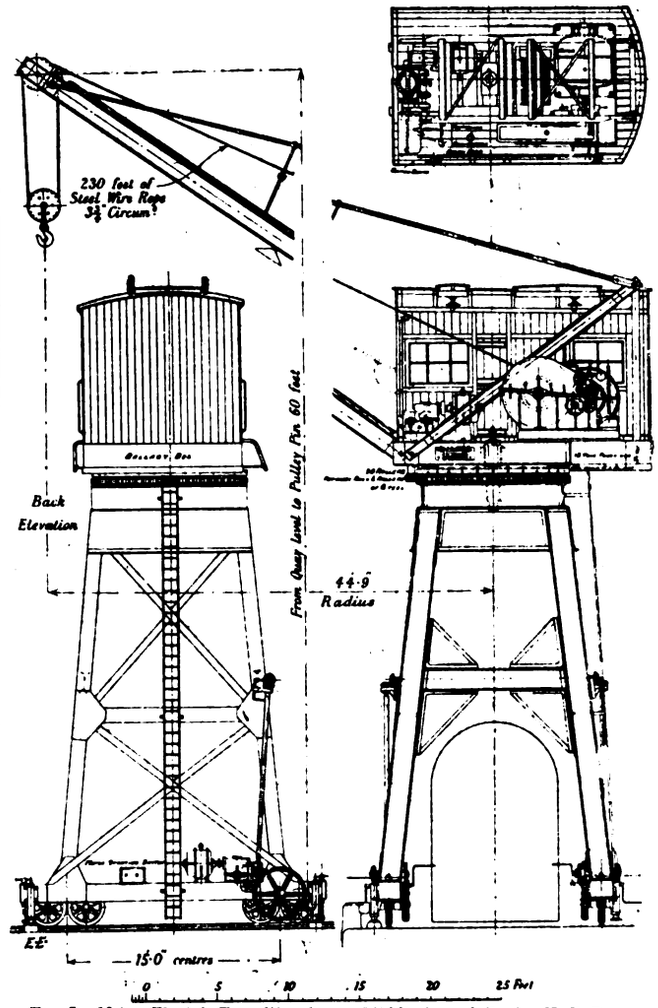

FIG. 3.—10-ton Electric Travelling Crane, Middlesbrough Docks, N. E. Ry.

working pressure 160lb. per square inch, and were made by Messrs. H. and T. Danks, of Netherton. The boilers are fitted with Proctor's shovel stokers, and the coal is supplied thereto by a coal elevator and conveyor supplied by Messrs. Graham, Morton, and Co., of Leeds, the coal in the first instance being raised from ground level in truck by means of a diagonal hydraulic hoist to the top of the coal cells and there discharged. A Green's economiser of 384 tubes, 9ft. long, $4\frac{0}{16}$in. diameter, is fitted in connection with the boilers. The boilers on a six hours' test gave the following results:

Grate area	38 square feet.
Coal burnt	5,208lb.
Clinker and ashes	356lb., or 7 per cent of coal burnt.
Net consumption of combustible	4,852lb.
Combustible burnt per hour	809lb.
Combustible burnt per square foot of grate area per hour	21·3lb.
Pounds of water evaporated	36,300
Pounds of water evaporated per hour	6,050
Pounds of water evaporated per pound of coal burnt	7·5lb.

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Feed water from hot-well at 110deg. F. was run to waste on account of measuring the water, and town water was put in feed tank at a temperature of 54deg. F., or equal to

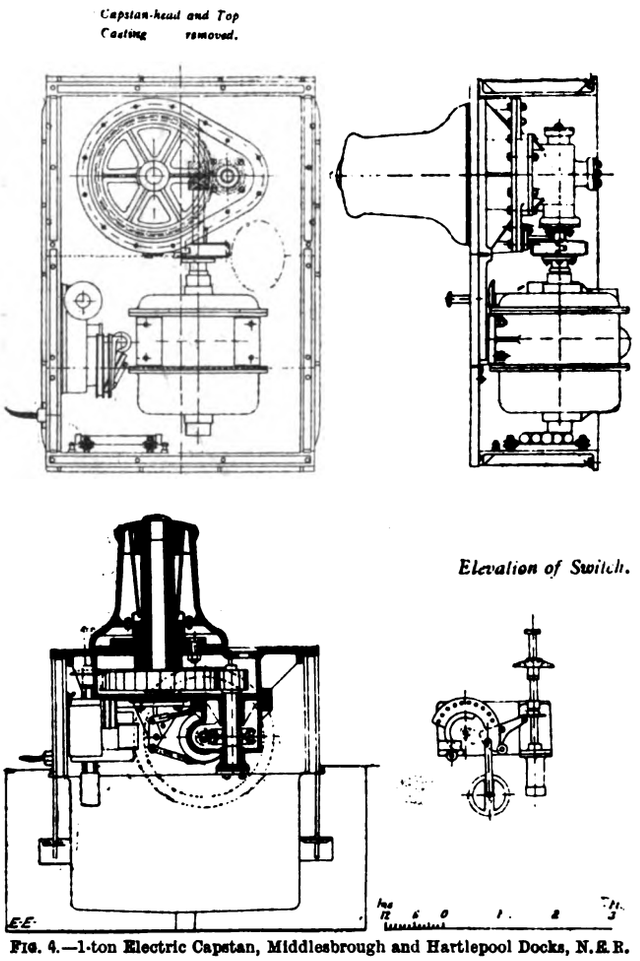

Fig. 4.—1-ton Electric Capstan, Middlesbrough and Hartlepool Docks, N.E.R.

a loss of 241lb. of coal. The steam and hydraulic mains are laid in circuit in the engine and boiler houses respectively. The contract for the electric cranes and capstans consisted of 19 three-ton and five 10-ton cranes (Figs. 2 and 3), and 26 one-ton pull capstans (Fig. 4). The whole of the electrical equipment for these was supplied under sub-contract by Messrs. Siemens Bros. and Co., of Woolwich. The following are the principal particulars of the three-ton cranes (Fig. 2) as specified.

Height of jib top pin from quay level	60ft.
Radius of jib	44ft. 9in.
Speed of lift, three-ton load	150ft. per minute
Speed of lift, 1½-ton load	250ft. per minute
Revolving speed at hook	400ft. per minute
Travelling speed	30ft. per minute
Lifting motor, 50 b.h.p.	300 revs. per minute
Revolving motor, 8 b.h.p.	1,000 revs. per minute

The cranes are of the high gantry type, with gantry 30ft. high, and so constructed as to admit of the passage of wagons and engines underneath. The whole structure is rigidly tied together. Holding-down clips for fixing to the rails and screw-down jacks for increasing the base when the maximum load is being dealt with are also provided, but the cranes are absolutely stable, even with a 50 per cent. overload, without these attachments. The travelling gear motion is fitted with both hand and electrical gear, the latter consisting of an enclosed series-wound multipolar motor, which is coupled to a steel worm working into a delta metal worm-wheel. The power is communicated to the trod-wheels by means of spur and bevel gearing, the wheels on each side being coupled together by means of a cross shaft, thereby ensuring uniformity of movement and avoiding any twisting strain on the gantry. The switchgear for the travelling motor is placed in a watertight case upon the bottom framing of the gantry. To prevent the possibility of unauthorised persons starting the gear, the switch is provided with a detachable key, which is kept in the charge of the crane-driver. The top framing is constructed of H beams riveted up into box shape and carrying the heavy plate which takes the roller path. H-beam cross-stays take the thrust and stiffen the structure. The roller path and rack are of cast steel; they are not bolted to the top plate, and whilst they are held down by a groove turned out of the latter, they admit of some movement and ease the crane in case of a sudden stop when revolving. The rollers are 24 in number and of cast steel. The collector is fitted to the centre pillar, through which the mains are passed and attached to (and consists of) two copper rings mounted upon ambroin and separated by rings of the same material. The collecting brushes consist of two gauze straps, each encircling one ring, the tension being regulated by springs. These straps are attached to terminals, which in turn are mounted upon porcelain insulators, from which the cables for the wiring of the cranes are taken. The

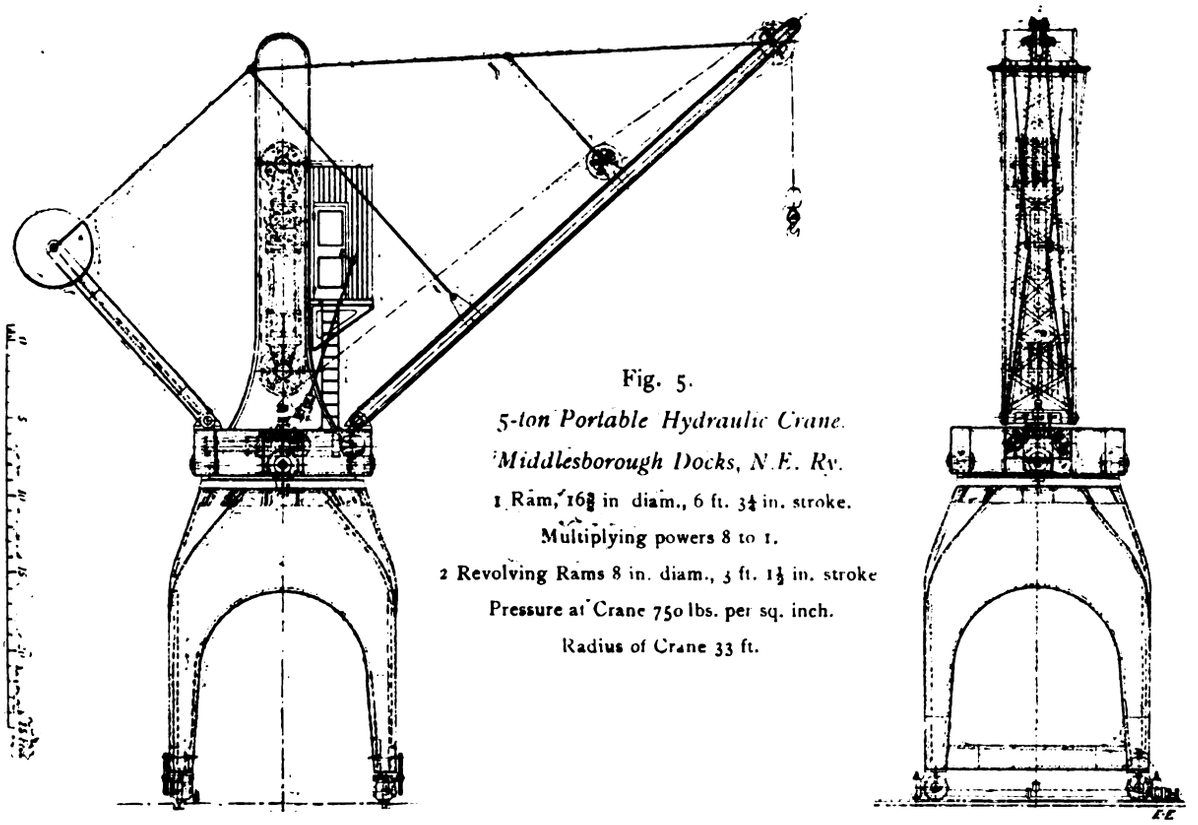

Fig. 5.

5-ton Portable Hydraulic Crane.

Middlesborough Docks, N.E. Ry.

1 Ram, 16⅜ in diam., 6 ft. 3¼ in. stroke.

Multiplying powers 8 to 1.

2 Revolving Rams 8 in. diam., 3 ft. 1½ in. stroke

Pressure at Crane 750 lbs. per sq. inch.

Radius of Crane 33 ft.

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crane cabin is of teak, and the front consists of a wrought-iron framing, glazed to enable the driver to have full view of his load throughout the operation. The cabin contains the lifting and sluing gear and the controlling apparatus. The lifting gear consists of a barrel, wheel, and pinion. The wrought steel pinion is cut from a blank forged solid with the shaft, which is fitted with a half-coupling to meet that upon the motor spindle. Upon this shaft there is a band brake, actuated by an electromagnet which will be described later. The pinion gears into a cast-iron spur wheel keyed on the barrel shaft. Both pinion and wheel have machine-cut teeth, and work in a cast-iron gear case, which forms an oil-bath. The revolving gear consists of a

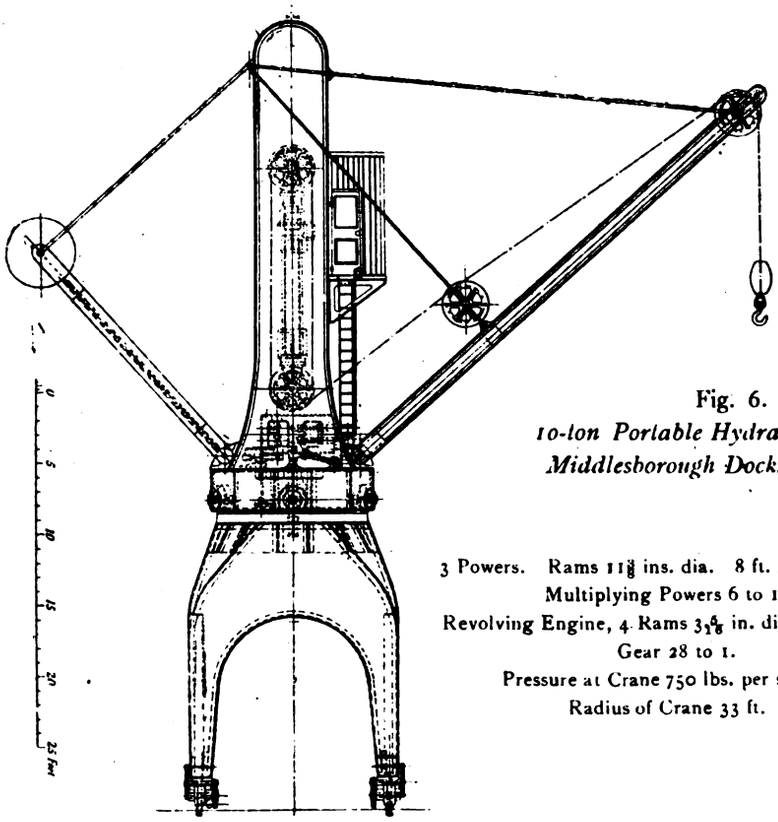
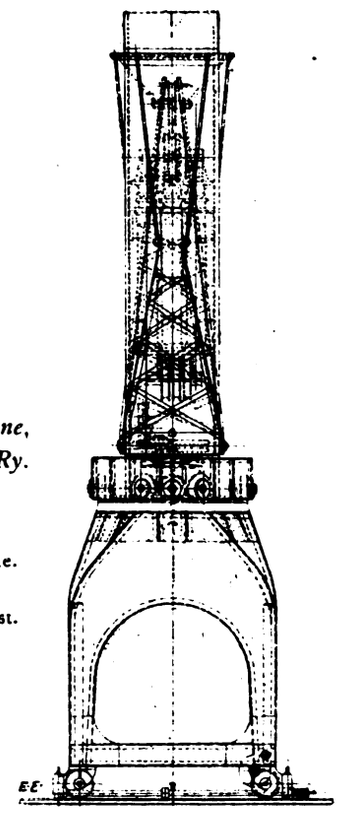


Fig. 6.
10-ton Portable Hydraulic Crane, Middlesborough Docks, N.E. Ry.

3 Powers. Rams 11⅞ ins. dia. 8 ft. 4 in. stroke.
Multiplying Powers 6 to 1.
Revolving Engine, 4 Rams 3 1/16 in. dia. : 6 in. st.
Gear 28 to 1.
Pressure at Crane 750 lbs. per sq. in.
Radius of Crane 33 ft.



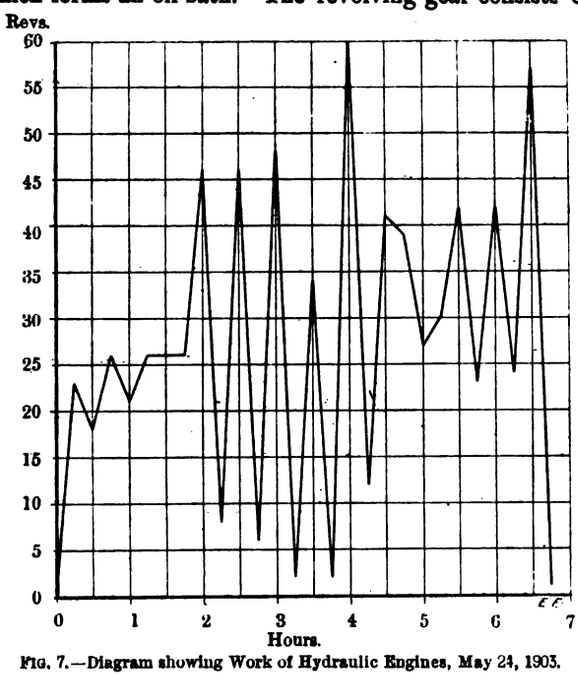


Fig. 7.—Diagram showing Work of Hydraulic Engines, May 24, 1903.

motor, worm, worm-wheel and spur gear. The worm is cut from a blank forged solid with the shaft, which in turn is fitted with a coupling to meet the motor. The worm engages with a delta metal worm-wheel, and a pinion keyed to the worm-wheel shaft engages with a spur wheel which is fitted to a short shaft actuating a pinion. This pinion travels round the rack of the crane and thus slues the cabin and jib. A brake actuated by a foot-treadle is fitted to the first-motion spindle, so that the sluing motion is always under control. The sluing motor is of similar type to the lifting.

The electric brake magnet, referred to previously, offers some points of interest. It is placed in series with the armature of the lifting motor, and consists of a horseshoe magnet (with poles arranged as those of a two-pole dynamo) with a solid steel armature of special shape capable of revolving between them. The passing of the current round the field coils tends to move the armature through a right angle. A lever is fixed to the end of the armature, and the brake, which is normally held on to the brake wheel by a weight, is connected thereto by a rod. The movement of the armature lifts the brake and releases the brake wheel. The great advantage of the particular form of magnet described lies in the strong pull and long range which it affords. The brake is also connected to a lever which stands

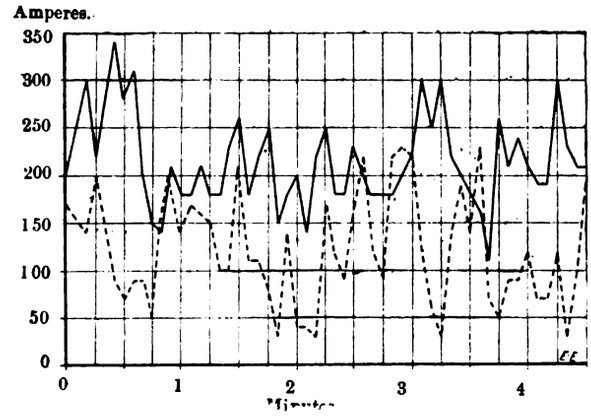


Fig. 8.—Electric Engine Current Diagram, May 31, 1903. Dotted line shows variations in the current load during the working of light loads. Full line, variation in the current load during the working of heavy loads.

at the driver's left, so that it can be operated instantly by hand when necessary. The controller is of the so-called Universal type, and consists of two separate controllers combined in one case and actuated by one handle. One controller actuates the lifting and the other the sluing, and both are connected by pinions and quadrants to the lever. The latter is so arranged, by means of a Universal device, that when moved in a vertical plane it actuates the lifting, and, in a horizontal plane, the sluing controller. Thus it will be seen that the hook follows the motion of the driver's hand, lifting when he raises the lever, and so on. One

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conspicuous point about the controller is the ease with which it is manipulated, owing to the absence of click gear upon the immediate contacts. Notches are provided only at the two extremes and the off positions, and in consequence the controller may be operated throughout the day without fatigue and its attendant slackness. The resistances are fixed inside the cabin. The switchboard consists of polished slate, framed in teak and fitted with main D.P. switch and automatic cut-out in lifting circuit, and isolating switches in sluing circuit, fuses, and lighting switches. The crane cabin is well lighted by fixed and portable lamps, and a cluster in an enamelled iron reflector is fixed beneath the jib half-way up its length. Terminals are provided upon the switchboard, to which may be connected an inspection voltmeter and ammeter.

Each three-ton crane on being completed was tested in the following manner. A large iron tub (fitted with a valve at the bottom), weighing one ton net, brought close to the quay wall, lowered into the dock, filled through the valve, there being a port in the side of the tub so that the weight of water could not exceed two tons, or a total load of three tons. This was lifted 30ft., and slued through a half circle simultaneously, then lowered on to the quay, where the valve on the bottom of the tank opened, and the water returned into the dock. The tub was again lifted empty, taken back, and the same process continued. Each crane was worked in this manner for three hours, making on an average 100 lifts in the stated time. The current used was, lifting 18·3 and sluing 6·4 Board of Trade units, or a total of 24·7 Board of Trade units, or 2·74 Board of Trade units per 1,000 foot-tons, or a total cost of 5·4d. per 1,000 foot-tons, as shown in the Table No. 2 of costs.

The 10-ton cranes (Fig. 3) are of the same design as the three-ton cranes. The revolving motor is 12 b.h.p. at 1,000 revolutions per minute, and the lifting motor, which is of 60 b.h.p., in single gear, drives directly through a pinion on to the barrel shaft, the ratio of gearing being 8 to 1, and a double part of rope is used. The double gear gives a multiplying power of 20 to 1. With the single gear loads up to two tons are lifted, and the double gear is used for loads from two to ten tons. As it was impossible to get both the hydraulic and the electric cranes working together under similar conditions into a vessel, on account of the cargoes at Middlesbrough being of such a varied nature and the vessels differing so much in dimensions, to obtain comparative figures as to the cost of the work done, a special test was made, which was considered to be the nearest approach to the actual working conditions in loading cargo into a vessel's hold, and the tabulated form shows work done and the power required. The first load was two tons lifted through a height of 20ft. by the single gear, slued through 180deg., and then lowered 20ft.; the light chain hoisted 20ft., and the crane slued back through 180deg. This cycle of evolutions was performed five times. The load was then increased a further two tons each time up to and including 10 tons, and the same number of evolutions made with each load as in the first case, but double gear being used for the lifting. The total current used being 8·1525 Board of Trade units, or 2·717 per 1,000 foot-tons, at a cost of 5·4d. per 1,000 foot-tons, equivalent to 358,710 foot-pounds of energy per minute for the total work.

The author does not propose to take up the members time by going fully into the details of the hydraulic crane, as this is so well known, but simply content himself by stating that it was of up-to-date design, as shown in accompanying drawing (Fig. 6), with a capacity of 10 tons, and having three vertical cylinders for lifting. Water is admitted to the centre cylinder for the light power, the two outside cylinders for the second power, and all three cylinders for the full load. The sluing is done by gearing driven by a small ordinary four-cylinder capstan engine, and the working pressure at the crane during the test was 700lb. The hydraulic cranes are 15 years old, but are all of exactly the same design as supplied by the same firm at the present day, and were overhauled and in perfect condition before the trials were made; and the capstan is quite modern. The power water was measured by means of two Kent's high-pressure water-meters, one on the lifting and the other on the revolving motion, and the crane was worked at its ordinary speed. Precisely the same evolutions were carried out as in the case of the electric crane, and the total gallons of pressure water used was 2,391, equivalent to a cost of 10·25d. per 1,000 foot-tons lifted, or equivalent to 687,412 foot-pounds of energy per minute for the total work.

Another test was made on a Sunday with six hydraulic cranes arranged to be as near as possible on one quay, and water-meters were attached to each crane. Wagons of rails were brought underneath the cranes and worked as if they had been ordinary cargo into a ship. They were lifted to a height of 20ft. slued half-circle, lowered down to empty wagons, the light chain lifted a height of 20ft., revolved through half circle, and lowered down again. Six hundred tons were dealt with as constant loads, and 600 tons as variable loads, and the tabulated statement shows the cost of handling the same. The cost of power per 1,000 foot-tons of work was 1s. 6d., the time occupied seven hours, as shown in Table 1 of hydraulic costs. The same work was done on the following Sunday by the electric cranes, and the cost per 1,000 foot-tons was 1s. 2·23d., and the time occupied 5¼ hours. (See Table 2). The total saving effected by the electric cranes, including cranemen and labourers, was 25 per cent., but the load factor for the electric was only 7·3 per cent., as against the hydraulic 14·4 per cent., so that if more cranes had been working, and a better load on at the power station, better results would have been obtained for the electric cranes. He would estimate that the total gain would have been 50 per cent. The diagrams, Figs. 7 and 8, show the fluctuations of the work.

Capstans.—The electric capstans (Fig. 4) are 24 b.h.p. at 100 revolutions per minute, and are capable of exerting a steady pull of one ton at a speed of 200ft. per minute, or of hauling a load of 100 tons along a level road. The capstan head is driven by a cast-iron spur wheel, which is engaged with a steel pinion. The latter is keyed on the same shaft as the brass worm-wheel. The driving worm is cut from a blank forged solid with its shaft, and is coupled direct to the motor spindle. The worm and wheel work in an oil-bath. The motor runs at 1,000 revolutions per minute, and is completely enclosed. In construction and design it is similar to the crane motors, but is shunt wound to avoid large variations in speed of the capstan head. Upon the motor shaft there is fixed an automatic mechanical brake, the principle of which provides that when the capstan head is driven by the motor the break releases itself automatically, but should the capstan tend to run back through being overhauled by the weight, the brake at once locks itself and sustains the load. Such a brake is absolutely necessary upon an electric capstan, as the latter differs from a hydraulic capstan in one important respect—namely, that in the hydraulic capstan the water in the cylinders holds the load, whereas in the electric capstan there is nothing to sustain the load upon the current being cut off, and if the load is allowed to run back a serious accident may ensue. It is also essential that the brake should be automatic, so as to claim none of the driver's attention from his work.

(To be continued.)

POWER CONSUMPTION ON ELECTRIC TRAMWAYS.

The *Elektrotechnischer Anzeiger* gives a summary of 47 replies from tramway companies to a circular sent out recently by the International Tramway and Railway Verein on the above subject. The figures obtainable from the various replies differ widely. Thus, converting to English equivalents, the lowest consumption per car mile is 560 watt-hours, whilst the maximum value is 1,500 watt-hours. Even the figures per ton-mile vary between 80 and 168 watt-hours. These wide differences result partly from differences in the methods of computing the figures sent in and partly from essential differences, such as the question of gradients and curves, the distance between stopping places, the adoption of special types of motor and trailer cars in some cases, and also the variations in road condition through the frequency or otherwise of rain and snow storms in the different districts. In some cases, also, the current used in the station workshops and

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lighting has not been subtracted. All these points, of course, greatly affect the consumption, so that it is impossible to decide definitely from the replies that any one tramway is more economically worked than another, but the wide variations naturally lead to the question whether further economies are not possible in many cases. Very few of the companies are of the opinion that such economies are impossible, and most of them hope, by increased efforts, to produce a further reduction in their current consumptions. Various methods of accomplishing this are suggested. Some expect to produce a saving merely by systematic training of the drivers and inspectors; others by the introduction of the three-wire system, the distribution of bonuses, etc. A fair proportion have gone so far as to instal meters on the cars, in order to keep account of the consumptions of the different drivers, and this, so far, has led to satisfactory results. It is satisfactory to note that the different companies agree as the reliability of the meters employed. These are obtained from various firms, and differ in price from £3. 12s. to £15. 15s. each. The meters are usually fitted under the seats, but sometimes they are fixed to the inside walls of the car, or even under the car. The frequency with which the meters are tested varies from once every four weeks to once every four months, and the inaccuracies discovered do not exceed ± 10 per cent. The meters are sometimes read once a day, and sometimes after each journey, or at the end of each driver's shift. Up to the present none of the companies have distributed a bonus on the strength of the meter reading, though several consider it desirable. The general opinion would seem to be that better results are obtainable by a mechanical control of the drivers, such as that offered by the meter system, combined with the distribution of premiums, so as to give the drivers more interest in the work than would be possible simply by the careful training of the drivers and inspectors. Of course, such a system of control involves considerable expense in time and trouble, but the resulting reduction in current consumption would more than balance this, whilst at the same time it tends to produce a *personnel* interested in the advancement of the line.

THE COMMONWEALTH TURBINE ACCIDENT.

Our contemporary *Power* gives the following account of an interesting accident:

On June 18 the three-phase system of the Commonwealth Electric Company of Chicago ran away, and the alternator on one of the turbines was damaged. The conditions before the accident were these: Two turbine-generators of 5,000 kw. each at the Fisk-street station were running in parallel, and supplying a number of rotary converters with three-phase current, which in turn were feeding a low-tension direct-current system. This direct-current system was also being fed by storage batteries and by direct-current generators. It appears that some weeks before this time one of the alternators had been damaged by being thrown on to a line considerably out of step, but the damage had been repaired. This may or may not have had anything to do with the trouble on the day in question.

Fig. 1 is a diagrammatical representation showing the features which it is necessary to consider in order to fully understand just what happened, and what combination of circumstances caused the accident: 2 and 3 are steam turbine alternators; *a b c* represent three of the rotaries being fed from these alternators by three-phase 25-cycle 6,600-volt current; *d* and *e* are two of the direct-current generators feeding the same low-tension system as the rotaries; *f* is one of the several storage batteries also feeding the system. Transformers, switches, neutrals, etc., are left out in the diagram as not necessary of representation in this case. The fields of both alternators were excited, as is shown, from the same source, only one of whose dynamos is represented. Now the first thing that happened that bears directly on the runaway was a short-circuit between the armature coils of No. 2 alternator—this is the alternator that had been previously injured and repaired. The armature on this machine is stationary and the fields revolve inside of it on a vertical shaft. As soon as the attendant noticed the short-circuit, he opened the switches at A, disconnecting the burning part from the alternating-current system. This cleared the armature, but he neglected to open the switches at B clearing the field of the alternator from the exciter 'bus. In the meantime the short-circuit had burned away the binding wires, which in turn caused a ground on the revolving fields. The exciter units now having to pump current into this ground, dropped in voltage, so that the exciting current of No. 3 alternator dropped very low.

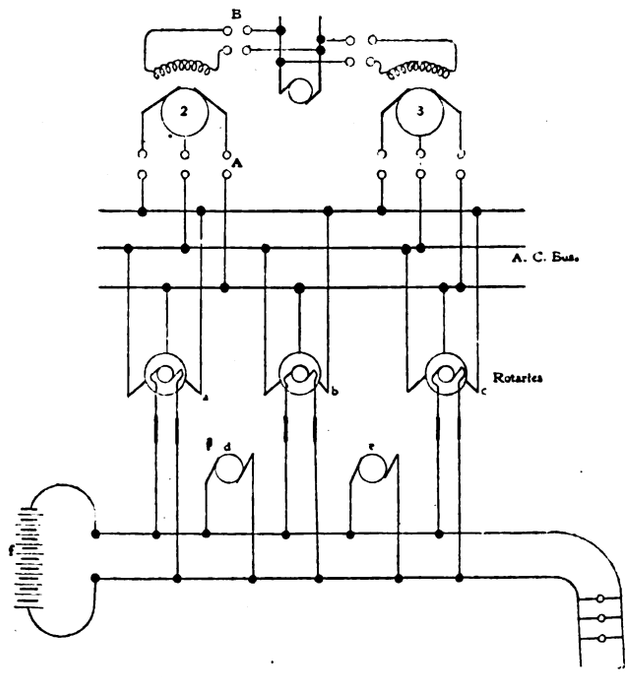

FIG. 1.

The conditions at this stage were as follows: One alternator with a very weak field tied to several rotaries which are feeding a direct-current system, and this system being also fed by generators and batteries. Now, the alternator being left alone on the line after No. 2 was cut out, would be greatly overloaded, even if the field were kept strong, but with the dropping of the field excitation the alternator became practically useless as a generator. If it were not for those outside sources of power the system voltage would simply go down, the load would be dropped off, and no damage would be done. But as soon as the rotaries stopped receiving current from the alternating-current side they began to receive it from the storage batteries and generators on the direct-current side. The rotaries then fed three-phase current back over the alternating-current line to the alternator. Some of the rotaries have reverse-current tripping apparatus on them, and these operated and cut those rotaries out of circuit. The few that were left were called upon to furnish current to the alternator—a unit eight times as large as either of them—and which acted as a huge motor.

Now, the current which this motor would take would be large in any case, but another factor enters into the calculation which makes it still larger, and this factor is induction. It is like pumping water through a very long pipe with a force pump. The pump is given a succession of strokes and the water moves, but on account of the inertia of the water the movement due to each stroke lags in time behind the stroke. The inertia corresponds to the induction. In the case we are considering the armature of the alternator furnished what is called an "inductive" load for the rotaries, and the current in the line lagged cosiderably behind the E M.F. The condition of each phase is shown in Fig. 2. Now, the energy in a line is a direct factor of the current multiplied by the voltage. At an instant (*x*), for example, while the product of the current and voltage is small, the current would be large. And this was exactly the case. There was an enormous current being sent out by the rotaries, but the biggest part of it was lagging way

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behind the E.M.F., and this is the current that caused the trouble. This current reacted directly against the field of the rotaries and weakened them. These rotaries, remember, were at this time being fed from the direct-current side, and, therefore, acted as shunt motors. The effect of weakening the field of a shunt motor is to make it speed up. This is what the rotaries did. They began to speed up, carrying the turbine with them. The faster they went the larger lagging current was produced, and the weaker the fields became; so there was a continual acceleration until the enormous speed broke the circuit in the turbine-alternator. Since the turbines run normally at nearly three times as many revolutions as the rotaries, it will be seen that the speed of the former must increase rapidly with the increase of the rotary speed. As soon as the turbine began to speed up, the man in charge of it closed the emergency valve, thus shutting the steam off from it entirely. This is mentioned, not because it made any real difference, but merely to show that the steam did not have anything to do with the disastrous increase in speed.

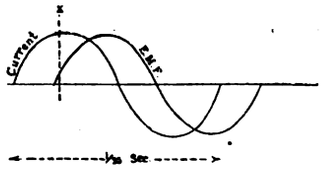

FIG. 2.

Now let us see what could have been done to prevent this: In the first place, if when No. 2 alternator short-circuited the operator had opened all the field switches on the machine, as well as opened those on the armature circuit, the ground on the exciter circuit would have been removed, the voltage on the field of the No. 3 alternator would have been high, and the alternator would have taken care of the load, perhaps under slightly reduced speed, until it could have been relieved. This opening of the field should always be done in the case of a short-circuited alternator armature; otherwise the generator will keep feeding the short-circuit, continually causing more damage. Again, if after the system had begun to speed up, the operator had opened the switches on No. 3 alternator, it would stop of its own accord, and the rotaries would gradually come down to normal speed, even if they were not cut out. Also if the sub-station operators had opened up their rotary circuits, either on the direct-current or the alternating-current side, the system would gradually come to rest. In defence of the operators it should be stated that the whole thing happened within the space of a few seconds.

This accident recalls one somewhat similar that happened on the New York Edison system some years ago. At that time one of the stations was feeding through inverted rotaries—that is, rotaries receiving current from the direct-current side—other stations of the same company. Through some accident a short-circuit was made on the high-tension line. All the rotaries immediately began feeding the short-circuit and receiving current from the direct-current sides. A large lagging current was produced, the fields of the rotaries weakened, and a general run away resulted, damaging some of the rotaries very badly.

WHISTLING GEORGE—WITH A MORAL.

George Barnes was a machinist by trade, and a whistler by profession. The statement is probably given in an inverse order; his profession was certainly the most prominent of the two qualifications; for whatever rank he might claim as a machinist, no one ever questioned his abilities as a whistler.

Whistling is very well at a proper time and place, and with a farther qualification as to quantity. It does much to relieve the tedium of shop manipulation, and is a common pastime with machinists; but the hero of this story was possessed of a mania for this shrill music, and hour after hour, if not day after day, he plied his notes, with pleasure and comfort to himself no doubt, but often to the great annoyance of those around him.

George, because of a want of musical taste on the part of his employers, had whistled himself out of a situation; and as his pecuniary affairs rendered it imperative that his machine fitting should go on with the whistling, he applied promptly for a new job at a large works near to where he had been previously employed.

The foreman being in need of hands, and favourably impressed with George, at once gave him a job to commence on the following morning. He was there promptly at the time with his tools and overalls, ready to begin. The foreman not having arrived, George sauntered around the shop examining the tools, and began in an unconscious way to whistle; but finding that it attracted the attention of the other workmen, who had never heard such an adept, he checked himself, feeling he was taking an unwarranted privilege in a strange shop. The foreman arriving, George was given his job for the day. The works, among other tools, employed several large punching machines; one of the dies having failed, George was given the bed-piece to prepare. The die was a solid block, about 12in. square, requiring a cylindrical hole 4in. in diameter to be made through the centre. It was forged from a tough, fibrous iron, about 4in. deep, with a steel facing ½in. thick on the face side.

George first drilled a starting hole through the piece, and then proceeded to "chuck" it on an old but powerful lathe used for drilling purposes. While mounting the work his attention was so much taken up in the search for bolts and blocks that the whistling was for the time neglected; besides, there had continually to be questions asked as to where tools were kept, and other things, and while George could do almost anything else and whistle at the same time, talking, of course, stopped his music.

When he finally had all arranged, his work chucked, a large flat drill prepared, and the belts adjusted, he began drilling, and there was nothing to prevent the music from commencing at the same time. Now, if there is anything more than another that provokes whistling in a machine shop, it is drilling, especially a large, deep hole, and the man who does not whistle when engaged at such work can be set down as "without music in his soul." There is a kind of stupor of the mind induced by its being for the time released from care of the work, and a person will whistle almost unconsciously, as a kind of relief to the monotony.

George had many a time been in circumstances that favoured the exercises of his piping proclivities, but never in his whole experience could he remember so propitious an occasion as the present one. Not that he thought of it in this light; he had no time to do so. The assumption is based upon the strength and continuity of his performance on the occasion. He whistled loud and long, soft and shrill, operas, hornpipes, marches, a very medley of tunes, apparently endeavouring to test his whole stock under such favourable circumstances.

A stolid German, who was working at a bench near by, would every now and then turn his head and stop his work in wonder, evidently enjoying the music, but astounded at the proficiency of the performer. The German had been but a short time in the country, and set this down as one of the prodigies among the many he had met with in the new land. An old shaft overhead that was out of repair by the screeching of a loose coupling marked time to the music, and blended like an accompaniment with the livelier tunes.

For an hour there was no cessation. The German began to think that whistling was the nominal condition of his new fellow-workman, and instead of looking around while the music was going on, he now found himself startled by its changes only. He even began to estimate as to whether the enjoyment derived from the music might not be in some degree measured by the amount that he might have to enjoy or endure.

In the second hour, and in the middle of a lively refrain, there was all at once, at George's lathe, a terrible crash, that called all hands to the place to see what had happened. Lying beneath the lathe was its face-plate with the die firmly bolted to it. The matter had a mysterious air, until someone noticed the lathe spindle, when the whole riddle was solved. George, engrossed with his whistling, had,

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by starting on the steel side of the die, miscalculated or forgotten the time, and had drilled through the piece, the face-plate of the lathe, and bored off the end of the spindle.

We need hardly say that the whistling stopped; George stopped also, learning at the same time the truth of the old maxim, that, in the circumstances just described, "enough is plenty of anything," applied not only to the whistling, but to the drilling as well.

LONGTON ELECTRICITY ACCOUNTS.

The following are abstracts of the 1903-4 revenue account and of the balance-sheet of the electrical section of the Longton Corporation gas and electricity department. The capital expenditure for electrical purposes at end of financial year was £21,309.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	351	6	10
Distribution of electricity	20	4	0
Rates and taxes	80	8	4
Management	2	11	3
Special charges	73	17	5
Balance carried to net revenue account	714	12	9
	£1,243	0	11

Cr. Income.	£	s.	d.
Sale of current	1,208	0	6
Rental of meters, etc.	35	0	5
	£1,243	0	11

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account	22,655	12	5
Sinking fund on loan—balance of	751	19	6
	£23,407	11	11

Cr. Assets.	£	s.	d.
Amount expended on works	21,309	4	6
Sundry debtors and sales	510	2	9
Stocks on hand	5	7	4
Balance from net revenue account	1,582	17	4
	£23,407	11	11

EAST HAM TRAMWAY ACCOUNTS.

Herewith are given abstracts of the revenue account and of the balance sheet of the tramway department of the East Ham Urban District Council for the year ended March 31, 1904. The capital expenditure at that date was £135,591.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Power	6,713	8	2
Traffic expenses, etc.	10,600	16	11
Car-shed expenses	290	0	9
Maintenance and renewals	4,486	18	2
Rates, taxes, and insurance	1,298	4	9
Management	727	12	4
Legal expenses, etc.	1,095	10	8
Balance carried to net revenue account	10,088	16	10
	£35,301	8	7

Cr. Income.	£	s.	d.
Traffic receipts	34,311	17	9
Miscellaneous receipts	987	9	8
Amount surcharged by auditor in 1902-3	2	1	2
	£35,301	8	7

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages	116,596	16	4
Sundry creditors	6,083	12	10
Cash due to bankers	9,601	14	10
Loans repaid, depreciation, repayment of capital	8,243	5	10
Suspense account	750	0	0
	£141,275	9	10

Cr. Assets.	£	s.	d.
Capital outlay	135,591	1	8
Sundry debtors	266	15	0
Cash in bankers' hands	5,236	9	9
Tickets, stationery, etc., on hand	124	19	11
Unexpired value of licenses	56	3	6
	£141,275	9	10

HAMMERSMITH ELECTRICITY ACCOUNTS.

Appended herewith are abstracts of the revenue account and balance-sheet of the Hammersmith Borough Council's electricity department, together with statement of electricity generated, sold, etc., for the year ended March 31, 1904. The capital expenditure to end of year was £200,935.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	10,377	5	2
Distribution of electricity	2,216	0	7
Public lamps	1,121	10	8
Management	1,801	16	7
Rates and taxes	1,194	6	7
Insurance	387	7	11
Law charges	5	16	8
Special charges	2,071	18	0
	19,276	2	2
Balance carried to net revenue account	13,449	3	3
	£32,725	5	5

Memoranda: gross cost £19,276. 2s. 2d., less special charges £2,071. 18s., and work done and goods supplied to consumers, etc. (distribution), £1,168. 12s. 11d.—total, £3,240. 10s. 11d. Net cost, £16,035. 11s. 3d.

Cr. Income.	£	s.	d.
Sale of current	31,230	5	7
Meter rents	48	0	5
Miscellaneous receipts	1,446	19	5
	£32,725	5	5

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
London County Council loans, etc.	176,168	0	0
Reserve fund	2,500	0	0
Sundry creditors and deposits	3,342	2	2
Net revenue account—balance of accumulated net profit	3,169	7	3
Due to treasurer	5,212	14	11
	£190,392	4	4

Cr. Assets.	£	s.	d.
Amount expended for works, less loans redeemed	180,791	18	7
Revenue account—sundry debtors	8,624	0	1
Stores on hand	971	2	9
Cash in hand	5	2	11
	£190,392	4	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		2,669,450
Quantity sold { Public lamps	326,731	2,223,923
Quantity sold { Private consumers	1,897,192	
Quantity used on works		407,450
Quantity accounted for		2,631,373
Quantity not accounted for		38,077
Total maximum supply demanded (kilowatts)		1,596

Number of public lamps: 167 arcs, 10 arcs (small), 75 incandescents.

TRADE NOTICES AND NOVELTIES.

Main Switches, Cut-Outs, etc.

The General Electric Company, Limited, Queen Victoria-street, E.C., have forwarded us a copy of their new list (X 1,060), in which it is stated that various improvements have been made from time to time, chiefly to keep pace with the increasing demand for high-voltage fittings, necessitating redesigning of apparatus to comply with the Board of Trade requirements. Several illustrations are shown of "Peel" and "Adelphi" main switches intended for switchboard work generally. These are substantially made, and possess many good features, chief of which is the long break. This break is very rapid in its action, and is properly arranged to allow of both contacts being broken simultaneously. The "Peel" switches are listed from 30 up to 1,000 amperes, either single, double, or triple pole, and are supplied with or without cut-out terminals. The change-over type range from 30 to 800 amperes, and are not provided with fuse terminals. Both types are constructed with strong dividing pieces of insulating material between the poles and the whole thoroughly finished. Carbon breaks are fitted to any switch where desired. A new type of "Adelphi" switch has been specially designed to meet the requirements of motor work. Two types of multiple switches are shown—viz., radial and rectangular—for regulating accumulator circuits and main resistances. The former is provided with a handwheel. The rectangular type is constructed with travelling contact brushes, which allow of uniform and smooth regulation from one contact to another. Shunt resistance regulating switches are also shown, and several types of house service fuses and main cut-outs. Amongst these will be found the "Concentric" (see

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Fig. 1) for use on circuits where this system is in vogue. The "Pedestal" type cut-out is an excellent design, ensuring perfect and easy access for replacement of fuses, and has a good clearance of 1in. between the conducting parts and the frames, which is of cast iron with hinged cover. The terminals are mounted on porcelain, and can be supplied to take "Mordey" fuses. Two examples of main switchboard fuses are illustrated—viz., the "Bobbin" and "Arch" type. These are very substantially made, and consist of the well-known hollow china tube, with a lining of a patent fireproof composition. The fuse

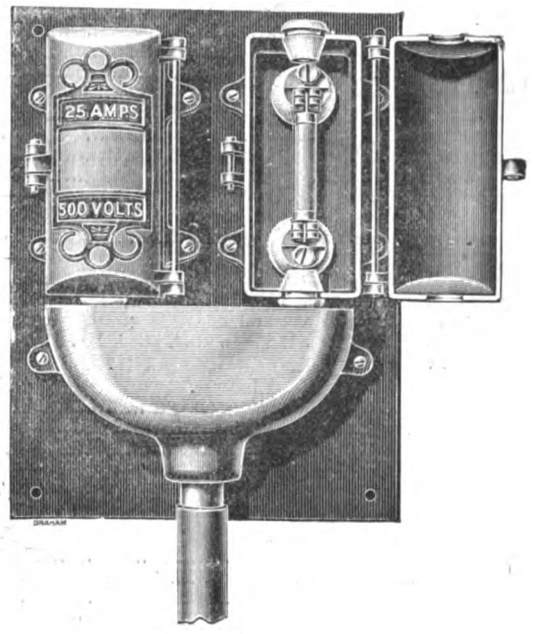

Fig. 1.—"Concentric" Main Cut-Out, for circuits up to 500 volts.

wires are clamped to solid gunmetal collars firmly fixed to the ends of the tube. Either type can be arranged to take a "Mordey" fuse in parallel. They are intended for circuits up to 500 volts, and are made to carry from 50 to 400 amperes. Illustrations are also given of the "Partridge" high-tension fuse (10,000 volts), and several voltmeter switches and ammeter plugs.

Catalogues.

The Electric Construction Company, Limited, Dashwood House, Broad-street, E.C., have issued a coloured illustrated poster showing of their engineering works at Wolverhampton, and of the standard types of generators, transformers, colliery haulage gear, mining locomotives, etc.

Excelsior System of Electrical Conduit.—The New Brotherton Tube Company, Limited, Excelsior Works, Commercial-road, Wolverhampton, have just issued their illustrated price list No. 5, in which they give details of conduits, switch-boxes, and fittings, etc.

Cryselco, Limited, Government contractors, Kempston Works, Bedford.—Cryselco lamps have been manufactured at the Kempston Works since 1885, since when a number of valuable improvements have been made, and the makers claim as a unique feature for this lamp that when run at the normal voltage, though of high initial efficiency, the consumption of current does not increase, and the light given does not materially decrease, during the first 1 000 hours' running.

Bailey's "Koester" Compressor and Vacuum Pumps. W. H. Bailey and Co., Limited, Albion Works, Salford, Manchester. Messrs. Bailey hold the license for the sole right of manufacturing in the United Kingdom compressors and vacuum pumps under the Köster patents. The mechanical and volumetric efficiency of these pumps is very high, and we propose to shortly deal further with the same as well as with the condensers. The latter are made on the single and multiple stage compound intercooling systems, the vacuum pumps being made on the single and double stage systems. All machines are arranged either for belt, steam, or direct electrical driving. The catalogue gives particulars and illustrates standard designs, and we are informed that although modifications and combinations of these machines can be made to suit customers' special requirements, the makers desire to keep to these standards in all cases wherever possible.

Flexible Cords.—The London Electric Wire Company, Limited, Anchor Works, Playhouse-yard, Golden-lane, London, E.C.

Photographers' Arc Lamps.—The Boardman Electrical Patents Company, Limited, 10, Southwark Bridge-road, London, S.E.

Lahmeyer New Motors.—Lahmeyer Electrical Company, Limited, 109, New Oxford-street (two new lists, describing continuous-current motors and the Schüler patent single-phase alternating-current motors.)

LEGAL INTELLIGENCE.

A SAFETY DEVICE.

At Manchester County Court last week his Honour Judge Parry tried an action arising out of a experiment made at Oldham with a patented invention for deadening the trolley wire of tramways in the event of accidents to the overhead equipment. The owner of the patent is Mr. J. A. Loughlin.

Two years ago, it was stated, he obtained permission from the Oldham Corporation to experiment with his invention on a section of their tramways. He employed Mr. Albert Maund, electrical engineer of Southport, to fix the apparatus on half a mile of trolley wire. When this had been completed, the device was tested and did not achieve the object for which it was erected. It was at once seen that the failure was due to the fact that the guard wires had not been isolated from the iron standards supporting them. The defect was remeded by another contractor, and then the device was found to work perfectly and to the complete satisfaction of members of the Corporation who were present at the test. The action was brought by Mr. Maund to recover from Mr. Loughlin the sum of £41. 11s., the amount expended on labour and material in carrying out the work. The defence was that the plaintiff had done the work negligently, with the result that the equipment had to be re-erected, and the cost of this re-erection was counter-claimed. The principal point made by the defence was that it ought to have been obvious to the plaintiff as an electrical engineer, even if he had received no express instructions on the point, that the insulators between the guard wires and the standards were essential to the successful working of the system. The plaintiff said he worked according to instructions which he received from day to day during the progress of the work.

The **Judge** said that as the plaintiff had no written specification to guide him, and as the work was of an experimental character, he thought it was absurd to charge him with serious negligence because he had not foreseen the necessity for insulators. He, therefore, gave judgment for the plaintiff on the claim and counter-claim.

PERSONAL.

The Burton-on-Trent Town Council have appointed Mr. T. Hall assistant electrical engineer at a salary of £150 per annum.

The Falkirk Town Council have appointed Mr. Theodore McDougald, of the Corporation electricity department, Dundee, as first assistant electrical engineer for the burgh at a commencing salary of £100 per annum.

The Paisley Town Council have increased the salary of Mr. Parkinson, the electrical engineer, by £100, making the salary £400, with free house, etc.

The Radcliffe District Council have appointed Mr. Geo. Nuttall as charge engineer, at 30s. per week.

Mr. E. J. Williams, chief assistant engineer, Hawick, N.B., has been appointed resident engineer at Inverness.

APPOINTMENTS VACANT.

Junior Assistants, Dundee Town Council, Sept. 28.

Draughtsman, Manchester district. See advertisement in last issue.

Estimating Assistant, North Country Cable Works. See advertisement.

Clerk, Heston and Isleworth Urban District Council, £100 per annum, Sept. 24.

Shift Engineer, Blackburn electricity department, £2 per week. See advertisement.

Wiring Inspector, Durban, Natal, £300 per annum. See advertisement in last issue.

Resident Electrical Engineer, Dartford, £250 per annum. See advertisement in last issue.

Chief Engineer and Manager, Southwark, £300 per annum, Oct. 5. See advertisement.

Electrical Engineer to take charge of driving and lighting plant of printing works. See advertisement in last issue.

Chief Assistant Engineer, Heston and Isleworth Urban District Council, £130 per annum, Sept. 24. See advertisement.

Electrical Assistant, Canterbury. Wages, 25s. per week. Applications to Engineer, Electricity Works, by 16th inst.

Electrical Engineer, with central-station experience, to manage and take charge of small lighting station in West Australia. Capital required, about £5,000. See advertisement in last issue.

Lecturer and Demonstrator, the School of Engineering, Electricity, and Technical Science, Canterbury College, University of New Zealand, £300 per annum. See advertisement in last issue.

Various.—Meter Fixer and Motor Inspector, £3 per week; two Switchboard Attendants, £1. 10s. per week; Fitter and Engine Driver, £2 per week; Assistant Engine Driver, £1. 10s. per week; two Stokers, 7d. per hour; Arc Lamp Attendant, £1. 10s. per week; Assistant to above, 15s. per week. Heston and Isleworth Urban District Council, Sept. 24. See advertisement.

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COMPANIES' MEETINGS AND REPORTS

FERRANTI RECONSTRUCTION.

The liquidator, Mr. J. M. Henderson, has convened, by order of the Court, meetings of the creditors, preference shareholders, and debenture holders, to be held on the 29th inst., for the purpose of considering a scheme for the reconstruction of the Company. This scheme provides for the incorporation of a new concern, to acquire the assets of the old undertaking with a capital of £130,000, of which £60,000 is to be in 6 per cent. cumulative preference, £60,000 in 7 per cent. ordinary, and £10,000 in deferred shares. There are also to be created first debenture stock to the amount of £100,000 and a second debenture of £30 000, both bearing interest at 5 per cent. The holders of the first debenture stock and of the second debenture in the old company will receive in exchange for their present security first debenture stock and the second debenture in the new company, which will make itself responsible for all arrears of interest. The unsecured creditors of the old company will receive preference shares in the new company of the nominal value of their debentures, and the preference shareholders of the old company will receive ordinary shares in the new company of half the nominal value of their present holdings. The deferred shares are to be allotted to Mr. Sebastian Ziani de Ferranti, in consideration of which he will enter into an agreement to serve the new company for a term of years at £500 per annum, and to give the company the benefit of all his inventions in switch and meter work.

ELECTRIFIED TIMBER SEASONING AND PRESERVATION.

Accounts have been issued under the winding-up order showing liabilities £8,996, of which £3,896 is expected to rank, against assets valued at £10,402. The account with the contributories shows a deficiency of £105,780. The official receiver (Mr. H. Brougham), reports that the Company, which was promoted by the Founders' Syndicate, Limited, was formed in April, 1899, with a nominal capital of £150,000, to acquire the British patent rights in the Nodon-Bretonneau process of seasoning and preserving timber by electrical agency. The purchase price was £100,000, and was satisfied by the issue of £88,693 fully-paid shares and the payment of £11,307 cash. Some 28,000 shares were subscribed for, but upwards of 9,000 of these have been forfeited for non-payment of calls. The Company acquired a lease of land at Charlton, and erected buildings thereon costing between £5,000 and £6,000, with a jetty, which cost £700. To provide working capital for current expenses cash advances were made from time to time by the directors and their friends, which at the date of the winding-up order amounted to £4,948, and in respect of which debentures were issued charging all the assets of the Company. No receiver has been appointed, the debentureholders being treated as secured creditors in the liquidation. The failure of the Company is attributed to the want of working capital. The patents of the Company are valued by the directors at £10,000, but the official receiver observes that it is doubtful whether this amount will be realised.

BUENOS AYRES ELECTRIC TRAMWAYS.

The report of the Buenos Ayres Electric Tramways Company (1901), Limited, for 1903 shows that the gross receipts for the year from the sections opened for traffic amounted to £18,282, and the working expenses, inclusive of London administrative charges, to £15,913, leaving a net profit of £2 506. Of this £1,410 has been set aside as a sinking fund for the redemption of debentures, and the remaining £1,094 has been applied towards payment of the debenture interest accrued to Dec. 31, 1903. The balance of the amount required for the debenture interest to date has been provided by the vendor syndicate under the terms of the purchase agreement, dated Jan. 5, 1903. At the commencement of the year the line was working up to Maldonado (5·6 miles), and a further section from Gazcon to Triunvirato (1·5 miles) was opened in June last. On Oct. 22, 1903, the Chacarica section (three miles) was also opened, giving an immediate and encouraging increase in receipts. The construction of the remaining sections—namely, the Belgrano and Flores sections—was proceeded with, but as these were not completed during the year, no benefit accrued to the Company therefrom. The business of the Company was greatly hampered by the construction and heavy repairing work which was proceeded with throughout the whole year, not only on the new lines, but also on the old lines taken over, often necessitating the running of the tramway on a single track, and the results of the year cannot therefore be considered as giving any indication of the company's real earning capacity. The Belgrano section and the Flores branch have lately been opened. A concession has been applied for and granted by the municipality for an extension of the Belgrano section through the streets near the station of the Central Argentine Railway. The construction of this is being rapidly proceeded with, so that it may be open for traffic early in the ensuing summer season. A concession has been obtained for an extension of the Flores route. Since Dec. 31 last the traffic receipts have shown fair increases.

The meeting of the Company was held on Tuesday, when the report was adopted.

Mr. Charles Lock has been elected a director in lieu of Colonel Oldham, resigned.

DICK, KERR, AND CO.

The report for the year ended June 30 last, to be submitted to the meeting on the 27th inst., states that the profits amount to £84,170. Out of this had to be paid debenture and loan interest and trustees' fees, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £14,441, leaving £69,729, to which must be added the profits brought forward, £35,544, making a total of £105,274 available for appropriation. After paying the dividend on the preference share capital, it is proposed to carry one-fifth (£10,285) of the remaining profits to reserve as required by the trust deed securing the debentures, and also a further sum of £10,765 to bring it up to the limit prescribed by the deed; to pay a dividend of 10 per cent. on the ordinary shares, and to carry forward the balance of £39 922. During the past year the Company has completed, amongst other important contracts, the electrification of the Lancashire and Yorkshire Railway between Liverpool and Southport, and the Hong Kong and Mandalay electric tramway systems, and are at present busily engaged in Tokyo, Singapore, Bangkok, and other places both at home and abroad. The directors call the attention of the shareholders to the fact that the reserve to be set aside under Clause 31 of the trust deed securing the debenture stock has now reached the limit of £150,000 prescribed by that deed. Mr. Claud T. Cayley having retired from the chairmanship of the Company, Mr. John Kerr, M.P., has been elected in his place, and Mr. Cayley has accepted the position of deputy-chairman. The directors regret that in consequence of ill-health Mr. G. W. Carr has resigned his position as secretary of the Company, and they have appointed Mr. Frank Mott in his place.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Buenos Ayres.—The Municipality of Chivilcoy require tenders for installation of electric lighting.

Tynemouth.—The Corporation invite tenders for a 600-kw. steam dynamo by Sept. 30. See advertisement.

Salford.—The Electricity Committee invite tenders for paper-insulated cables. Tenders to the Town Clerk by Oct. 6.

Crejeur (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Espinar (Spain).—The Municipality require tenders for construction and working of an electric tramway for 20 years. Particulars from the Alcalde. Tenders by Oct. 12.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

The Hague (Holland).—The Council of the Hague require tenders for the supply of from 8,000 to 9,000 tons of steel rails, including appurtenances, for electric tramways. Tenders by Sept.

Arenas de S. Pedro (Spain).—The municipality require tenders for electric lighting for eight years. One hundred 10-c.p. lamps are required for public lighting. Tenders by 25th inst. to above.

Edmonton.—The Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. Tenders by Sept. 27. See advertisement.

Ilford.—The Urban District Council invite tenders for the supply and erection of balancer and switchboard panel, and reversible traction booster and switchboard panel. Tenders by Oct. 4. See advertisement.

Mortlake.—The Urban District Council invite tenders for wiring their isolation hospital, South Worple-way, Mortlake, for the electric lighting. Tenders to Mr. John Eustace Anderson, clerk, High-street, Mortlake, by 12 noon on Sept. 27.

Aberdeen.—The Tramways Committee invite tenders for the supply and delivery of 20 top-deck car-covers. Drawings and specifications may be had from Mr. J. Alex. Bell, city electrical engineer, Aberdeen. Tenders by Sept. 27. See advertisement.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Tynemouth.—The Corporation invite tenders for the supply and erection at their electricity works, Tanners-bank, North Shields, of one 600-kw. steam dynamo. Tenders to Mr. Horatio A. Adamson, town clerk, Town Clerk's Offices, Tynemouth, by Sept. 30.

Hull.—The Corporation invite tenders for wiring and fitting Beverley-road baths. Particulars, etc., of Mr. A. E. White, city engineer, Town Hall, Hull. Tenders to the Chairman of the Baths Committee, Town Clerk's Office, before 10 a.m. on Sept. 30.

Canterbury.—The Drainage Committee invite tenders for electric light fittings in the engine-house at the sewage farm. Particulars may be obtained of Mr. Arthur C. Turley, A.M.I.C.E., city surveyor, Guildhall-street, Canterbury. Tenders to the Town Clerk by 10 a.m. on Oct. 3.

Weymouth.—The Town Council invite tenders for the wiring of 12, Gloucester-row, in accordance with specification and conditions which may be seen at the offices of the Borough Electrical Engineer, Sunnybank, Westham. Tenders to the Guildhall, Melcombe Regis, by 3 p.m. on Oct. 3.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London.

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Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Philippopolis (Roumelia).—The Municipality requires tenders for a concession to construct and work electric lighting and tramways for 50 years. A guarantee of £6,000 is required. Tenders by Oct. 15. On the next day a second adjudication will take place in case there is an offer of £5 per cent. less per kilowatt-hour than the minimum.

Tschatschak (Servia).—The Electricity Company Owtschar und Kablar in this town require two turbines of 750 h.p. each, two generators for three-phase currents, and other plant for the erection of a hydro-electric central station, and equipment of lines of distribution within 40 miles, by Oct. 2. Specifications, etc., may be obtained from the Manager of the Company.

Bangour (Scotland).—The Edinburgh District Lunacy Board invite tenders for (1) electric wiring and cables, (2) telephone installations, (3) electric bells, required in connection with certain buildings erected and to be erected at Bangour. Tenders to be lodged with Mr. And. Ferrier, clerk, Edinburgh District Lunacy Board, Castle-terrace, Edinburgh, by 28th inst.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station of Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

London, N.—The Edmonton Urban District Council desire to enter into an arrangement with a company for the exercise of their powers under their provisional order. They are prepared to consider offers based upon certain alternative arrangements, particulars of which are set out in the form of tender. Particulars and form of tender may be obtained at the office of Mr. William Francis Payne, clerk, Town Hall, Edmonton. Tenders must be addressed to the Clerk, and delivered by 12 noon on Sept. 27.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Shanghai.—The Board of Trade have received through the Foreign Office copy of a telegram from the British commercial agent in Shanghai to the effect that tenders are invited by the municipality of that city for the construction and working of 24 miles of electric tramways on the trolley system, double or single. Conditions of contract, together with plans, etc., may be seen on application to Messrs. Pook and Co., agents for the municipality of Shanghai, 63, Leadenhall-street, E.C., and such modifications of the conditions as may be necessary may be made by tenderers. Tenders must be sent in by March 31, 1905.

London, S.W.—The London County Council require tenders for the manufacture, delivery, and erection at the Council's tramways electricity generating station at Greenwich of two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Persons desiring to submit tenders may inspect the drawings and obtain the specifications, bills of quantities, form of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the Cashier to the Council of £2 deposit. Tenders to be addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Pumping Plant." No tender will be received after 10 a.m. on Oct. 4.

RESULTS OF TENDERS.

Swansea.—The Town Council have accepted the tender of Laidlaw, Laidler, and Co., Stockport, at £250, for two negative tramway boosters.

Saffron Walden.—The Town Council have accepted the tender of Messrs. Godfrey for electric bells at £37, and £3 a year for maintenance.

Oban.—The Town Council have accepted the tender of the St. Helens Cable Company, at £37. 10s., for the supply of 240 yards of three-core unarmoured cable.

Ilford.—The District Council have accepted the tender of F. and A. Willmott, Ilford-hill, Ilford, Essex, at £1,243, for extensions to buildings at the electric lighting station.

Worksop.—The Electric Lighting Committee have recommended the acceptance of the tender of W. T. Glover and Co., Limited, at £786. 9s. 6d., for the supply of armoured cable.

Carnarvon.—The Hart Accumulator Company have secured the contract for the supply of storage battery, consisting of 256 of their standard lighting type cells, at the electricity works.

Hammersmith.—The Borough Council have accepted the tender of the Beldam Foundry Company, at £90, for cast-iron pipes, and that of Westwood and Wrights, at 39s. 6d. per yard, for wrought-iron pipes.

Philpstoun Oil Works.—The British Electric Plant Company, Alloa, N.B., have been awarded the contract for three electric power generators, of 250 h.p. each, for James Ross and Co., Philpstoun Oil Works.

London, S.W.—The Chelsea Guardians have received the following tenders for wiring the wards of the infirmary for electric light:

Coleby and Co., 7, Thayer-street, W.	£585	10	0
W. Smith, College-street	642	0	0
Bolton, Fane, and Co., Goswell-road	652	0	0
P. McCarthy, Fulham-road	475	0	0
W. Seymour, Sloane-square	547	0	0
Wells, Raynor, and Co., Limited, Paddington-street, W.	399	0	0
Buckley and Beach, Cale-street	545	0	0
G. E. Taylor and Co., 8, Bush-lane	480	0	0
M. Wiedhofft, Islington	366	0	0
J. Boulding and Sons, Upper Marylebone-street	403	10	0
E. P. Allam and Co., Hatton-garden	430	0	0
E. Probert and Co., Bond-street	511	0	0
Donnison, Sillem, and Co., Great Portland-street	618	0	0
T. Potter and Sons, South Molton-street	525	0	0
T. Clarke and Co., Sloane-street	481	4	6
C. Mickleborough, 420, Harrow-road (accepted)	366	17	6
District Electric Company, Wolverhampton	380	0	0
W. Wing, Borough	399	4	0
Lee and Warren, Kettering	375	0	0
Fryer and Co., Sloane-square	508	0	0
P. Turner, Markham-square	995	0	0
Smitham and Page, Queen Victoria-street	552	3	0
Engineering Company, York-place, Portman-square	537	9	0
Farringdon Electric Wiring Company, Farringdon-road	530	3	0

BUSINESS NOTES.

TRACTION.

Exeter.—The construction of the first section has been somewhat retarded by the weather, but excellent progress is being made.

Warwick.—The Corporation have approved the plans submitted by the company for the electrification of the tramway to Leamington.

Bury, Oldham, and Rochdale.—The directors of the company are to receive an honorarium of £2,000 for successfully negotiating the sale of the undertaking.

Liverpool-Southport.—The electric service on the Liverpool-to-Southport branch of the Yorkshire and Lancashire Railway has been considerably increased.

Paris Underground Railway.—The æsthetics may rejoice! A polished balustrade now surrounds the space in the Place de l'Opera leading to the station, in lieu of the high hoarding previously enclosing the site.

Paisley.—A trial trip was run on the Renfrew section last week, and proved satisfactory. It may be a week or two before the service will be opened to the public, as the overhead wires to the extremity of the route have not been completed.

Southampton.—The extensions contemplated by the Corporation, which were practically decided upon some time ago, were the subject of a formal resolution of approval at the last meeting of the Corporation, and application is to be made for a provisional order.

Tunstall.—The Urban District Council have given their sanction to the laying of a line by the British Electric Traction Company to connect the system with the Chatterfield-Whitfield Collieries for the purpose of conveying fuel to the company's generating stations.

Swansea.—The borough electrical engineer, Mr. Prusmann, reported at the meeting of the Town Council that the work in connection with the tramway contracts was progressing in an entirely satisfactory manner, both in relation to the rate of progress and the quality of the work.

Mansfield.—The Council have approved the plans for the light railway with the exception of minor points, and last week representatives of the Council and the promoters inspected the routes. The plans still await the approval of the Board of Trade, after which an early start is expected to be made.

Christchurch (N.Z.).—Sleeper and ballast construction has been adopted for the tramways in preference to concrete construction, which proved unsatisfactory in Auckland. The contractors are proceeding rapidly. The permanent-way materials are well in hand. It is hoped the first section will be opened for traffic early next April.

Hyde, Stalybridge, etc., Board.—As the result of the new railway bridge at Throstle Bank, Hyde, undertaken by the Joint Board, there will be a branch line for the benefit of residents in Dukinfield-road. The old bridge was too narrow to allow of the electric cars passing under it, and the Board decided upon a larger one at a cost of £5,000.

Belfast.—The Corporation have given a general approval to the joint specification prepared by the electrical engineer, the tramways manager and the city surveyor. A consulting expert is not deemed necessary by the Corporation, but the electrical engineer has been instructed to report to the committee if any special points calling for expert advice arise.

Manchester.—The Tramways Committee having inspected various top-cover designs, have decided to adopt a pattern with movable windows and ventilating louvre on the top. This is to be fitted to 100 of the cars, and the cost will be £124 a car. The work will be put in hand at once, so that as many as possible of the cars may be ready for use during the coming winter.

Bettws-y-coed Light Railway.—The order made by the Light Railway Commissioners sanctioning the construction of this railway, subject to one or two restrictions affecting the scenery, has been sub-

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mitted to the Board of Trade for confirmation. A correspondent to the *Times*, after reciting the advantages of and objections to the scheme, suggests that the purpose would be better served by a motorcar service.

Anglo-Argentine Tramways Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 6 per cent. per annum, leaving a balance of £34,614. This sum, together with the surplus carried over from last year's accounts (amounting to £4,120, after deducting the 2,000 guineas voted to the chairman at the last annual general meeting), will be dealt with in the final accounts at the end of the current year.

Halifax.—In reference to the line to be extended to Sowerby Bridge, it is understood between the Corporation and the Sowerby District Council that the latter will remit the rates on the portion of the tramway within their area, but as the Legislature does not recognise such an arrangement, the District Council have passed a resolution consenting to support the Bill to be promoted by the Corporation, in which they will seek the necessary sanction.

Cambridge.—The Corporation and the Cambridge Electric Tramways Syndicate, Limited, have arranged terms, described in another column, under which the latter are to electrify and extend the tramways. The total length of the scheme amounts to nine route miles, including extensions of the Station and East road to Market-road sections. Energy will be taken from the Cambridge Electric Supply Company. The syndicate will promote a Bill next session.

Baker-street and Waterloo Railway.—Mr. Chapman, chief engineer to Mr. Yerkes, stated to a *St. James's Gazette* representative that the syndicate have been compelled to give an order, valued at £100,000, for a hundred cars to the American Car Company, because they were unable to obtain a quotation in England or on the Continent. Further cars, to the value of £300,000, will, Mr. Chapman added, be required for the other tubes, and he states that these will be bought in this country if possible, otherwise the company must again go to America.

Stockport.—There has been a renewal of the negotiations between the Corporation and the company. At a meeting last week the former made an offer of £23,500, but the company held out for £24,000. Arbitration was suggested, to which the representatives of the company replied that they had no authority from the shareholders to consent. A special meeting of the Corporation is to be held, when the question of accepting the company's terms will be discussed. Just as we go to press we learn that the Corporation have decided to accede to the company's terms.

Aston.—A trial of the reconstructed tramlines between Aston Cross and the parish church took place last week, when one of the Birmingham Corporation cars were run over the route. The car ran to the satisfaction of all parties. Amongst those who were present to conduct the test were Alderman W. Evans (chairman of the Aston Pubic Works Committee), Mr. Robert Green (consulting tramways engineer to the Aston Corporation), Mr. Baker (representing the Birmingham Corporation), and Mr. Conaty (representing the City of Birmingham Tramways Company. The service was opened to the public this week.

Chester.—Mr. John Gardner, Corporation tramways manager, has issued the following report on the July and August working: The receipts for July show an increase of £64. 11s 11½d. as compared with the corresponding month of last year. The takings for August show a slight decrease of £5. 19s., which is accounted for by the fact that in August last year there were five Saturdays, whereas this year there were only four. The net increase for the two months is £58. 12s. 11½d. The increase is chiefly in 1d. and ½d. fares." The cars have now been running for two months, and Mr. Gardner recommends the application of a little varnish.

South Shields.—A special meeting of the Corporation was held on Monday in reference to the discovery of a private document relating to the tramway negotiations. This purported to be a communication from certain parties not disclosed to the British Electric Traction Company, stating that "they had been in constant communication with two members or friends of the company on the committee." It will be remembered that when the question of the tramways was before the Corporation recently, it was stated that the committee would be ready with their report in November. In view of the above development, however, it is reported that a special meeting is to be held on the 29th inst. for the purpose of considering a proposition in favour of municipalisation.

Cardiff.—At a meeting of the Finance Committee on Monday the estimates for the half-year ending March next showed that the anticipated surplus from the tramways for the year 1904-5 was £5,980. 18s. 10d. The Tramways Committee have not yet decided how to allocate this, and it was therefore agreed not to take the amount into account by reducing the rate to that extent. Incidentally Mr. Ellis, the manager, intimated that he proposed recommending the committee to set aside all the profits earned towards reducing the capital paid to the old tramways company for their undertaking, upon which a councillor said he should oppose such a course being adopted, adding that a rearrangement of fares was urgently needed. Mr. Ellis has this point under consideration.

London County Council.—The Stoke Newington Borough Council had on its agenda for last Tuesday's meeting a recommendation by the Tramways Committee that the Board of Trade be asked not to sanction the use of a centre slot 1in. in width in lieu of ⅜in. for the County Council's tramways. The committee pointed out in their report that certain sections of the Bournemouth tramways (to which the County Council had referred) are worked, not with a 1in. centre track slot, but with a 1in. side or rail slot, except at the termini, points, and crossings, where a ⅜in. slot is used, in regard to which no difficulty has been experienced. The committee consider that a 1in. slot might be attended with inconvenience and danger to other traffic. A service has been started between Southwark Bridge and Tooting, and another between Westminster Bridge and the Tower Bridge, the route taken being by way of the Obelisk, Elephant and Castle, New Kent-road, and Bermondsey New-road. A service between Westminster Bridge and Southwark Bridge is under consideration.

Liverpool.—At last week's meeting of the Corporation, a resolution was proposed that a universal 1d. fare should be adopted. The Tramways Committee had previously decided against the principle, and the proposal was withdrawn on the chairman of the committee giving a promise that the manager should report upon the advisability of giving those travelling before eight o'clock in the morning, the majority of whom were working-men, the privilege of riding the whole distance for 1d., and the option of purchasing a ticket to return in the evening at the same rate. On Wednesday the Corporation considered a scheme for providing routes within the city for joining up the existing system, and also sections of light railway to Woolton, Speke, Halewood, Ditton, Widnes, and Fazakerley. The length of proposed new tramways is nearly 12 miles, whilst that of the suggested light railways is rather longer. As noted last week, top covers have found favour with the Corporation, and some half-dozen cars are to be fitted up experimentally. At the conference between the Tramways, Estate, and Health Committees, it was agreed that the widening of Edge-lane to allow of a double track would entail too great an expenditure. The plough lifeguard demonstrated its value last week, when in three cases children escaped practically scathless.

Keighley.—At Tuesday's meeting of the Corporation it was stated that the tramways might be available in about a month. The proposed Stockbridge extension was again discussed, and a proposition that the scheme be adopted was carried. Single track will be used. The eight cars ordered by the Corporation have been delivered. The vehicles are of the latest design, and include all the improvements recommended by the Board of Trade and adopted by the leading makers. The bodies and trucks have been made by the Brush Electrical Engineering Company, of Loughborough, and the motors and controllers by the British Thomson-Houston Company, of Rugby. The motors, which are worked at a pressure of 500 volts, direct current, are capable of giving a maximum of 35 h.p. A trial trip was made the other day from the tramshed in South-street to the Ingrow terminus. A special switchboard has been erected at the power station for working the tramways, and one of the 200-h.p. engines and dynamos will be used for generating the power. The engines and dynamos which were laid down at the generating station four years ago will at present suffice for lighting, power, and tramway purposes, but as the demand for electricity for lighting and power purposes is rapidly increasing, it is quite possible that the plant will have to be extended next year. This the Corporation have foreseen, and borrowing powers have been obtained.

Bradford.—The report of the general manager (Mr. C. J. Spencer) on the year's working to March 31 has just been issued to the members of the Tramways Committee. We published particulars of the year's accounts some weeks back. The total income amounts to £197,437. 13s. 5d., or 10·421d. per car mile, an increase in the aggregate of £23 903. 7s. 11d., or ·044d. per car mile since March 31, 1903. As to whether these figures can be considered satisfactory or no, Mr. Spencer invites a comparison with the accounts of the various municipal tramway concerns of the size and importance of Bradford, bearing in mind the route miles laid in each case and the population served. Mr. Spencer directs attention to the following features: first, the receipts per 1,000 of population served are well above the average; and, secondly, the receipts per route mile of tramway in operation are several thousand pounds below systems of like size and importance. Mr. Spencer attributes the interest in working costs the hilly character of the new routes, their distance from the power station, the increased power consumption resulting from top-covered cars, which he states require 15 to 20 per cent. additional energy, and the overloading of the power cables, causing high transmission losses. The last-mentioned factor is being dealt with by the Electricity Committee. Careful management has resulted in an appreciable decrease in coal costs. The expenditure on rolling-stock repairs has been high, and in this respect the manager adverts to his contention, advanced in a former report, that, as a general rule, repairs will vary *pro rata* with the current consumption per car mile.

LIGHTING AND GENERAL.

Radcliffe.—The electricity works are to be formally on Wednesday, Oct. 5 next.

Harrogate.—A number of additional incandescent and Nernst lamps are about to be placed on the streets.

Armagh.—It has been decided to extend the lighting of the fish wharf by placing 10 arc lamps south of the ferry.

Whitby.—An enquiry has been held into an application for sanction to borrow £3,100 for further purposes for the electric light.

Sale of Plant.—The St. Pancras Borough Council invite offers for engines and dynamos. Particulars appear in another column.

Leigh.—The Town Council have adopted a report of the Electricity Committee recommending extensions estimated to cost £16,000.

Babcock and Wilcox.—The directors have declared interim dividends of 1s. 7½d. each on the ordinary and preference shares.

Luton.—The Council have sealed an agreement with the Midland Railway as to carrying the electric cable underneath their bridges.

Southampton.—Sanction has been received to the borrowing of £22,000 to meet prospective expenditure on electric lighting mains and services.

Irthlingborough.—Mr. Harvey, of Richmond, intends to apply for power to supply electricity to Rushden, Higham, and Irthlingborough.

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Dalkeith.—The Town Council have signed an agreement with Messrs. Crompton and Co. in regard to the lighting of the streets by electricity.

Lynn.—Sanction has now been received to a further loan of £2,756 for electricity purposes, making a total of only £78 less than the Council at first applied for.

Removal.—Messrs. F A. Glover and Co., Limited, Garrick-street, W.C., will on Sept 24 move into larger premises at Vine-street, E.C. (off Rosebery-avenue).

Brighton Telephones.—The manager is ordering from the International Electric Company a new switchboard and batteries at the cost of their estimate of £55.

Portpatrick.—An electric lighting installation for the streets in and the roads around the town was officially opened last week by Lady Augusta Orr-Ewing of Dunspey.

Drighlington.—The Yorkshire Electric Power Company are about to lay cables, junction boxes, etc., on the Leeds and Whitehall road from Birkenshaw boundary to Farnley.

Direct Spanish Telegraph Co.—The directors have decided to pay an interim dividend at the rate of 4 per cent. on the ordinary shares for the half-year ended June 30, 1904.

Calcutta Electric Supply Co.—The directors have decided to declare an interim dividend on the paid-up share capital of the company at the rate of 6 per cent. per annum for the half-year ended June 30 last, payable on Nov. 15 next.

Agency.—The London Electric Wire Company, Limited, Anchor Works, Playhouse-yard, Golden-lane, London, E.C., have appointed Mr. David Alexander, A.M.I.E.E., 43, Mains-street, Waterloo-street, Glasgow, as their representative for Scotland.

Norwich.—The Executive Committee have accepted the offer of the Electricity Committee to light Prince of Wales's-road, from Thorpe Station to Bank Plain, with 12 arc lamps, at £16 per annum each for eight lamps lighted all night, and £12 per annum each for four lamps lighted up to midnight.

Hove Electric Lighting Co.—The directors have decided to declare an interim dividend on the paid-up share capital of the company at the rate of 3½ per cent. for the six months ended June 30 last. The dividend, which is the same as at this period last year, will, as usual, be paid on Oct. 15 next.

Abyssinian Telephones.—It is reported that nearly 800 miles of wire have been put up in Abyssinia, and 1,000 miles more are planned. There are many difficulties in the way, for while white ants completely detroy wooden poles in the ground, iron poles are stolen by the natives, who want them to make tools of.

London Gazette.—Edward Thomas Peirson, 17, Hertford-street, Coventry, has been released from trusteeship in the estate of William Henry Hooley and John William Talbot (carrying on business as Hooley, Talbot, and Co.), electrical engineers and contractors, residing and carrying on business at Regent-street, Rugby, Warwick.

Calcutta.—The Government of India have sanctioned the expenditure of Rs 50,000 on the purchase of electric transporters for use at Shalimar. The Municipality of Darjeeling have been granted a license, under the Indian Electricity Act of 1903, to supply electricity within certain specified areas in the town and neighbourhood of Darjeeling.

Stratton's Patent Four-Way Hydraulic Valve.—The sole licensees and makers of this gear, Messrs. David Bridge and Co., Castleton, Manchester, have just published an interesting pamphlet fully describing these valves, and we believe that a copy of the same will be sent to any of our readers who care to apply to Messrs. Bridge for it.

New Cable.—The French Government have decided to cross the Great Sahara from South Algeria to the West Coast by an electric cable, which is to be laid from In-Salah, *via* Tidekalt and Tageneut, to Timbuctoo. The distance is about 620 miles, and the estimated cost amounts to £60,000. The work is to be completed in about 12 months.

Harwich.—The proposed electric lighting of the borough is the subject of a report which will be discussed at the next Council meeting. It is suggested that the three-wire low-pressure system should be adopted, and that current be supplied at 6d. per unit. A refuse destructor is proposed at a cost of £3,000, while the total expenditure is put at £21,012.

New Barnet.—The District Council propose to enter into an agreement with the National Electric Construction Company for an electric lighting scheme estimated at £16,375, and having regard to the comparatively large sum proposed to be expended for the purpose, they have agreed that the ratepayers should be offered an opportunity of expressing their opinion on the proposed scheme.

Walsall.—The following figures are available for Aug. 31: Total number of consumers supplied, 360; total units generated at the station during the past month, 117,994; total output from the main generators, 114,391 units; total units from the transformers, 88,878 (estimated); total units registered, 88,699. The machinery was run for 708 hours, and the wages paid amounted to £124.

Sleaford.—The Electric Lighting Committee reported at the last Urban District Council meeting that they should not have to make any call upon the rates for the present half-year. They had decided to erect a new workshop, and were going to ask for tenders. Up to the end of the last half-year the receipts from private lighting had been £346, and the gross profit on the working of the scheme had been £205.

Swansea.—The electrical engineer's report for September stated that there were 553 consumers on the books. Mr. Prussman hoped to have a limited electric light supply for Morriston ready by the end of September. The work on the arc lighting of St. Helens road is now completed. There was an increase of 37,120, or 21 per cent., in the units sold during the quarter ending June last as compared with the corresponding period of last year.

Agency.—Messrs. Cecil Hodges and Co., Balfour House, Finsbury-pavement, E.C., have appointed Messrs. W. G. Morrison and Co., of 59, St. Vincent-street, Glasgow, as their sole agents for Scotland, Mr. James Gray, of Glasgow, having ceased to represent the firm for that district. A new catalogue fully illustrating and describing various types of instruments, switches, etc., has been prepared, and will be posted to any of our readers sending a trade card to Messrs. Hodges.

Stock Exchange.—The Stock Exchange Committee have appointed Wednesday, Sept. 28, a special settling day in London Electric Supply Corporation, Limited, further issue of 10,000 6 per cent. preference shares of £5 each, fully paid—Nos. 50,001 to 60,000—and United River Plate Telephone Company, Limited, further issue of 12,000 ordinary shares of £5 each, fully and partly paid—Nos. 58,001 to 70,000—and have ordered the first-mentioned securities to be quoted in the official list.

Stoke Newington.—On the agenda for this week's Council meeting we note: "To consider the following business (adjourned from July 19, 1904)—viz.: (*a*) report of the Electric Lighting Committee on an electric lighting scheme for this borough, and submitting an agreement with the North Metropolitan Electric Power Supply Company for adoption and sealing by the Council; (*b*) the appointment of a Standing Electric Lighting Company for the remainder of the current year, consisting of 11 members."

Hull Telephones.—The formal opening of the exchange in Trippet will take place soon. Up to the present 1,600 subscribers have been obtained out of the 2,000 which the Council guaranteed; 100 of these have already been connected, and the intercommunication is working with perfectly satisfactory results. The first cable was only laid in January, and to-day cables have been laid for 2,000 subscribers. Wires have also been laid to Kirkella, and another line goes from Springhead to Anlaby and Hessle, where an exchange will be open in the course of a week or two.

Saltney.—The Flintshire Council at their last meeting discussed the following communication from the Saltney Parish Council: "The Council have adopted the Lighting Act. The question of electricity seems to be the favoured system. Before asking for estimates I am instructed to ask your Council whether any objection would be taken to overhead wires in place of underground. Part of the area would be on your main road from Shotton Church to the Bridge Inn at Sandycroft, and from cross roads at Queen's Ferry to Hawarden Castle Hotel. The rest on District Council roads. The overhead system would be much the cheapest." It was decided to inform the Parish Council that the County Council approve and recommend the underground system.

Saffron Walden.—The Corporation have entered into an agreement with Messrs. Foote and Milne for installing electric lighting, and an enquiry has been held into an application for sanction to borrow £9,950 for the purpose. It is proposed to use the boilers connected with the electric lighting for working the pumping machinery. The cost of the day shift will fall upon the waterworks on account of the use of the boilers, and the electric lighting undertaking will provide the coal. During the past 10 years the amount of coal consumed per 1,000 gallons of water pumped was 12½lb. The water undertaking propose to pay the electric lighting undertaking at that rate for the coal on the average price for the year.

Birmingham.—The work of excavations and laying the foundations for the new generating station on the site of the old general hospital is proceeding apace. The building of the station will soon be begun. The estimated cost of equipping the station to the full ultimate capacity of 22,000 kw. is £380,000, while the estimated cost of the necessary building is £130,000. For the present, however, the Electric Supply Committee believe that the needs of the department will be met by the equipment of the station to a capacity of 8,500 kw., at a total cost of £260,620. The buildings, upon which a start will shortly be made, will include an engine-house 275ft. long by 100ft. wide and 65ft. high. The boiler-house will be of similar dimensions, and there will also be a small pumping station, workshop, and engineers' stores and offices. Five new sub-stations will ultimately be necessary, and the existing station at Parker-street will require alterations.

Mexborough.—A petition by private consumers is before a committee. It is really a protest against the Council supplying current to the Great Central Railway Company at 2d. per unit. The petitioners asked for a reduction from 5d. to 4d. per unit, and contended that if the Council could afford to put down larger engines, and otherwise incur extra expenses to meet the requirements of their large customer (the Great Central Railway Company), they could well afford to grant the request. It was further pointed out that many of the smaller consumers were induced to use the current on the statements made in handbills, issued by the Council, that at 5d. per unit it was equally cheap or cheaper than gas at 3s. 3d., which by practice they had found incorrect, experience having taught them that electric light worked out at about double the cost of gas. The balance-sheet of the electric undertaking showed in revenue account that the sale of electric current had increased from £565 in 1903 to £995. Public lighting in 1903 cost £645, while this year £903 had been paid. There was a loss of about £340, as against a deficit of £179 the previous year, notwithstanding that a sum of £550 received by the committee as damages from contractors for late arrival of machinery was included in the net revenue account, bringing a deficit of about £720 down to £170. No allowance had been made for renewals or depreciation, but during the year £569 had been repaid of borrowed capital, and £565 interest on mortgage debt, the most satisfactory aspect of the report.

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Machine Drawing.—Messrs. P. S. King and Son, Orchard House, Westminster, have issued at 2s. 6d. a large collection of plates, which are fully described in the text, and which will be welcomed by many evening students who are unable to attend more than one evening class a week, and who will find the volume extremely useful for obtaining a practical knowledge of machine drawing. It will at the same time assist them in the study of elementary calculations connected with separate machines.

Walton.—The difficulty arising out of the injunction obtained by the Weybridge Urban District Council, restraining the Urban Electric Supply Company from supplying current from their works in that parish, has been removed. Edmundson's Electricity Corporation, Limited, propose to utilise the site of the old brewery for the substation in Walton, and to instal for temporary use a pair of portable boilers and an engine set, an apparatus to soften (if not altogether do away with) the noise from the exhaust of the engine, etc., so as to supply current during the coming winter.

Bristol.—An enquiry has been held into the application of the City Council for powers to borrow £126,500 for the purposes of the electric lighting. Mr. Faraday Proctor, chief electrical engineer, produced the plans, and explained the amount expended (£601,893) and the amount borrowed from 1902 up to date (£574,080). Part of the new loan was required for the extension of the mains. They had already put in hand some of the work which was necessary consequent on the fire at the Temple Back station at Christmas last. It was proposed to replace the destroyed switchboards by fireproof switchrooms. The plans had all been passed by Colonel Yabbicom's department.

Hammersmith.—The Electricity Committee's last report states that the premises of 40 additional consumers, representing a maximum of 1,083 8-c.p. lamps, have been connected to the mains; that 18 consumers have been disconnected; and that the present number of consumers taking current from the mains is 1,500. The builders of the London Bishopric Estate, Uxbridge-road, propose wiring the whole of the houses to be erected upon this estate, provided mains are laid and a supply of electricity given at a satisfactory rate. The estimated total cost of laying the mains (including high-tension feeder from Boscombe-road) is £983. 5s. 6d., but as it will be some years before all the houses are erected, a portion of the mains to the value of £100 will be laid at the present time.

Robertson Electric Lamps' Fire Brigade.—The competition for the championship of the private fire brigades of the United Kingdom was held at the Crystal Palace on Saturday last. The teams consisted of five men from each brigade, who had to don hats, coats, and belts, and then run out five 50ft. lengths of hose coiled up, turn on the water, and strike two targets which were placed about 200ft. away. The Robertson Lamp brigade tied for first place, doing the drill in 70¼ seconds, whilst other teams ranged from 76 up to 98 seconds. In all 18 brigades took part in the competition, Manchester, Leicester, and other parts of the country being represented, so that the members of the Robertson brigade may congratulate themselves on the smartness of their performance.

Accident.—An inquest was held on Tuesday at the Dean and Chapter Colliery Offices, Ferryhill, into the circumstances connected with the death of Thomas Lee, who was killed while employed as onsetter at Messrs. Bolckow, Vaughan, and Co.'s Dean Bank Colliery Ferryhill. In the evidence it was stated that deceased received a severe shock while catching hold of a naked "wrapper" wire, which was about 6in. from an electric cable carrying 220 volts in a very damp atmosphere. The jury returned a verdict that deceased was accidentally killed by coming in contact with an electric cable whilst using the wrapper rope, and added the following rider: "That they were of the opinion that cable, wrapper, and other ropes should be kept sufficiently apart from danger, or some other means of complete insulation should be adopted."

Cardiff.—At a meeting of the Electric Lighting Committee on Tuesday, Mr. Arthur Ellis, electrical engineer, submitted a statement with regard to electric lighting for the year ended March 31, 1904, showing that the sum of £11,318 9s. was borrowed from the rates for the purpose of carrying on the undertaking and of this amount, up to the end of March, 1903, £6,599. 1s. 3d. had been repaid. For the year ended March, 1904, a further sum of £2,900. 16s. 11d. was placed to the credit of the rates, which left a balance of £1,818. 11s. 7d. due. The Electricity Committee have decided to contribute £3 000 out of the profits of the current year, leaving a balance of £1,200 above the amount borrowed. In addition, there is a reserve fund to their credit of £2,232, which, if they realised the profit which they had estimated at the end of the year, would be increased to £4,415. 11s. 7d. All temporary loan charges were paid off up to date.

St. Pancras.—The estimated requirements for purposes of the electricity undertaking for the six months ending March 31, 1905, are as follows: engine-room supplies—oil, waste, water, tools, packing, etc., £550; materials, etc., for repairs and upkeep of buildings, engines, boilers, dynamos, and accessories, £1,000; meters and indicators for recording the supply, etc., to consumers' premises, £300; house-service switches, £160; joint-boxes, connectors, etc., for connecting service lines with mains, £100; cables for service lines, etc., £140; general stores, tools, etc., £100; wood casing and capping, creosoted boards, etc., £30; repairs to meters, switches, public lamps, etc., £100; repairs to mains, £600—total, £3,080. The above requirements do not include coal, which is supplied under contract, nor cables and materials required for extensions of supply mains, arc lighting, etc., which the Council may authorise to be carried out, and which would be the subject for a supplementary estimate.

Motor Exhibition.—The Society of Motor Manufacturers and Traders propose to hold a motor exhibition at Olympia in February next. The society have concluded a contract with the proprietors of Olympia whereby the building will be altered and properly fitted up for exhibition purposes, including the wiring for lighting the premises by electricity. It is estimated that the lighting will involve the use of between 10,000 and 20,000 8-c.p. lamps, and the society are prepared to pay at the rate of 4d. per unit for the supply of electricity, and to guarantee a minimum payment of £500 at the first exhibition, which will be held from Feb 10 to 18 next. The society are endeavouring to arrange for a series of exhibitions to be held at Olympia extending over a number of years, and as the building will be fitted up for the purpose, it is probable that other exhibitions will also be held there at which a considerable amount of electric current would be required. The Hammersmith electricity department will, subject to an agreement being entered into by the society, lay a special main at a cost of £1,898 to give the required supply to Olympia.

Western Australia.—The agreement made by the Mayors of Fremantle and East Fremantle, on behalf of the respective municipalities and Messrs. Noyes Bros., of Sydney, for the carrying out of the construction works in connection with the Freemantle electric lighting and tramway scheme, was signed on June 11. The agreement provides that all plant and material shall be ordered by the Tramway Board through Messrs. Noyes Bros.; that within 18 months of the date on which they are authorised to order the first portion of the material Messrs. Noyes Bros. shall have the undertakings, rolling-stock, and plant complete and in full working order, unless delayed by strike, etc. They must at their own cost instruct and organise the operating staff, enginemen, motormen, conductors, and linemen before handing the works over. If the cost of the undertakings should exceed £284,000, Messrs. Noyes Bros. are to pay the amount of the excess to the Tramway Board. The firm is to receive a commission of 10 per cent. upon the amount actually expended in the construction of the undertaking, but the total sum on which commission shall be payable, exclusive of cost of extra work, shall not exceed £76,400.—*N.S.W. Railway Budget.*

Holyhead.—The Urban District Council's electricity and destructor works were opened on Friday last by Lord Stanley of Alderley. Mr. Robert Roberts, chairman of the District Council, presided over a large audience at the town hall. Mr. James Lansbury, chairman of the Electricity Committee, gave a history of the works. Other speakers were Mr. W. D. Jones, one of the pioneers of the movement for the establishment of the works, and Messrs. J. T. Griffiths and J. James. The scheme has involved an expenditure of £16,000, including a two-cell Meldrum refuse destructor, with a complete plant and mains for generating and distributing current on the three-wire system. The Council were fortunate in acquiring a substantially built steam mill for the works, situate in the King's-road, and the building has proved to be eminently suited for its present purpose, with ample room for extensions. The whole of the street-lighting, which was formerly by means of gas and oil, is now to be effected by electricity, and includes 10 arc lamps, with about 240 incandescent lamp standards, the old gas standards having been adapted for the latter. The present contracts provide for 100 consumers, 60 being already connected. Mr. Price F. White, of Bangor, is the consulting engineer for the scheme, and Mr. Philip Williams acted as clerk of works and resident engineer. The contract for the plant, mains, street-lighting, etc., was entrusted to the National Electric Construction Company, Limited, of 34, Victoria-street S.W. Messrs. Meldrum Bros., of Timperley, supplied the destructor plant and Babcock boilers, while the Aphons Custodis Chimney Construction Company, Limited, erected the chimney shaft. After the proceedings at the town hall, a subscription banquet took place at the North-Western Hotel, at which the chairman of the Council presided, supported by Lord Stanley of Alderley, Mr. Ellis Jones-Griffiths M.P., Captain Barr, R.N., Mr. W. B. Cownie (manager, National Electric Construction Company, Limited), Mr. Price F. White, Mr. Moreton Prichard, Mr. John Meldrum, etc., with all the members and officials of the District Council. Mr. Lansbury, chairman of the committee, in responding to the toast of the evening, "Success to the Electricity Undertaking," expressed his satisfaction with the way in which all concerned with the undertaking—consulting engineer, contractors, and clerk of works—had carried out their respective work, and prophesied its early success. Mr. W. B. Cownie, on behalf of the National Electric Construction Company, afterwards presented the two chairmen with silver bowls as mementoes of the occasion. The consulting engineer and resident engineer were also the recipients of mementoes from Messrs. Meldrum Bros. The town generally was *en fête* at night, and if enthusiasm goes for anything, the new undertaking ought to prove a great success.

Refuse Destructors.—An interesting article appeared in the *Liverpool Courier* a few days ago on this subject, and it is of especial value as it relates to the experience of the Liverpool Corporation, whose destructor of 250 tons per day capacity is probably the largest in use in the United Kingdom. Our contemporary says the system of destroying refuse by cremation obtains in about 180 towns, in 63 of which the destructors are combined with electricity works, whilst in 40 towns they are operated in conjunction with sewage works. At Nottingham and Leicester destructors have recently been built on the Liverpool pattern to supply power for electric traction, and Wolverhampton and Preston are about to erect destructors for power purposes. Liverpool was one of the first to see the possibilities of the destructor in the matter of supplying electric current, and at various refuse centres in the city steam is generated on the high temperature system to furnish electric power for the trams. The utilisation of the destructor for this purpose was first attempted for operating the electric tramlines along Smithdown-road. Some little difficulty was experienced in obtaining the requisite power, which was then solely supplied from the generating station in Cleveland-square. An arrangement was, therefore, made to obtain a supply of electricity from the Smithdown-road destructor works for working the outlying length of line, and this entirely met the difficulty. Following upon this the system was extended to three of the other works mentioned, to which has since been added the Garston destructor; so that at the present time five out of the six works are actually engaged in providing

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steam for electricity purposes. As regards the Rathbone-road destructor, there is as yet no electrical generation. The chief interest would now appear to centre in the Laverock-bank destructor. Here the Corporation have brought to bear all the experience they have gained in the past from the utilisation of steam generated from the burning of the refuse, with the result that a design of the very latest principle was adopted, and an eight-cell destructor constructed. This installation is now in full work, the result being that about 60 units of electricity are being delivered for every ton of refuse sent to the depôt. It will, therefore, be seen that the Laverock-bank destructor is the most important of the installations, as well as the most modern. It should be specially noted that, with one exception, no coal is used at any of the destructors except on a Monday morning to start the firing up. To see what amount of power these destructors are capable of giving, the case of Cobb's Quarry furnishes a capital illustration. This branch has been in existence for about four years. During 1902 the total number of units of electricity sent out from this place for electric traction and electric lighting was close upon one million and a quarter, whilst the sum paid by the Electric Lighting and Power Committee to the Health Committee for the steam to generate this electricity amounted to nearly £21,700. This represents a value in electricity of about 11¾d. per ton for every ton of refuse sent to this destructor during that year, which is a very considerable contribution towards the total working and maintenance of the destructor. The figures relating to the other destructors are not available, but it can be safely asserted that when the works are fully equipped for this purpose the sums paid by the Electric Power Committee for the steam will increase. As regards the output from five destructors for the current year, it is calculated, and given as a fair assumption, that the total number of units of electricity will amount to about 4½ millions, or equal to about 25 per cent. of the whole of the electric current generated by the Liverpool Corporation for tramway purposes, so that their utility in this respect is beyond doubt. If they were not put to this purpose, it would certainly mean the putting down of additional plant at the various electricity generating stations. The municipality of Liverpool again shows its enterprising spirit and its desire to be in the front of other large corporations in all matters which tend to the advancement and the improvement of the city as a whole. It is pleasing to note that the continuous efforts of the Health Committee for some years past are producing results which are enabling objectionable town's refuse to be dealt with so promptly by fire that the materials collected daily from ashpits are disposed of within 24 hours, while the amounts paid to the Health Committee by the Electric Power and Lighting Committee form a very important contribution towards reducing the cost of the cleansing operations of a great city like Liverpool.

PROVISIONAL PATENTS, 1904.

SEPT. 12.

19609. An electromagnetic variable-speed gear for motorcars and other purposes. Arthur George Seaman, 32, Beaufort-road, Kingston, Surrey.

19611. Improvements in controlling apparatus for electric motors. John Klinkenberg, 121, West George-street, Glasgow. (Complete specification.)

19612. An improved terminal for electrical conductors. Alexander Duncan, 132, Stoke Newington-road, London.

19646. Improvements in or relating to electrolytic electricity meters. The Bastian Meter Company, Limited, Charles Orme Bastian, and Charles Henberow Churchill, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

19647. Improvements in chains for pendant electric light fittings. Frederick Charles Smith and Frank Herbert Davis, 128, Colemore-row, Birmingham.

19651. Improvements in electric railways and tramways. James Clarke, 5, Hatton-garden, Holborn-circus London.

19665. Improvements in automatic transmitters for electric fire-alarm or other signals. Harold Hawthorn, 40, Chancery-lane, London.

SEPT. 13.

19685. Improvements in and connected with trolley poles of electric tramcars. James Schofield, 4, Corporation-street, Manchester.

19748. Improvements in or relating to apparatus for supplying alternating electric current. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

19749. Improvements in or relating to apparatus for use in the distribution of alternating electric current. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

19762. Improvements in and connected with points for electric tramways and light railways on the conduit system. Richard Ames, 82, Mark-lane, London.

SEPT. 14.

19822. Improvements relating to starting resistances for electric collector motors. Marius Latour, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 16, 1903, being date of application in France.) (Complete specification.)

19823. Improved means of protecting "live" rails on electric railways. John Joseph Hodgson, 56, Ludgate-hill, London.

19825. Improvements in magnetic inductors. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (Adolf Hommel, Switzerland.)

19833. Improvements in or connected with arc lamps. William James Davy, 40, Chancery-lane, London.

SEPT. 15.

19838. A means by which the points of an electrical railway or car line may be operated from an approaching car. Thomas Miller, 15, Partick-hill-road, Glasgow.

19848. Improvements in electric conduit systems. Alexander Gibson Hyslop, 37, West Nile-street, Glasgow.

19883. Improvements in electric igniters. Ernst Eisemann, 6, Lord-street, Liverpool. (Complete specification.)

19885. Improvements in and relating to electric controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19886. Improvements in electric railway systems employing sectional conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19887. Improvements in and relating to safety devices for electric signalling systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19888. Improvements in signalling systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19889. Improvements in and relating to electromagnetic mechanism. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19890. Improvements in and relating to systems of signalling. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19891. Improvements in protective devices for signal systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19898. Improvements in primary batteries. Harriette Elizabeth Blackburn, 27, Ranelagh-gardens, Barnes, Surrey.

19917. Improvements relating to push-buttons and the like for electric bells and similar services. Edgar Goodwin Harcourt, 18, Southampton-buildings, Chancery-lane, London.

19923. Improvements in electromagnets having polarised armatures for use in apparatus operated by reversals of electric current. Adolf Hommel, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 21, 1903, being date of application in Switzerland. (Complete specification.)

SEPT. 16.

19958. Improvements in third-rail systems of electric traction. Edward Everett Clark, 3, Brown-street, Market-street, Manchester.

19961. Improvements in electrically or mechanically controlled driving gear. Henry Vincent James, 3, Brown-street, Market-street, Manchester.

19976. Improvements in systems for the electrical propulsion of vehicles. William R. Everett and Edwin J. Newton, 7, Southampton-buildings, Chancery-lane, London.

19979. Improvements in magnetic wheels. William R. Everett and Edwin J. Newton, 7, Southampton-buildings, Chancery-lane, London.

19993. Improvements in shunts for electrical instruments of the moving-coil type. Evershed and Vignoles, Limited, and Ernest Blacker Vignoles, 1, Queen Victoria-street, London.

19997. Improvements in or relating to apparatus for regulating the voltage of electrical circuits. Harve Reed Stuart, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 26, 1903, being date of application in United States.) (Complete specification.)

19998. Improvements in current-collecting devices for electric generators and motors. Karl Fredrik Elers, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 26, 1903, being date of application in United States.) (Complete specification.)

19999. Improvements in electrical transformers. Charles le Geyt Fortescue, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street Strand, London. (Date applied for under Patents Act, 1901, Sept. 30, 1903, being date of application in United States. (Complete specification.)

20000. Improvements in or relating to coils for electrical apparatus. Charles le Geyt Fortescue, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street Strand London. (Date applied for under Patents Act, 1901, Sept. 30, 1903, being date of application in United States.) (Complete specification.)

20001. Improvements in systems of electrical distribution. Paul Martyn Lincoln, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 30, 1903, being date of application in United States.) (Complete specification.)

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20663. Improved process and furnace for subjecting solid materials to the action of the electric arc. Kristian Birkeland and Samuel Eyde, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Sept. 19, 1903, being date of application in Norway.) (Complete specification.)

20667. Improvements in supports for incandescent electric lamps. Adolphe Romain and Jean d'Ayguesvives, 6, Lord-street, Liverpool. (Complete specification.)

20669. Improvements in and relating to electric telegraphy. Alexander Muirhead, 323, High Holborn, London.

20618. An improved holder for electric lamps. Charles Clare Regnart and the Hunter Electric Candle Lamp Company, Limited, 29, Anson-road, Cricklewood, London.

20619. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

SEPT. 17.

20629. Effecting the electric propulsion of navigable vessels. Benjamin Howarth Thwaite, 29, Great George-street, Westminster, London.

20670. Improved magnetised board for teaching purposes. Joseph Bohy, 33, Cannon-street, London. (Complete specification.)

20699. Improvements in incandescent glow lamps. Hubert Frank Ashe, 9, Regent-street, London.

20165. Improvements in electrical signalling apparatus for fire-calls and the like. Edward Lawley Pinching and Walter Henry Walton, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 6, 1904.

1903.

19449. Apparatus for reducing or preventing the production of sparks at the collectors or commutators of dynamos, electric motors, and the like. Thury. (Date applied for under International Convention, Oct. 16, 1902.)

19382. Electric fuses and the like. Baby.

20072. Coin mechanism, especially applicable to electricity and other meters. Du Bois.

21294. Dynamo-electric machines and electric motors. Erik Artur Fagerlund and Allan Ernest Messer.

21551. Switches for use for electric lighting and power. Quaney and Kirwan.

24630. Current-collecting devices for electric railway vehicles. Shaw.

24800. Electric braking systems. British Thomson-Houston Company, Limited. (General Electric Company.)

26772. Electric arc lighting. Carbone.

1904.

7642. Electric fuses. Lee.

8216. Electric furnace for converting pig iron into steel. Gin. (Date applied for under International Convention, June, 4, 1903.)

10430. Electric cables. Whalley and Bayles.

13433. Process and apparatus for cleaning out electric accumulator batteries. Hicking.

13779. Electrical distribution, particularly applicable for controlling electric motors. Dunn. (Date applied for under International Convention, June 18, 1903.)

14529. Branch connections or couplings for electric cables. Everhart and Dossert.

15441. Automatic firing apparatus for guns having electrical or electro-mechanical ignition. Pechy and Rea.

15468. Vapour electric lamps, rectifiers, and the like. Weintraub. (Date applied for under International Convention, July 11, 1903.)

16762. Method and means for joining together the ends of telegraph wires and the like. Schmidmer.

17339. Electric switch. Heys. Meyrowitz Manufacturing Company.)

17493. Transmitter for electric telegraphs. Potiewski.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5½-6 xd
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5½-6
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅞-3⅛
—— 4 per cent. Mortgage Debenture Stock	100	..	84-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,751 ..	2	..	½-⅝
—— Non. Cum., 6 per cent. Pref.	2	–	1-1⅛
—— 4½ per cent. 1st Debenture Stock.....	100	–	94-97 xd
—— 4½ per cent. 2nd Debenture Stock	100	–	70-75
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9½-10⅛
—— 5 per cent. Pref.	5	–	5-5⅛
Crompton and Co.	5	–	14-2
—— 5 per cent. Debentures.....	100	–	90 95
Edison and Swan United, "A" Shares, 1-99,261	5	–	½-⅝
—— "A" Shares, 01-017,139	5	–	1-2
—— 5 per cent. Debentures.....	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1½
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9-9⅛
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	10½-11⅛ xd
—— 4½ per cent. Preference	5	–	5-5⅛
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18⅛-19⅛
—— 4 per cent. Debentures.....	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10½
Telegraph Construction and Maintenance.....	12	–	34-37
—— 5 per cent. Bonds	100	–	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11½-12⅛
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅞-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10½-11⅛
—— 4½ per cent. Debenture Stock. Red.	100	–	103-106
Bromley (Kent) Electric Light and Power Co.	5	..	5⅛-6
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary.....	5	–	10⅜-11⅛
—— 7 per cent. Preference	5	–	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 ..	5	–	7⅛-7⅜
—— Nos. 20,001-30,000	5	–	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12⅛-13⅛
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	107-110
Charing Cross and Strand, Nos. 1-70,000	5	–	8-8⅛
—— 70,001-80,000.....	5	..	7⅛-8
—— 4½ per cent. Cum. Pref.	5	–	5⅛-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 40,001-80,000.....	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	102-104
Chelsea Electricity Supply	5	–	6½-7 xd
—— 4½ per cent. Debentures	100	–	105-109
City of London, Ordinary.....	10	–	10½-10⅝
—— 6 per cent. Cumulative Pref.....	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	102-105
County of London Electric Supply, Ordinary	10	–	8-9
—— 6 per cent. Cum. Pref.	10	–	11½-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	101-104
—— 4½ per cent. 2nd Debentures Prov. Certs.....	100	..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6 6½
—— 6 per cent. Cum. Pref.	5	–	6-6½
—— 4½ per cent. First Mort. Deb.....	100	–	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1½-2⅛
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5⅜-5⅝
—— 4½ per cent. First Deb. Stock, Red.....	100	–	99-102
Havana Electricity, Limited, 1-15,000	10	–	9½-10⅛
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7⅛-8⅛
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	101-105
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10⅛
London Electric, Ordinary	5	–	1⅜-2⅛
—— 6 per cent. Pref.....	5	–	5-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	96-99
Metropolitan Ordinary	10	–	16-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-115
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	–	96-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb..	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14½-15½
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)..	100		100-103
Oxford Electric, Ordinary, 1-96 and 12,514-14,510.....	5	–	5⅛-5½ xd
—— 4 per cent. Debenture Stock	100	–	97-100
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2⅜-3½
—— 4 per cent. Debenture Stock	100	–	83-88
South London, Ordinary	–	–	4¼-4⅜
South Metropolitan Electric Light and Power Co., Ord...	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	..	105-109
—— Ditto, June, 1904	–	..	–
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	14½-15⅛
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4⅜-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4⅜-5⅛
Westminster, Ordinary	5	–	12-13
—— 5 per cent. Cum. Pref., 210,101-138,351.....	5	–	6-6½
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅛-5⅜
—— Ord.	5	..	6¼-6⅜
—— Permanent 6 per cent. Debenture Stock, 1888 ..	100	..	139 142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	100-103
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98 101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..	1	..	11/16-13/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	½-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1½-2⅛
—— 5 per cent. Cum. Pref., Nos. 1 75,000.....	5	–	3⅜-4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.....	100	–	97-100
—— Ord Pref.	100	..	00-103
—— Non. Cum. 5 per cent. Pref.	10	–	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	–	104-106 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-500,000 & 60,001-90,000	10	–	9⅛-10
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10⅛-11
—— 5 per cent. Perpetual Debenture Stock	100		117-120
—— 4½ per cent. 2nd Deb. Stock	100		94-97

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Name.	Amount paid. £	Last price. £
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	3¼-3⅜ xd
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-4½ xd
—— 5 per cent. Deb. Stock, Red.	100	106 108
—— Prov. Cert., all paid	100	102 105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	94-99
Calcutta Tramways, Limited, 1-102,268	5	7 -8
—— 4½ per cent 1st Deb. Stock, Red.	100	105-108
Cape Electric Tramways, Nos. 1-480,000	1	1⅛ 1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	9½-10
—— 5 per cent. Cum. Pref.	10	11-12
—— 4 per cent. Debentures	100	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb Stock	100	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	3½-4
—— 4 per cent. Debenture Stock	100	88-91
Kidderminster and District Lighting and Traction, Pref.	5	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	10½ 11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	104 106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb Stk., Red.	100	102-105
Metropolitan Elec. Trams., Ld., Defd., 1 000,001-1,314,016.	1	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	⅛-1
—— 4½ per cent. Deb. Stock, Red.	100	98-100
Milwaukee Electric Rail and Light. 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	103-105
New General Traction, Ordinary	5	½
—— 6 per cent. Cum. Pref.	5	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	12-12½
—— 5 per cent. Cum. Pref.	10	9⅜ 9½
Perth Elec. Tramways (W. A.) 5 per cent. 1 Mrt. Deb. Stk.	100	101 104
Potteries Electric Traction, Ordinary 20,001-40,000	10	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼ 8½
—— 4½ per cent. Debenture Stock	100	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.
Electric Railways.—		
Central London, Ordinary	100	85 87
—— 4 per cent. Pref.	100	100 102
—— " deferred	100	79 81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	106 09
City and South London, Consolidated Ordinary	100	46 48
—— 4 per cent. Debenture Stock	100	105-108
—— 5 per cent. Pref. Stock '91	100	121-124
—— " " '96	100	117-120
—— " " '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	98-101
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	97⅛-98⅛
Waterloo and City, Ordinary	100	86-89
Telephones.—		
National Telephone, Preferred	100	104-106
—— Deferred Stock	100	92-95
—— 6 per cent. Cum. First Pref.	10	12 14
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 5½ per cent. Deb. Stock, Red.	100	97 99
—— 4 per cent. Deb. Stock, Red.	100	104 106
—— 4 per cent. Prov. Cert.	—	67-69
Ottawa Electric and Electric Company	1	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	1 1/16-1 3/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week: Ending	1904. £	1903. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1904.	1903.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per Pass'nger d.	Receipts per Car mile. d	Receipts per Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	Sep. 17	1,395	1,164	+ 231	+26,065h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Barking Corporation	Sep. 17	42	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 18	1,077	1,113	- 36	+ 81	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways	,, 17	5,328	5,094	+ 234	—	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 16	1,034	9 0	+ 94	+ 2,339	24	24	March 25g	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 15	2,037	1,582	+ 455	+ 4,859	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 5	1,463	1,368	+ 95	- 40	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 18	1,956	1,8 4	+ 102	+ 462	38	38	March 31g	85,704	17,761,605	1,896,247	1 15	10·75	3,430	5·67
Bournemouth Corporation	,, 14	1,294	1 163	+ 126	+ 1,570	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 17	4,864	3,801	+1,033	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 18	1,166	985	+ 181	+ 2,867h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 16	5 225	4,894	+ 331	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 17	1,065	851	+ 212	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 18	369	410	- 41	—	8¼	—	—	—	—	—	—	—	—	—
Cardiff Corporation	Aug. 2	2,189	2,088	+ 101	+ 1,376	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	Sep. 17	228	205	+ 22	+ 293	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 17	6,088	5,900	+ 188	— h	6	6	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City & South London Railway	,, 18	2,493	2,482	+ 11	— h	6⅔	6⅔	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	,, 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. I. and L. Company	,, 15	529	588	- 58	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 16	261	271	- 10	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 17	250	258	- 8	- 253	4½	3	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Ry.	,, 16	129	128	+ 1	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 16	4,034	3,814	+ 190	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 16	1,007	966	+ 41											
Dundee City Tramways	,, 14	861	813	+ 21	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 17	729	708	+ 21	+ 1,430	10·75	10·75	March 31g	25 341	9,971,337	650,224	0·61	9·35	2,357	—
Glasgow Corporation	,, 17	15,511	14,568	+ 943	— h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 14	339	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 7	3,357	2,784	+ 573	+ 3 034	31½	30½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 17	1,337	1,211	+ 126	+ 2,760	34	34	March 31	55,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 17	2,182	1,808	+ 373	+ 7,311	25	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 17	481	493	- 12	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 15	141	162	- 20	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 14	233	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 17	6,078	5,496	+ 531	+ 9,953	77	77	March 25g	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Leicester Corporation	,, 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 10	10,685	10,566	+ 89	+12,336	103	101	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 18	1,561	1,690	- 129	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 17	13,916	10 413	+3,492	+65,027	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 17	310	262	+ 48	—	—	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 17	12 619	11,731	+ 888	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 16	2,000	1,330	+ 679	+ 5,027h	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 17	133	97	+ 36	+ 1,036	3	3	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corptn.	,, 17	3,618	3,401	+ 217	—	38½	38½	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Newport (Mon.) Corporation	,, 17	525	457	+ 68	+ 2,289	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,025	+ 466	+ 3,051	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	March 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Sep. 15	473	474	- 1	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	Sep. 17	253	—	—	—	7⅔	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 18	4,743	4,572	+ 170	+ 3,122h	53½	53½	Mar. 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 8	1,317	1,205	+ 112	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 14	476	409	+ 67	+ 1,167	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 16	562	372	+ 190	+ 6 274	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 17	1,274	1,834	- 560	—	18·48	18·48	,, 31g	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·4
Wallasey U.D.C	,, 17	793	750	+ 43	—	10·5	10·5	,, 31g	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03
West Ham Corporation	,, 15	1,122	—	—	—	1¾	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 14	739	429	+ 310	—	7½	—	—	—	—	—	—	—	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and trams. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Cable Concession.—The *Daily Mail* states that a German company has succeeded in obtaining from the Porte a concession for the submarine cable between Constantinople and Constanza (Roumania), which will be connected with Berlin and Bagdad. This result was secured despite all the efforts of the British Embassy to support the rights of the Eastern Telegraph Company, which has a monopoly for all submarine cables in Turkey.

Rugby Engineering Society.—The annual general meeting will be held in the Benn-buildings, High-street, Rugby, on Thursday next, at eight o'clock, when the following business will be transacted: election of officers and members of council; ballot for day of meeting; president's report for session 1903-4; and alteration to Rule 10, *re* auditors. After this, there will be a discussion on the metric system, which will be opened by Mr. E. R. Briggs, hon. recording secretary, and replied to by Mr. R. C. Jackson. Members may obtain copies of the opening remarks after to-day.

Tramways and Light Railways Association.—In the Official Circular for September are given the model by-laws regulating the stopping, etc., of tramcars; the last Board of Trade regulations under the Electric Lighting Acts, and under the provisions of special Tramway Acts or light railway orders. It is also notified that the following lectures will be given at the Society of Arts, John-street, Adelphi—viz.: "Automatic Regenerative Control for Electric Traction," by Mr. J. I. Hall, on Oct. 20; "Notes on Permanent Way," by Mr. A. N. Connett, on Nov. 3; and "Running Powers," by Mr. Stephen Sellon, in December; and that members of the association have been invited to visit the various works of the London County Council tramways on Nov. 11.

Motorcar Speed Limit.—The Local Government Board conducted an enquiry at the Guildhall on Tuesday into the speed at which motorcars should be allowed to travel through the City. Sir Homewood Crawford, on behalf of the City Corporation, contended that a limit of 10 miles an hour should be fixed. Major Nott-Bower, Commissioner of Police, considered even this "almost too high." A quantity of evidence was tendered for and against, one member of the Court of Common Council declaring that the professional chauffeur "is the curse of London"; while Mr. J. R. Nisbet, of the Motor Union, produced statistics to show that in the roll of fatalities in the Metropolis the motor played an infinitesimal part. The Automobile Club and the Motor Union were represented by counsel.

The Cable to Iceland.—It is announced that the negotiations have now been concluded between the Great Northern Telegraph Company and the Danish Government for the establishment of a cable from Iceland to Copenhagen. The company pays all the expenses of the cable, which is to be ready in two years. The Danish and Icelandic Governments will allow a subvention of £5,000 a year for 20 years to the company. Permission has been obtained from the British Government to land a cable in the Shetland Islands, and this will be in communication with the existing cable from Shetland to Scotland. The cable from Shetland will be laid *via* Thorshavn, in Faroe, to the east coast of Iceland. Thus Iceland will again have a main line from the east coast to its capital, Reykiavik. The company is to commence the work immediately.

New Publications.—"Central Electrical Stations: Their Design, Organisation, and Management," by C. H. Wordingham (London: Chas. Griffin and Co. 24s.). This is the second edition of this valuable treatise, which describes the scientific, engineering, and commercial problems arising in the practical operation of central stations, and offers solutions to them from actual experience. "Elementary Manual on Applied Mechanics," by Prof. A. Jamieson (London: Chas. Griffin and Co. 3s. 6d.). The continued popularity of this work has induced the author to publish a sixth edition, in which have been included the question papers for stage 1 of the Board of Education and other examinations. Messrs. Harper and Brothers are about to publish "The Diseases of Electric Machinery: Their Symptoms, Causes, and Remedy," by C. Kinzbrunner. Price 1s. 6d. This manual could not well be in a more succinct form, as the subject is dealt with throughout in three parallel columns under the headings "Symptom," "Cause," and "Remedy," and it should prove very serviceable to those in charge of either continuous or alternating current generators or motors.

Electricity and Therapeutics.—A letter appears in the *Liverpool Courier* from Mr. R. W. Mackenna, in which he takes the Corporation of that city to task for refusing to supply the hospitals with current for the Finsen treatment at power rates and insisting upon the usual scale for light, the result of which, he states, is that the hospitals resort to a modification of the Finsen apparatus, which modification, though giving excellent results, is not so efficacious as the original treatment. The essence of the differential charges for light and power is the fact that the latter is used fairly regularly for a number of hours, while for lighting current is only required during the periods of darkness. The current required for the Finsen cure is certainly, as the nature of the treatment necessitates, converted into light, and even in hospitals devoted to this treatment the load factor is not, we think, large. In smaller hospitals, where the use of current for this purpose is intermittent, the load factor becomes worse, and we think that the ordinary lighting rates are not excessive. We certainly cannot agree with Mr. Mackenna that the charge for current is the chief obstacle to the introduction of the Finsen lamp into Liverpool hospitals.

The Relation between the Pressure and the Discharge Voltage in Exhausted Tubes.—In a note to the Academie des Sciences, M. Séguy describes some experiments on this subject. It is well known that as the vacuum is pushed to an extreme limit the voltage required to speak across a given distance increases rapidly. So long as the pressure does not fall below $\frac{1}{100}$mm. the McLeod gauge can be employed for determining it, but below that pressure the gauge is useless. M. Séguy considered that by deciding the relation between the pressure, p, and the length of spark-gap, d, corresponding to the discharge in the tube down to the limiting point, the relation for lower pressures could be determined by extrapolation, and the spark-gap distance could then be employed as a measure of these very low pressures. He therefore arranged a micrometer spark-gap in parallel with a tube fitted with a McLeod gauge, and obtained the following results:

Spark-gap distance, d, in mm.	Measured pressure, p.
1	·1320
3	·0660
5	·0330
7	·0165
9	·0082

It will be seen that as the spark-gap distance increased in an arithmetical progression, the pressure, p, decreased geometrically; p is, therefore, an exponential function of d,

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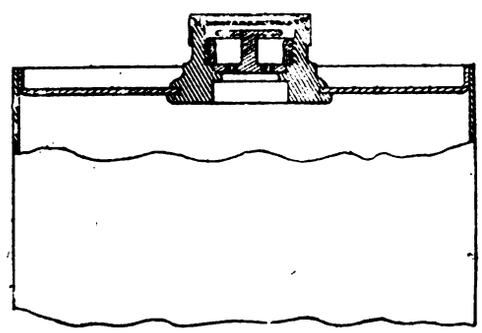
and lower pressures can be arrived at by measuring the corresponding spark-gap distances with a micrometer.

Transmission and Distribution Problems Peculiar to the Single-Phase Railway. — This subject was dealt with in a paper presented to the International Electrical Congress by Mr. P. M. Lincoln, for the following abstract of which we are indebted to the *Electrical World*: An apparent handicap for the single-phase in comparison with the three-phase transmission system is the fact that the copper required is in the ratio of 4 to 3. This ratio holds true on the basis of equal potential between wires, but if equal normal potential to ground be considered the basis, then the single-phase and the three-phase are on an equality. A polyphase generator is cheaper by 30 per cent. than a single-phase machine of the same capacity; hence it is advantageous to use polyphase generators for supply, dividing the load as equally among the phases as possible. A disadvantage is found in thus operating from a polyphase circuit, since if one of the three wires be taken away, the sum of the static potentials no longer remains at zero, and static induction will take place on neighbouring (telephone) circuits without the possibility of correction by any method of transposition. After discussing the application of Kelvin's law for the determination of maximum commercial economy of conducting material and the relation of the voltage drop to the spacing of transformer stations, the author concludes that there is no golden rule for the determination of the spacing and capacity of transformer stations or of the size of the conductor. It is a matter of compromise between various elements, some of which point in one direction and some in the other, and is a matter which must be determined by engineering judgment rather than by any inflexible law.

Electric Power for Oil Wells.—Mr. M. L. Gaster has tabulated some facts regarding the use of electricity in connection with petroleum production. The demand for petroleum greatly exceeds the present production. The substitution of oil for coal, in order to be advantageous, needs a better regulation of the methods of producing it, and also of the price. In this connection the use of electric motors is a question of great interest. Mr. Gaster considers that the employment of electricity, which is generated in a large central station, to operate motors for petroleum wells is justified by the area covered by the wells, as well as by the fact of the danger from fire caused by the steam-engines which operate the drills and pumps. A central-station system also has the advantage of being able to cope with the variations of load at the different wells. Electric motors were first used for drilling wells some five or six years ago in Roumania. The plant was provided with a set of motor-driven pumps. A central station was erected at a distance of 1½ miles. The motors are of the three-phase type, operating at 300 volts. The total capacity of the station is 200 kw. Later, the Lahmeyer Company erected a large station for working the wells at Campana and at Bushtenari. The first cost of the plant was £500 per well, and the running expenses £8 per horse-power year. In Russia, which is the greatest petroleum-producing country, the conditions are less favourable to the use of electric power, owing to the fact that the oil consumed to furnish the power for the wells is not subject to any tax, and therefore a very cheap supply of energy can be had. It is to be noted, however, that a large number of electric plants have latterly been installed in that country.

New South Wales.—The annual report of the Commissioners on the New South Wales railways and tramways for the year ending June 30 has come to hand promptly. In regard to the railways, the receipts amounted to £3,436,413, against £3,314,893 during the previous year; the expenditure decreased from £2,266,299 to £2,258,940; and the balance represented £1,177,473 against £1,048,594. The mileage opened for traffic totals 3,280¾, and the amount spent on construction and equipment aggregates £42,288,517. The number of miles of tramway line opened for traffic at the date of the report was 125¾, the amount spent on construction and equipment totalling £3,471,759. Several new sections were opened during the year, and in the capital the forms of traction other than electric are rapidly disappearing. There was only an increase of 1¼ miles over the previous year in the length of line available for traffic, but the receipts rose from £752,034 to £802,985. The expenditure amounted to £673,625, against £654,165, leaving a balance of £129,360, against £97,869. The receipts per mile averaged £6,398, and the earnings per car mile 11¾d., against working expenses of 9¾d., showing a profit of 2d., against 1¾d. during the previous year. The passengers numbered 137,843,513, against 130,405,402, and the total mileage amounted to 16,387,019, against 13,695,630. The plant at the Ultimo power-house worked satisfactorily throughout the year, and is now being extended by the addition of a 1,875-kw. turbo-generator, the power from which will be applied to the conversion of the Ocean-street cable line and the remaining steam lines connected with the city system, and also to enlarging the existing services in order to meet the increased traffic requirements. Additions are also being made to the sub-stations.

Non-Explosive Storage Battery.—A method of rendering storage battery gases non-explosive has been patented by Mr. Thomas A. Edison, who has assigned the patent to the Edison Storage Battery Company. A description of the apparatus, with the accompanying diagram, appears in the *Electrical Review* of New York. The case, which is made of thin nickel-plated steel, is provided with a neck having a perforated plug, and carried by this plug is a deflecting plate for diffusing the gases escaping through the perforations. At the top of the neck is a suitable cooling medium through which the gases pass. When the apparatus is not provided with special means for effecting



the separation of the mechanically-entrained globules, the gases will escape continuously through the perforations in the plug, but if separating devices are employed the gases will escape intermittently through these perforations. The escaping gases will be deflected outwardly by the deflector, so as to be comparatively attenuated, and they will escape through the cooling medium in a highly rarefied condition. Even if they could ignite on the outside of the medium, the radiating capacity of the latter is sufficient to prevent it becoming hot enough to ignite the gas below it, so that no explosion can take place. This is especially true when the deflector is used; otherwise there would be danger of a small stream of gas passing directly from each perforation through the medium in a sufficiently concentrated condition to result in the gauze being dangerously heated.

Unaccounted-for Current.—At the tenth annual convention of the Ohio Electric Light Association last

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month a paper on this subject was presented by Mr. W. E. Richards, in which he pointed out the several sources of lost current. The most important of these he stated to be that which occurs at the meter in the shunt circuit and through meters running slowly. In direct-current watt-meters the shunt loss runs approximately 35 to 175 kilowatt-hours per year, and in the induction type from 17 to 35 kilowatt-hours per year. A table given by the author showed that the loss in a commutator type of meter, after having been in use 21 months, was 37 per cent. at one-twentieth load, 18 per cent. at one-tenth load, 8 per cent. at quarter load, 3·5 per cent. at half load, 2·2 per cent. at full load. Even with the precaution of installing meters of a capacity as near the lighting load as possible, data collected show a loss of from 12 to 18 per cent. on one-tenth load, and 5 to 8 per cent. on quarter load. Mr. Richards remarks that meter losses in unaccounted-for current can be reduced to a minimum only by an intelligent effort of the meter department, as upon the care and upkeep of the meter depends at least 10 per cent. of the earnings of the company. The author recognises as a practical step the systematic cleaning and inspection of meters, the interval between such cleaning and inspection depending on the capacity and service. To reduce the controllable losses on a meter system, of course, requires additional expense. Just where the balance of the additional expense and the reduction of the losses occur is a fine point to decide. If the meters are of the induction type, Mr. Richards's practice is to give them attention every 18 months, but the commutator type requires an inspection every 8 or 12 months.

Municipal Electrical Association.—It will be remembered that at the annual general meeting, held at Derby on July 2, and duly chronicled in these columns, it was reported that the membership had increased to 387. The *Proceedings* of the association are just to hand, and contain various other points worthy of recapitulation. Mr. Wilmhurst remarked, in the course of his presidential address, that in the first year of the association's existence its members controlled undertakings with a capital outlay amounting to £4,000,000, and now, within eight short years, the figure had risen to nearly £40,000,000. He concluded by exhorting members to support the work of the Engineering Standards Committee. The papers presented consisted of "The Commercial Practicability of Electric Traction by Surface Contacts," by C. E. C. Shawfield; "The Organisation and Management of a Central-Station Meter Department," by A. J. Cridge; "Polyphase Sub-Stations: Their Equipment and Working," by S. L. Pearce; "Notes on the Bristol Electricity Fire," by H. Faraday Proctor; "Boiler-House Economies," by R. S. Downe; "The Financial Position of Municipal Electrical Undertakings," by J. R. Blakeway; and "Steam-Turbines: Their Efficiency compared with Reciprocating Engines," by H. Howard, the last-named being the associates' prize paper. There was a very limited entry for this prize, and the association hope that there will be a better response in future. In the course of the year the Parliamentary Committee considered a number of electrical measures, and especially the Supply of Electricity Bill, taking steps to ensure that the objections it had raised would receive attention. The balance-sheet showed a small deficit. As the treasurer's report observed, the association does not exist for the purpose of making a profit, but it ought to make both ends meet. The election of officers for the ensuing year resulted in the choice as president of Mr. F. A. Newington, Edinburgh, where the next annual convention is to be held. At a special meeting the articles of association were altered so as to facilitate qualification for the different grades of membership, full particulars of which appeared in our issue of July 8.

Obituary.—In the passing of Niels Ryberg Finsen, at the age of 43, science loses a distinguished votary, though his discoveries remain to ameliorate the lot of suffering humanity. His name will always be associated with the light cure of lupus, but he had a varied gift for invention, and devised, among other things, an improved breechloader, a cool summer-house, a cooking apparatus, and some hæmatine lozenges. It is interesting to note what prompted his researches into the curative properties of light. Finsen heard that during the American War of Independence some prisoners suffering from small-pox were shut up in dark rooms. It was noticed that these men had no secondary fever, that there was no matter in the pox, and that no scars were left by the disease. It had been pointed out by Prof. Widmark that the chemical rays of light, the blue violet and ultra-violet rays, inflamed the skin. Finsen devised a method of using light from which these rays had been removed. This was known as the red or negative light treatment, and has been widely used with beneficial results for small-pox and other affections. While it does not cure small-pox, it prevents the secondary fever. This led to his great achievement in evolving the positive application of light. It occurred to him that by the concentration of light upon the diseased spot of the body, and applied perhaps for a long period, it might be possible to destroy the bacteria which caused the terrible corroding diseases. He put the matter to a test by using an ordinary magnifying glass, cooling the rays in a sphere of glass filled with water. The patient, who had suffered from lupus for eight years, was cured. With the assistance of friends and the Danish Government, the Finsen Institute was founded, and some 2,000 patients have been treated there from all parts of the world. Finsen early discovered that concentrated sunlight or the usual electric lamps were not powerful enough to yield the best results. He experimented with lamps of various powers, and those now in use are of 50 amperes and 45 volts, which kill in a second microbes which will resist daylight for hours. He was awarded the Nobel prize of 100,000 crowns (about £5,500), a large portion of which he devoted to the institute. It is of interest to recall the fact that it was due to Queen Alexandra's appreciation of the Finsen treatment that the cure was introduced into this country. Her Majesty presented the first lamps to the London Hospital, and thus inaugurated a most successful department, which has clearly shown the value of the treatment to English medical men. Although his system of therapeutics did so much for the relief of others, Finsen himself had been a martyr for the past 20 years to a malady of the heart, and the conditions under which he pursued his beneficent work partook of the heroic.

Starting Devices for Mercury-Vapour Lamps.—One of the features of the vapour-electric apparatus invented by Mr. P. C. Hewitt three years ago was the well-known "starting band" in proximity to the negative electrode. The band was located outside the container, within which both the positive and negative electrode of the apparatus were enclosed. Mr. Hewitt has since found that the function of the starting band will be performed whether it is located outside or inside the material constituting the negative electrode, and he has accordingly patented a device (described in the *Western Electrician*) embodying a starting band which is internal with respect to the negative electrode. The invention is illustrated in the accompanying diagrams. Figs. 1 and 2 are vertical sections of different forms of the invention. Naturally, the apparatus may assume many forms, and those illus-

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trated are simply given as typical. In the diagrams (1) is a container, within which are electrodes (2) and (5), connected respectively with leading-in wires (7) and (8). The positive electrode (2) may be of iron or some other suitable substance, while the negative electrode (5) may conveniently be of mercury, or some material which will undergo disintegration by the action of the electric current, which disintegrated portions will eventually return and re-form as the electrode. In proximity to the negative electrode, and usually projecting somewhat above the level of the upper surface, is placed a starting band (9), which in Fig. 1 is represented as a strip of metallic foil, or may consist of a metallic paint, either in the form of a complete ring or in the form of one or more strips of foil or paint. The starting band (9) in Fig. 1 is internal with respect to the material of the negative electrode, by reason of the fact that the container is made of re-entrant form at the bottom, and

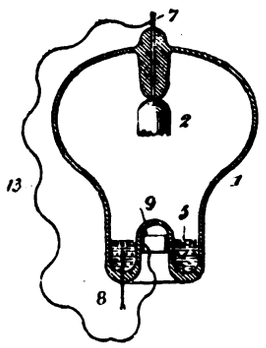

FIG. 1.

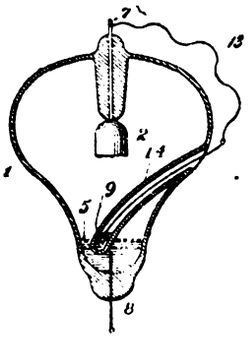

FIG. 2.

the starting band is applied to the inner side of the re-entrant portion in substantially the position indicated in the diagram. In Fig. 2 is shown a tube (14) running in from the outer wire of the container (1), and dipping slightly below the surface of the mercury or other materials constituting the other electrode (5). In this instance the starting band is in the form of a drop of mercury in the bottom of the tube (14), it having been found that this form of starting band operates well in practice.

Iron and Steel Institute.—In accordance with previous announcements, the autumn meeting will be held in New York on Monday and Wednesday, Oct. 24 and 26 next, for which occasion the following papers have been offered: "Iron and Steel at the St. Louis Exposition," by Prof. H. Bauerman; "A West African Smelting-House," by C. V. Bellamy, with an appendix by F. W. Harbord; "The Influence of Carbon and Phosphorus upon the Strength of Iron and Steel," by H. H. Campbell; "The Rateau Low-Pressure Turbine at Steelworks and Collieries," by E. Demenge; "A Dry-Air Blast Apparatus," by James Gayley; "High-Speed Tool Steels," by J. M. Gledhill; "The Determination of Carbon and Phosphorus in Steel," by Baron H. Jüptner von Jonstorff, Andrew A. Blair, Gunnar Dillner, and J. E. Stead; "Acid Open Hearth Manipulation," by Andrew McWilliam and W. H. Hatfield; "A Power-Gas Plant for Johannesburg," by P. J. Mallmann. The following is an outline of the programme for this meeting. The headquarters will be at the Hotel Astor, New York, where the majority of the members are expected to arrive by the 23rd prox. On the following day the opening of the annual general meeting will be preceded by visits to places of interest in the city, and succeeded by a reception, at which addresses of welcome will be delivered, and the Bessemer gold medal presented to Mr. Carnegie in recognition of his great services. The following day will be devoted to an excursion up the Hudson River. On the Wednesday the general meeting will be resumed, and in the evening the institute will entertain the Reception Committee to dinner at the Waldorf-Astoria Hotel, whilst a theatre party is to be arranged for the ladies accompanying the members. After this the party will leave for Philadelphia, visiting various places of interest in that city, and will then proceed to Washington, where, on the 29th, they will be received by President Roosevelt. The 31st will see the party at Pittsburg, and after spending a couple of days in examining iron and steel works, a move will be made for Cleveland. Buffalo will be reached on Nov. 5, and a visit paid to the Niagara Falls. There will be an opportunity for those desiring to inspect the General Electric Company's plant to do so by breaking the journey between Cleveland and Buffalo at Albany. The party will leave New York for England on Nov. 9. For the convenience of members desiring to visit the St. Louis Exhibition, arrangements will be made for a limited number to leave Pittsburg on Thursday, Nov. 3, returning to New York in time for the steamer leaving on Nov. 12. The estimated cost of the circular trip is £25; of the St. Louis excursion £35. The arrangements for ocean transport have been placed in the hands of Messrs. Thos. Cook and Son, who have secured for members the advantages of special rates. Further details may be had on application to the institute.

The American Tour.—The cordial welcome promised to visitors of the American Institute is being amply fulfilled, and our Transatlantic friends are showing themselves indefatigable in the entertainment of their guests. The English party landed at Boston on the 2nd inst., and confessed to an exceptionally pleasant trip, save for apprehensions of a tedious process with the Customs authorities, which were speedily dispelled by the co-operation of the Reception Committee, and these little troubles were disposed of in summary fashion. The visitors were promptly conducted to the sports ground, where a novelty awaited many of them in the form of a baseball match. In the evening there was a reception by the local committee, and the Governor of the State welcomed the English and Italian institutions to the birthplace of Franklin. The next day was spent in exploring Boston, after which the party left for New York. An excursion up the beautiful Hudson was followed by a visit to the City Hall Station of the Interborough Rapid Transit Company, whence a pioneer train of eight cars—some of the all-metal construction—conveyed the party at varying speeds to the Columbus Circle Station at Fifty-ninth-street, ample opportunity being afforded of noting the construction of the track, cars, signals, and stations. From this point the party inspected the company's new power-house, and subsequently visits were paid to the power-houses of the New York City and the Manhattan Elevated Railway Companies, whilst in the course of the day the New York City Fire Department treated the travellers to a splendid exhibition of fighting the flames from the river front by one of its largest fire-boats. The stay in the capital concluded with a reception at the Waldorf-Astoria. Early on the morning of the 6th the party hied off to Schenectady, where the General Electric Company gave the party a trip over the new single-phase system to Ballston. The next day saw the party at Montreal, where they visited several places of interest, followed by a reception at McGill University. A visit to the plant of the Shawinigan Falls Water and Power Company, at Shawinigan Falls, some 70 miles from Montreal, was the chief feature of the second day's programme in the Dominion. Higher even than those of Niagara, the falls have not the same volume behind them, but with the present equipment they supply 15,000 h.p. with an 84-mile transmission, and the company is now conducting opera-

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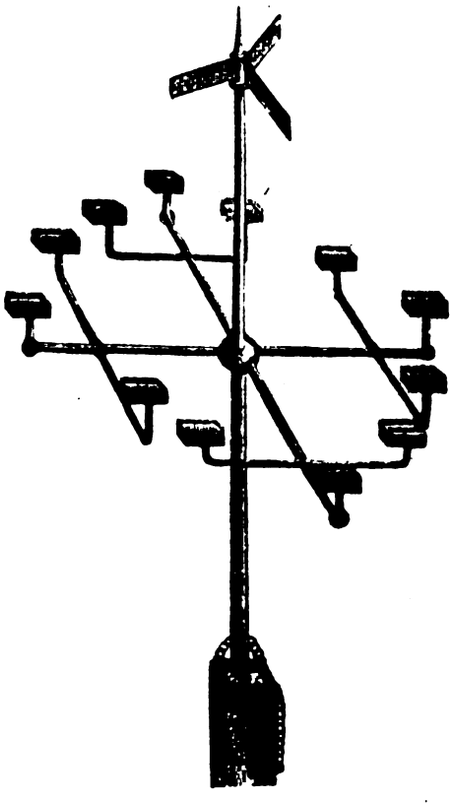
tions to increase the production by 20,000 h.p. The party then moved on to Niagara itself, where the visitors were enchanted with the scenery. Besides viewing the falls, the various power-houses were duly inspected, and the local committee presented each of the party with a handsome souvenir volume. Chicago was reached on the 9th, and here the party were welcomed by Mr. Samuel Insull, while a couple of days later they arrived at St. Louis, in time for the International Electrical Congress, concerning which we shall have more to say in our next issue.

A New Phonographic Principle.—The magnetic phonograph due to Poulsen has lately aroused much sensation, not only on account of its exceedingly pure rendering of the human voice, but, in the first place, because of the originality of the underlying principle. Instead of using, like Edison, the mechanical deformation of soft masses, as produced by sound waves, for recording the corresponding sounds, Poulsen utilises, so to speak, the magnetic impressions produced in a substance magnetically deformable (steel) under the action of microphone currents. Now, it will be evident that, generally speaking, any phenomenon giving rise to a permanent alteration proportional to the effect of the sound waves may be used on the phonographic principle. When resorting to the electrification of insulators, an electrostatic equivalent of Poulsen's electromagnetic apparatus would evidently be obtained. The above reflections a short time ago induced Prof. W. Nernst, the well-known scientist of Göttingen University, to construct an electrochemical apparatus, utilising the permanent alterations produced on an electrode by galvanic currents—*i e*, galvanic polarisation. The following arrangement was chosen: An endless platinum band, running over two rollers and receiving a permanent movement from a motor, is galvanically polarised by microphone currents. As it is important to comply with the condition that the variable polarisation produced by current oscillations should be separated locally, the platinum band should, on the one hand, be displaced with sufficient rapidity, and there should, on the other, be a point of contact as narrow as possible between the band and the electrolyte. The latter condition is satisfied approximately by using as electrolyte a wood wedge soaked with a conductive liquid and placed in a glass tank filled with the liquid in question and fitted with an electrode. The experiment, as stated by Nernst, will succeed perfectly. A more or less distinct rendering will, it is true, be noted according to the kind of electrolyte used. The sound record may be reproduced several times repeatedly before any appreciable diminution of the sound intensity is noted. The remarkable statement is made that during the reproduction a current should traverse the telephone circuit, the reproduction being the stronger as the intensity of this current is greater. In order to control this current, a variable E M.F. may be inserted into the circuit. The phenomenon obviously fails to be accounted for on the hypothesis that the currents setting up the sound vibration in the telephone during reproduction are merely discharge currents of a polarised electrode; a similar discharge should occur also with no current, while a constant current would not be able to exert any appreciable effect. The experimenter, therefore, suggests that the oscillations in the microphone currents result in a superficial loosening of the metal electrode, passing on the electrolyte; during reproduction there will arise oscillations in the constant current, causing the telephone to vibrate and depending on the loosening referred to above. The apparatus allows in many cases of a rather distinct and even sufficiently loud reproduction of spoken words, though its practical possibilities are evidently inferior to its theoretical interest.

Procopius Diviss.—Who was he? the reader may ask. Some light is thrown upon the question by Dr. J. Rudis-Jicinsky in the *Western Electrician*. Diviss was a doctor of philosophy and theology, and was born in Moravia in 1696. He made his first electrical experiments in 1728, and at that early day he thought that an electric spark might be a good stimulant for certain lesions or diseased tissues of low vitality. For several years he delivered lectures, accompanied by experiments, on physics at the University of Salzburg, where he remained in constant study and research until 1735. In 1741 Diviss was appointed superior of the institute for priests in Luce, on account of the war with Prussia, but on its cessation he returned to the village of Primetice, near Znojmo, to prove beyond doubt, several years before Franklin, that "the electrical stream, not being exactly a fluid, was identical with the lightning." After many efforts he completed his first lightning-rod on June 15, 1754. This apparatus, illustrated in the accompanying diagram, consisted of an iron rod, 1½in. thick and 24 yards high, fastened on to the top of a heavy wooden pole. Iron chains ran down the side of this pole, connecting the metal rod with earth.



Four horizontal iron arms projected from the rod, and to the ends of these arms were fixed smaller arms, attached to which were little boxes covered with iron plates, and having at the edges many iron nails pointing towards the sky. On one occasion he gave a demonstration at Vienna before Francis and Maria Theresa, who bestowed gold medals upon him; but the German and Austrian scientific institutions could not realise his principles, and his communications were received with derision, whilst his one-time tutor besought him to discard such occult practices. Two or three years later the authorities sided with some farmers at Primetice, who attributed an unfavourable summer to the influence of Diviss, and so depressed was the scientist at this incident that he withdrew from further research, and died in seclusion shortly afterwards. His lightning-rod can still be seen at the museum of Bruk. The encyclopædias know nothing of Procopius Diviss, but he prepared the way for the practical application of electricity, and his name should not be forgotten.

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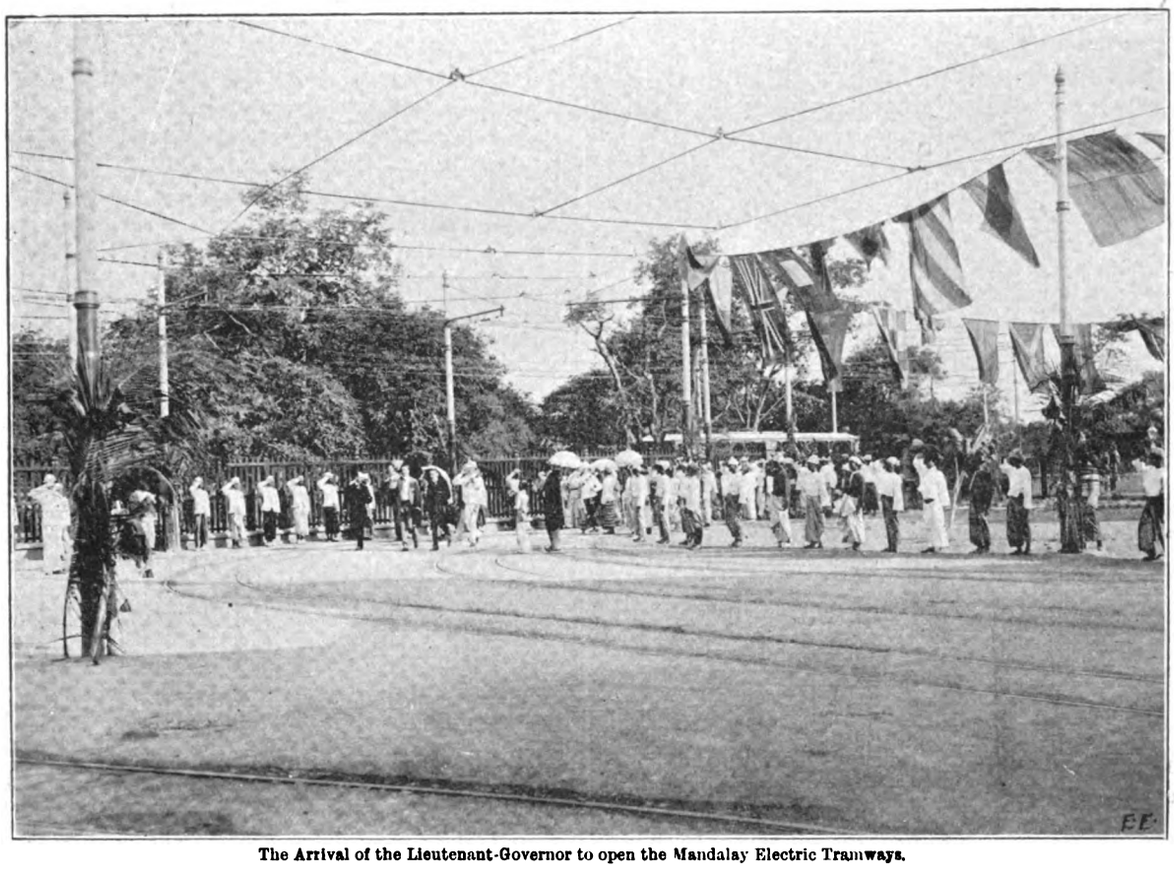
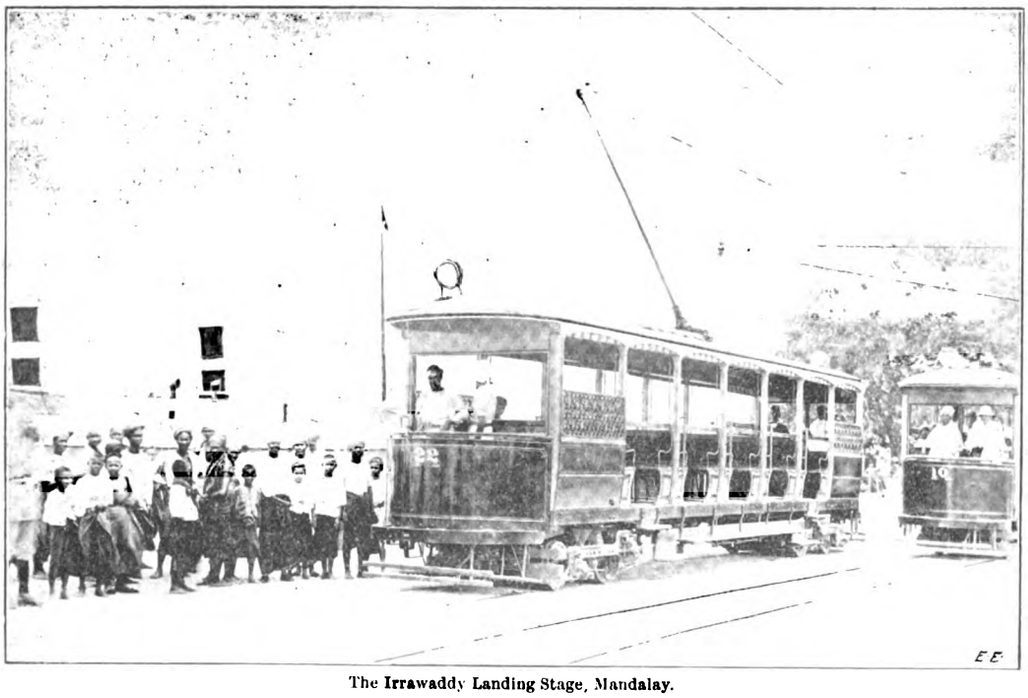
ELECTRIC TRAMWAY IN MANDALAY.

A few weeks ago a short announcement was published in our journal relating to the opening of an electric tramway system in Mandalay by the Lieutenant-Governor of Burma, Sir Hugh Barnes, K.C.S.I., K.C.V.O. Now that the system has been in successful operation for the last two months, and in view of the fact that Mandalay is the first city in Burma to adopt the very latest mode of transit in the shape of electric cars in place of horse traction, a detailed description of the enterprise will no doubt be of interest.



The Arrival of the Lieutenant-Governor to open the Mandalay Electric Tramways.

The Mandalay Electric Company was floated in London in October, 1902, with a capital of £200,000. Actual work was commenced in December of the same year by the contractors, Messrs. Dick, Kerr, and Co., Limited, and within the short space of a year and a half the first car was moved by electrical power on June 17, 1904. The centre of the tramway system has been wisely placed at the new Zegyo Bazaar, on which the municipality is spending a large sum of money, and which promises to be, when finished, the largest bazaar of its kind in the East, and a position that will become a centre of attraction to the Burmese from all parts of the city. From the Zegyo Bazaar the tramway radiates in three branches. One leads to the shore, where the Irrawaddy Flotilla Company's steamers embark their passengers, and so will cater for the travelling public. The second runs to the Arakan Pagoda, and will serve the suburbs which cluster round that famous shrine. The third leads to the Court House, where the daily legal business of the city and district is transacted, and to which a certain number of citizens would always



The Irrawaddy Landing Stage, Mandalay.

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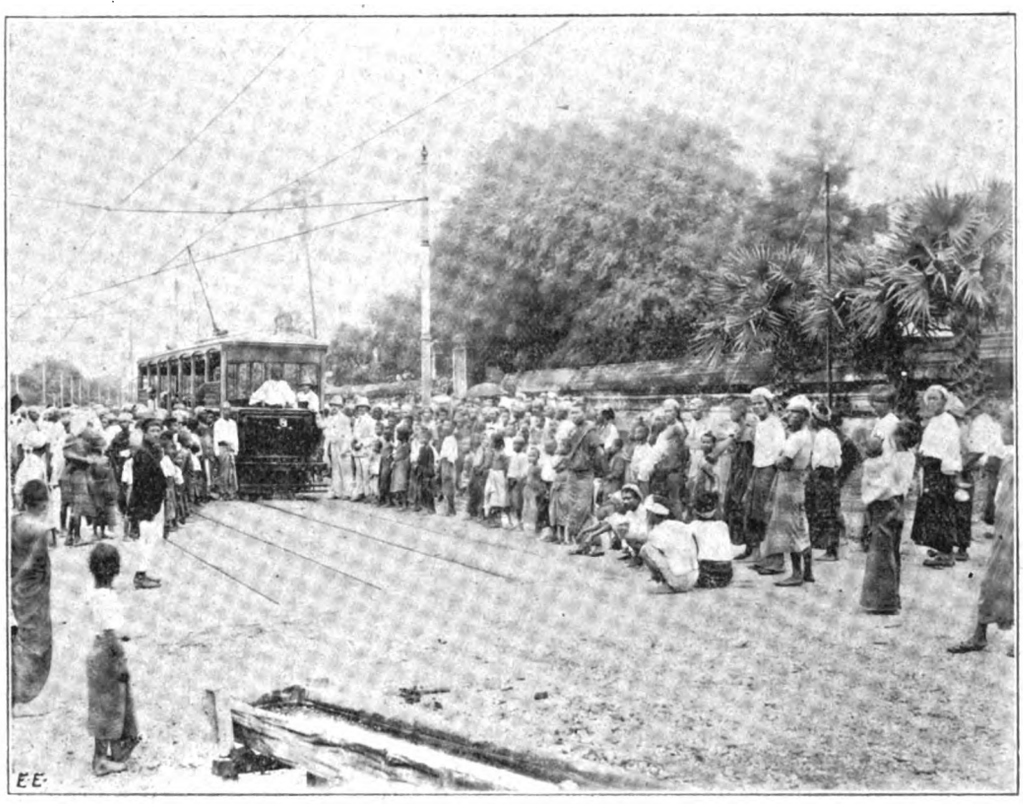
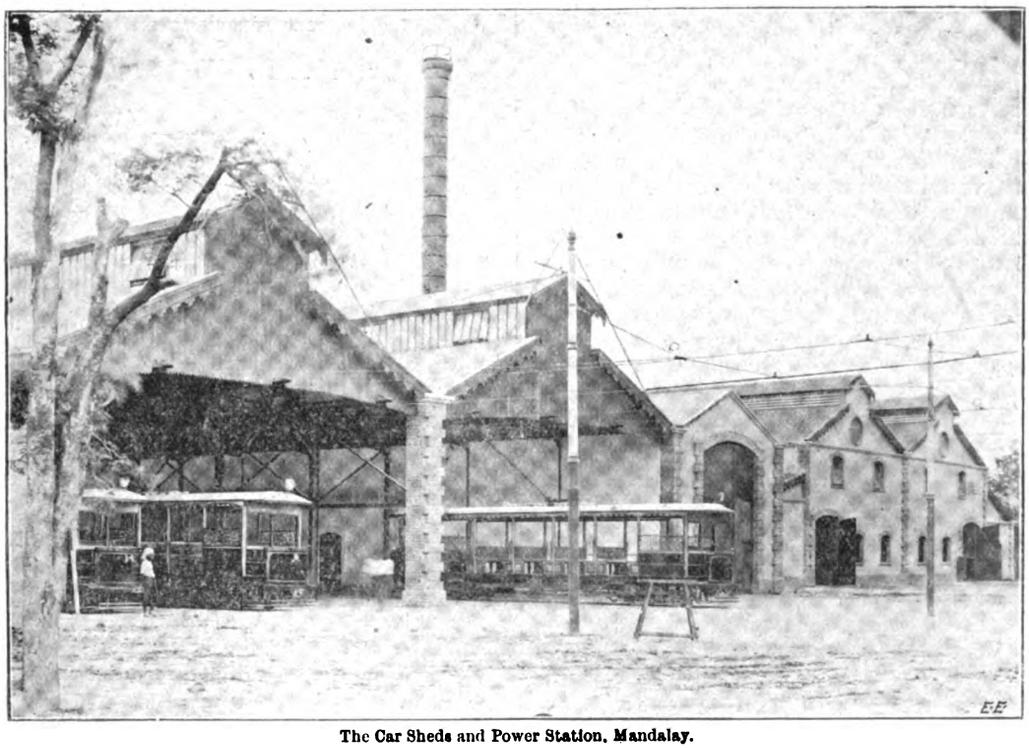
desire to resort, and so would use the tramways for that purpose.

The tramways have a route length of seven miles, double track throughout, and equals, exclusive of cross-over roads, approximately 14 miles of single track. The rails are in



The Pyagyi Terminus of the Mandalay Tramways.

accordance with standard tramway practice, 6in. deep, with a 1¼in. groove, laid to a gauge of 3ft. 6in., in 45ft. lengths, with a proportion of shorter lengths to allow for piecing in and closures. The rails are double spiked to hardwood sleepers, which are laid at 2ft. 9in. centres, the whole being



The Car Sheds and Power Station, Mandalay.

laid on a ballasted bed, the road surface being made up with macadam in the ordinary way. The joints are of the plain type, and are secured with six-holed fishplates, and are double bonded with two 4/0 B. & S Neptune pin bonds, the usual cross and intertrack bonds being provided.

The overhead equipment is on the span-wire system, a double line of trolley wire being used throughout. The standards are made up of solid-drawn weldless steel tubes, and have an over-all length of 28ft. They are set 6ft. deep below the upper surface of the rails, the excavation being entirely filled with concrete. The trolley wires consist of hard-drawn copper ·364in. diameter, with a breaking strain of 23 tons per square inch. Section insulators are provided, so that each half-mile of trolley can be controlled separately if required. Lightning arresters of the Garton-Daniel type have been provided at every half-mile of route.

The feeder system, which is a somewhat elaborate one for an Eastern tramway, consists of solid soft-drawn copper wire, carried on special high-resistance toggle-clamp insulators, which are in turn bolted to substantial malleable iron brackets attached to the poles. At several points along the route of the tramways these feeders are tapped by

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insulated cables, which are connected to the main feeder switches in switch pillars fixed on the sidewalk, in a manner similar to what is used in underground feeders.

The rolling-stock consists of 24 electric motorcars of the single-deck, open, cross-bench type. They have all the very latest improvements, and were built for Dick, Kerr, and Co., Limited, by the Electric Railway and Tramway Carriage Works, Limited, Preston. Special care has been taken in designing the cars to ensure the interchangeability of all the important parts entering into the construction of the rolling-stock; the car bodies are 35ft. 4½in. in length, and about 6ft. wide, and are designed to provide seating accommodation for 48 passengers. The floor frames are built of well-seasoned teak in combination with steel sections of such members and sizes as to ensure maximum strength and minimum weight. Openings are arranged in the frame over the motors to afford convenient access to the armature brushes and to all bearings requiring frequent inspection and oiling. The platform floor frames are formed of teak timbers, extending under the main floor frame as far as possible without interfering with the clearance of the trucks, and project out from each end sill 3ft. to provide room for the brake shaft and controllers. Teak end bars are secured to the outside ends of these timbers, forming sills, to which the platform dashes and the entrance steps are secured. The main floor is laid with ⅞in. matched teak boards, and secured at all bearings with barbed wire nails. To prevent the car from sagging, a substantial truss is provided, supported in the centre by two wrought-iron standards. The roof frames are composed entirely of teak, the covering being of cotton duck, laid wet in a coat of white lead paint. Storm curtains are provided for each side entrance of the cars, sliding in grooves between the post. The dashes are made up of No. 16 B.W.G. steel plates, furnished with substantial iron rails and wrought-iron post. The collision buffers are made up of 3ft. by 5in. steel angles, and are secured to the ends of the platform to protect them from injury in case of accidents. These are slotted, and pins provided to enable hauling of cars in case of emergency. Each car is provided with two circuits of 100-volt incandescent lamps, with change-over switches for putting one or the other headlight in circuit.

The trucks upon which the cars are mounted are of the Brush Company's single type; they are suitably built to support the car bodies and to receive the motors and gearing. The cars are fitted with a complete set of electrical equipments, each set consisting of two of the well-known Dick-Kerr standard 25B traction motors, capable of delivering approximately 28 h.p., the temperature of the various parts not exceeding 75deg. C. after running at full load for one hour. The controllers supplied with the electrical equipments are of the same firm's standard D B 1 form, C type, especially arranged with resistances for emergency braking, operated by the driving handle, which may be utilised either when the car is proceeding forwards or backwards. The power-house has been erected on the company's site in Seventy-Eighth-street, together with the necessary offices, car-shed, and repair shops. The steam plant consists of three Babcock and Wilcox water-tube boilers, with a working pressure of 160lb. per square inch; each boiler is provided with a steam superheater fitted with all the usual accessories, a water storage tank with a capacity of 20,000 gallons of water, a fuel economiser, and two double-acting single-cylinder feed pumps, each capable of delivering 2,000 gallons of water per hour.

The engines, which are three in number, are of the well-known Belliss compound two-crank type, mounted on bed-plates extended to take the direct-coupled generators. Each engine is fitted with a heavy flywheel and steam separator, and is capable of giving a normal output of 300 b.h p. when running at 400 revolutions per minute, non-condensing, with steam at a pressure of 155lb. per square inch at the stop valve.

The electrical plant consists of three continuous-current compound-wound generators, coupled direct to the engines, the output of each generator being 200 kw. when running at 400 revolutions per minute, and they are designed to give an overload of 20 per cent. for 2½ hours, with a moderate rise of temperature, current being developed at a voltage of 500-550. The generators are in every respect in accordance with the standard practice of Dick, Kerr, and Co., Limited, the magnet frames being of cast iron, the pole-pieces being built of laminated steel and cast into the magnet frame. The commutation is sparkless at all loads, and the field windings are so arranged to give a 10 per cent. rise in the E.M F. from no load to full load. The switchboard was built by Dick, Kerr, and Co, Limited, and consists of nine black enamelled slate panels 1½in. thick, each supported independently on an iron frame. The board consists of three generator panels, four feeder panels, one station lighting, one Board of Trade panel. Each generator panel is provided with two single-pole switches, one being on each panel; one equalising switch to connect the shunt of the compound-wound dynamo on to the equalising omnibus bar; one shunt field rheostat to enable the E.M F. of the generator to be raised and lowered 50 volts; one field switch with resistance and pilot lamp; one main ammeter; an automatic circuit breaker with magnetic blow-out. Each feeder panel is provided with one main single-pole switch; one automatic circuit breaker; one ammeter. The testing panel has mounted on it all the necessary instruments and switches for recording or measuring the leakage taking place. Also recording voltmeter for recording the difference in potential between the terminus ends of the rails and the negative omnibus bar. The station circuit panel is mounted with all the necessary switches and fuses, together with ammeters required for the station lighting and motor circuits.

One of Higginbottom and Mannock's 10-ton engine-room travelling cranes for a span of 38½ft., with a lift of 20ft., has been erected in the power-house, the lifting longitudinal and transverse traverse being worked by chains from the engine-room floor.

The contractors for the whole of the work and plant were the well-known firm of Messrs. Dick, Kerr, and Co., Limited, represented in Mandalay by Mr. T. Williamson. The sub-contractors were Messrs. Nahapiet and Martin, of Rangoon. The consulting engineers for the work were Messrs. Kincaid, Waller, Manville, and Dawson, of Westminster, who prepared the detailed plans and specifications, and were represented in Mandalay by Mr. E. Sellon. The local work was carried out under the able superintendence of Mr. Griffin and Mr. A. C. Morgan.

MUNICIPAL TRAMWAYS ASSOCIATION OF GREAT BRITAIN.

LIVERPOOL CONGRESS

Presidential Address.

BY MR. C. R. BELLAMY, A.M.I.C.E.

My first duty, and a very pleasurable one, is to thank the members of this association for the honour conferred in electing me its second president. It is customary, and perhaps convenient, for the president's address to immediately succeed his election. Circumstances over which I had no control rendered it impossible for me to attend the first conference of the enlarged association at Glasgow in July last, to do honour to our first president, Mr. Young. Had I been present, I should have felt inclined to suggest that our good friend should have held the office until the Liverpool meeting, an arrangement which would have imparted to my address to-day the perhaps more fitting and congenial flavour of the inaugural presidential address, rather than the valedictory discourse of one relinquishing a pleasurable and distinguished position.

Recognising the importance of the position to which you were good enough to call me, I have from the outset done my best to maintain and enhance the usefulness and prosperity of the association. Primarily affiliated in membership for the betterment of tramway interests and for the cultivation of the social instinct which, notwithstanding our toilsome lives and incessant worries, survives in very vital force, we are invariably animated by the consciousness that the central objects of our official existence are the public weal and advantage, and there is not among us one who

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holds or works to any other belief, save the one essential that the interests of managers and the public in municipal tramways are mutual, and act and react one upon another. Efficiency, always with due regard to economy, in tramways management is the indispensable handmaid to public convenience. Acutely mindful of this, the ideal which our association inculcates in its members is just that efficiency of administration and service which accounts for the greatest public benefit in the realm of street travel.

May I be permitted, as its mouthpiece for the moment, to claim for the association the extension to members of municipalities as well as managers such ever ready help and direction as cannot be secured through any other channel. With interests so obviously mutual you will, I am sure, be prepared to agree that any subject or scheme paraded for consideration should appeal with equal force to the civic representative as well as the manager. Hence it is needless for me to apologise for bringing before you now, not as the critic, and certainly not as the dogmatist, but necessarily in a more or less cursory way, though with a very earnest purpose, one or two of the topics affecting tramway interests, wide and general in their scope, which may form reasonable matter for careful thought.

As a preliminary, it is perhaps well that I should refer to the progress and work of the association during the year. Since the Glasgow conference 11 corporations and 13 officials have been added to the roll, the association now numbering 56 corporations and 71 managers or their assistants. This indicates that practically all the municipal tramway undertakings of the country are allied with us, a circumstance upon which we are reasonably entitled to congratulate ourselves. The standardisation of tramway accounts, which was referred at the last conference to a joint committee of the Institute of Municipal Treasurers and Accountants and this association, has been pushed forward with the vigour and care which the importance of the subject demanded. As a result of conferences held at Nottingham and Bradford, a form of accounts has been evolved which it is hoped will meet the requirement of enabling a fair comparison to be made of the working results of comparable undertakings. The initial difficulty appeared to be to bring into line for the purpose those undertakings which generate their own electricity with those purchasing from another source, chiefly owing to the impossibility of dealing with capital charges in the revenue account. The trouble has been overcome by providing a supplementary statement setting forth the total energy costs in the case of self-contained undertakings, which will be comparable with the purchase price of the others. The vexed question of differential depreciation has been left entirely open by carrying the balance from net revenue account to an appropriation account, where, after satisfying mortgage loans and sinking fund charges, any balance is allocated either to "reserve or renewal fund," or to "relief of rates." Mr. Dalrymple, who introduced the subject of standardisation at our last conference, will at a later stage to-day give you a more detailed description of the form now submitted for final approval, which will doubtless be most interesting and useful.

In May last the managers' section of the association had a meeting at Bradford, where we were met by the mayor, and entertained most hospitably by the Tramways Committee. The conference was of the nature of a family gathering, where there was no "chiel amang no takin' notes," and we discussed our failures freely, as well as our successes, and exchanged experiences on a variety of topics of everyday interest, with great advantage to all.

The municipalisation of British tramways is making steady progress, about 215 additional miles of tramways having been applied for during the present session under an estimated cost of over £5,000,000, and provisional orders have been granted for about 34 miles, the estimated expenditure amounting to £307,380. There is evidence of a better recognition of the principle underlying the early action of some of the large towns in arranging to acquire or operate the tramways of small adjacent authorities. It is increasingly clear that unity means strength and makes for success in tramway operations, and that what could not be obtained in small self-contained concerns is readily secured under a combination extending the obvious advantages of a large undertaking over the whole of the area administered. In this connection the subject of through running becomes increasingly important, because where combination or absorption cannot be arranged between adjoining districts, it will have to be considered. The convenience of the public must always be placed in the forefront of traffic considerations, and just as the railway companies had to arrange through running very early in their history, so it is becoming a necessity with the ever-extending systems of tramways, and it is desirable that this should be recognised, and the principles controlling it settled by municipalities while their position for purposes of negotiation is strong. In many cases where adjacent local authorities have failed to amalgamate for tramway purposes or link their systems, company promoters, recognising the necessity, have stepped in to provide the required connections. Thus, in the case of our own county, the South Lancashire Company has connected or obtained authority for connecting 28 of the principal towns, bringing into one vast network Liverpool and Manchester, which in turn is rapidly linking itself with an equally important combination of the principal towns of Yorkshire. It is unfortunate that the municipalities concerned do not control all these lines. Under a system of joint municipal ownership and more centralised management their usefulness would be enormously increased. There are many important reasons why the work of tramways should be largely extended. There are considerations apart and beyond the immediate benefits to the public that would follow.

The safeguarding of the financial stability of our undertakings must be considered. It must have struck the student of municipal tramway administration throughout the country that there is a tendency under periodic pressure to make unsound concessions. The returns for last year disclose the grave fact that nearly a dozen municipal undertakings ended the year with a deficit. It is probable that in most of these cases satisfactory results would have been obtained if routes, stages, and fares had been arranged on a basis suitable to the particular district concerned, rather than framed in an attempt to imitate those of large towns, where continuous streams of point-to-point traffic alone render them possible. In the large towns there are also signs of danger ahead.

Great benefits have accrued under municipal control. Routes, service, and speed of cars have been largely increased, with a reduction in many cases to less than one-half the fares under horse traction. A few years ago a house in the suburbs was regarded as in an eligible position if it were within 10 or 12 minutes' walk of a railway station, with a quarter or half-hourly service. To-day the tramways are within a few minutes' walk of everyone's door, with a practically continuous service at all times of the day, and nearly all night, throughout the year, and prudence suggests that further concessions should be sparingly accorded until systems are consolidated and their financial stability finally secured. It is, however, difficult to obtain proper recognition of these requirements, and we all experience the well-nigh impossible task of resisting at certain periods of the year proposals which are fraught with grave danger. The halfpenny stage, the penny universal fare, the all-night service, the season ticket, a multiplication of adjacent parallel routes, and lately farthing fares for scholars, are all questions of most serious importance, which, if carelessly dealt with, may at any time lead to disastrous results, and the obvious danger underlying them should suggest the advisability of increasing the sources of tramway revenue in directions less subject to popular attack.

It will be remembered that the Tramways Act of 1870 provided for a general merchandise traffic, and while this class of business under company control has been practically ignored, it is probable that with interurban connections and joint municipal control it would become a very useful source of additional revenue as well as a great boon to important sections of the trade of the country. It is satisfactory to note that the carriage of parcels has already been taken up on nearly one-half of our tramway systems. For many years it has been apparent that some better method of collecting and carrying the agricultural and

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varied produce of the districts surrounding large towns has been necessary beyond that provided by the railways, which cater almost exclusively for the traffic between the large centres. Considerable areas are wholly without any form of carriage other than the horse vehicles—in fact, the abandonment of the canals of the country, largely as a result of their purchase by the railway companies, has reduced the distributing network. This was made clear in the evidence tendered to the Royal Commission on Agricultural Depression in 1895 to 1897, when the Light Railway Act was offered as a possible solution of the difficulty. Under this Act the Treasury was empowered to make loans for the construction of light railways and free grants where the construction of such railways would benefit agriculture or connect fishing harbours with a market, or for the development or maintenance of some definite industry. During the first seven years of the operation of this Act 257 applications were sent to the Board of Trade for confirmation, the length of line being 1,638 miles, and the estimated cost £12,150,447; but these were largely for passenger tramways, which I do not think were contemplated under the Act, and, therefore, towards the construction of these lines the Treasury has only assisted to the extent of £250,000 by loan or free grant. The object of the Government in passing the Light Railway Act was avowedly in the interest of the small agriculturists and traders carrying on business at distances from the railway which excluded them from the markets of the country.

The recommendations of the committee on which the Bill was framed were mainly on two points—the cheapening of the methods of obtaining parliamentary powers, and the relaxation of the Board of Trade requirements. The Bill proposed to commit the authorisation of light railways to county councils and county boroughs. The committee reported that they had given special attention to the case of light railways in agricultural districts, and had also considered tramways in rural as well as urban districts, and pointed out that the powers then existing had not been availed of in the case of light railways owing to the consent of the railway companies being necessary, and to want of latitude on the part of the Board of Trade, and, in the case of tramways, in consequence of the local authorities requiring conditions which were considered too onerous.

The committee considered that impediments to construction might be greatly diminished, and that on a large portion of the lines contemplated regulations which had been previously enforced might be considerably relaxed. It was considered that the newly-formed county councils and county boroughs might be vested with powers of authorisation, which it was assumed would be exercised with due regard to the existence of local control and responsibility. With these changes it was thought that the initial cost of construction and the expense of working would be so greatly reduced that many light railways and tramways would be constructed to the general advantage of trade, and especially to agricultural districts without any satisfactory means of transport.

The Light Railways Act has failed for two principal reasons: firstly, because the authorisation was not transferred to local authorities; and, secondly, largely consequent upon the first, local authorities have not attempted to provide the railways. Market gardening, including fruit-growing and dairy work, are carried on profitably within easy cartage distance of any large town, but beyond a radius of a few miles from such centres heavy cartage and railway terminal charges, coupled with the unavoidably delay attending transhipment in transit, render these industries unremunerative. Declining agriculture has led many of our legislators to consider the problem of dealing with the production in this country of fruit, vegetables, and dairy produce which our climate favours, and which is at present largely imported. Their production at home would take a large amount of labour back to the land, which for present bulk crops is principally operated by machinery. The imports of food stuffs capable of being raised at home amounted in 1903 to the amazing total of £43,752,162, made up as follows—viz.: butter, £20,798,707; cheese, £7,054,710; eggs, £6,617,599; apples, £2,781,643; cherries, £167,142; gooseberries, £28,444; grapes, £715,057; pears, £326,463; plums, £622,268; strawberries, £49,362; honey, £30,349; milk (fresh), £1,062; onions, £1,003,016; potatoes, £2,603,238; tomatoes, £953,102. Competent authorities have persistently asserted that the bulk of this produce could be profitably raised in this country if it were possible to convey it cheaply and expeditiously from the producer to the consumer.

The only attempted solution of this problem was the effort to promote the construction of light railways, which, by reason of their cheaper construction, would, it was hoped, provide a network of mechanical carriage of great flexibility capable of dealing with a traffic that the railways do not, and cannot, cater for. An American has said in describing a tramway goods system that it was as flexible as an elephant's trunk, and quite as capable of picking up small things, and that it could flourish on the crumbs that a steam railway would despise. It is this power to pick up small things over large areas expeditiously, cheaply, and frequently which the railway companies lack, and for which they should welcome us as allies. The ever-increasing network of municipal tramways, with their connecting links, might quickly provide the whole country with a system cheaper in operation than was contemplated under the Light Railways Act, which would do much under proper recognition of its capacity to largely increase the trade and revenue of the country. There can be no doubt as to this in the minds of anyone who has had an opportunity of seeing what has been effected in America in connection with interurban tramways. The manufacturer there has no difficulty in selecting a cheap and suitable site for building, as an inexpensive tramway siding to his premises connects him practically at any point with the gathering and distributing systems of the country. Agriculturists are largely benefited, cheap and rapid transit between the land and the town for more remunerative produce is secured, and where large systems such as Detroit, Cleveland, Toledo, and Buffalo have got well under weigh, it is clear that large and general benefits ensue, and no interests are adversely affected.

It was at one time thought that goods traffic on tramways would interfere very largely with the revenue of railways, but it is found that tramways make a business peculiarly their own, while aiding largely in the development of railways. In the towns referred to, industrial life appears to follow the interurban tramways, and the land has been put to far more profitable use. Beet sugar factories have been erected in positions which would have been quite impossible but for the tramways, which ramify into the district, collect the beet and convey it to the factory, and take the manufactured article from the factory to the steam railways with which they are connected. Fruit-growing over a largely widened area is becoming highly remunerative. Suitably arranged cars are run into the heart of the country at various points, where the freshly-gathered fruit is collected and carried on trays on adjustable shelves right into the town markets, where it is on sale within two or three hours of gathering from a distance of 20 to 30 miles. In these towns the rail and tramway companies are working with the utmost harmony, their systems are connected, and often a number of railway cars are taken from the steam roads over the tramways by electric locomotives from point to point in the city to the great advantage of traders, who, by this means, secure much earlier and cheaper delivery. I believe there is great scope for such a development of tramways in this country. With the provision of such a system a farmer would be able to place his produce on a car always within easy cartage distance of his land, with a certainty that it would be promptly delivered into the market of one of the adjacent towns, whither he could accompany it for a few pence. Traders and manufacturers could obtain or send light consignments of goods at any time under short notice to the connected towns, railways, or docks. They could replenish their supplies from the markets or cold stores by telephonic order practically in a few minutes, and the experience of America that such traffic on tramways assists rather than injures railway companies would be demonstrated in this country.

Coming nearer home, the Belgian light railways may be referred to. These lines are independent of the main lines, but in connection with them, and are light rural railways running alongside or on main roads. Generally

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they are from two to thirty miles in length in the neighbourhood of most of the principal towns. About a quarter of the capital is furnished by the State, another quarter by the provinces, and the remainder by the National Light Railways Society, which is nominally a private company, but is practically controlled by the Belgian Government. Agricultural, dairy, and general produce is carried at very low rates, milk is taken for distribution free of charge, and empties are returned free. It is stated that these railways have been a great success, and the maximum interest of 4½ per cent. paid. A similar system is in operation in Italy and other parts on the Continent; indeed, every country in Europe, with the exception of England, is doing all it can to develop light railways for the benefit of the vast areas of land untouched by railways.

I may refer to a letter sent some time ago by the Belgian Minister of Agriculture to the local government of the various provinces of the kingdom enclosing a circular issued by the National Light Railways Society. It contained the following statement—viz.: "I beg to direct your special attention to the exceptional importance of the work that the National Society is charged to conduct to a successful end, and to the great services which it can render to the country. The society comes at the precise moment in the middle of the serious crisis which weighs upon agriculture, industry, and commerce—in a word, on all the sources of the prosperity and wealth of the nation. It will be able to contribute largely to diminish the intensity of the crisis, if it is well understood, and wisely made use of. The Government will do everything in its power to encourage the construction of these new methods of communication. For years past the spirit of enterprise and progress has directed itself almost exclusively to the extension and improvement of main lines of railway. It is true that the number of roads and canals has been increased, and that their construction has been improved, but there have been no changes, or almost none, in the manner in which traffic is conducted on these lines of communication. Old-fashioned wagons continue to travel on the high roads, and whereas the price of carriage for long distances has enormously decreased, it costs as much, if not more than it did half a century back to cart a load of wheat. It is the function of light railways to improve this state of things. Constructed, as a general rule, on the existing roads, and, in consequence, more economically than main railway lines, operated with utmost economy, and by means of cheap rolling-stock, they will furnish the people with the means of transporting their products at the lowest possible price. By means of their junctions with the main railway lines, they will render access to them more convenient both for passengers and for goods. They will assist communication from village to village, and from the village to the adjacent station. They will call into being new industries and increase the prosperity of existing industries by affording them new outlets for their products. Finally, they will enable the farmer to procure at a cheap rate the fertilisers necessary to enable him to face foreign competition, and by the low cost of carriage will open to him the markets of his own country as well as those abroad. For many places, deprived, as it seemed, for all time of railway communication, these light railways will furnish an opportunity unhoped for, and possibly the last, of escaping from their fatal position of isolation."

Again, the German Minister of Public Works, on moving the third reading of the Light Railways Law in the German Parliament, stated: "Elsewhere the construction and working of similar light railways have proved a blessing to the country. A traveller to-day through North Italy, through Belgium, and through Holland, can satisfy himself what a blessing these light railways have been. It is as though irrigation canals had been carried through the fields, and everything was growing and flourishing under their fertilising streams. In North Italy, in particular, the blessing which they bring with them is so obvious that even the casual tourist can hardly fail to notice it." Mr. George Lambert, member of the Royal Commission on Agriculture, stated: "The killing competition that now exists in such produce as cereals forces farmers to rely on products of a more perishable, therefore of a less competitive, character. To get these products quickly to the consumer, rapid, cheap, and easy transit is essential, which it would be an enormous benefit to secure."

The municipalities, acting in concert with county councils, have an opportunity of providing a system of light railways by making the most effective use of the public highways, which would render it possible, in addition to other obvious benefits, to produce in our own country the £40,000,000 worth of foodstuffs annually which are at present imported, and would thus confer both upon producer and consumer immeasurable benefits, which should secure to our tramway undertakings the success which has followed the adoption of this class of haulage on the Continent, where, by the cheap concentration of produce and combined bulk forwarding, it has been placed on the English markets under lower transit cost than can be secured by the British farmers operating within 20 or 30 miles of the same market. After studying the evidence given before the Royal Commission on Agricultural Depression, I feel satisfied that farmers and landowners would join with the county council in affording, as far as possible, necessary facilities for the widening of roads, and the provision of common collecting and distributing depôts which might be found necessary.

I would suggest that this association might effectively demonstrate its general usefulness by preparing a memorandum of a scheme for facilitating the provision of interf urban tramways, in conference with the representatives o county councils, for consideration by the Minister of Agriculture. It is not too much to hope that the Government might be induced to accept the recommendations of the Special Committee of 1895 on Light Railways in connection with the amendment of that Act, which is now under consideration, which unfortunately were largely omitted in the present Act, and following the Continental practice of more generous assistance, preferably in the matter of road widening, enabling municipal and county councils acting in concert to provide a system of road carriage which would confer inestimable benefits on the whole community.

Cars: Their Equipment and Maintenance.

BY MR. JOHN ALDWORTH, GENERAL MANAGER, NOTTINGHAM CORPORATION TRAMWAYS.

"Cars: their equipment and maintenance," is undoubtedly one of the most important matters with which tramway managers and their staffs have to deal, as this is the actual and visible source from which the revenue of the undertaking is derived. The average passenger does not trouble himself about such matters as the design or equipment of the power station, and provided there is always sufficient power to run the car on which he is travelling, rests satisfied that everything there is as it should be; but let the car be not quite to his liking as regards accommodation, especially when asked to close up and make room for "just one more, please," or the temperature inside does not exactly suit his particular ideas on the subject, he is often very much in evidence; whilst, for want of something else to grumble at, he occasionally enlarges upon the way in which he would build and run cars if he had anything to do with the matter beyond, as he is fond of telling the tramway employés, "having to help to pay for them."

The subject is also a very large one, and no attempt will be made in this paper to treat it at all fully, as to do so would be to raise more points than could be reasonably dealt with in a paper of this description, or discussed in the limited time at our disposal. The writer, therefore, proposes to touch only upon a few of what he considers to be the most important features, and wishes it to be understood that his observations are chiefly a description of the methods in operation on the Nottingham system, the result of some 11 years' experience in the working of that and other electric tramway undertakings; also that it is not intended to lay down rules and regulations upon matters which have to be dealt with in accordance with the local or special conditions pertaining to each separate undertaking, but only to provide a basis for discussion and comparison with the methods in operation on such undertakings.

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Design of Cars.—Cars should be of a design and size most suitable for the safe and expeditious handling of the particular class of traffic to be dealt with. For the traffic in the streets of large towns single-truck cars carrying from 50 to 56 passengers are, in the writer's opinion, the most suitable. From the passenger's point of view it gives a more frequent and a quicker service, whilst from an operating point the car is more easily handled, and can work its way through the ordinary traffic of the streets with much less risk of accidents. For dealing with a long-distance and varying traffic over suburban lines, the large bogie car carrying from 80 to 100 passengers has its advantages. Of the reversed and the ordinary type of staircase, both have their advocates. For ensuring the safety of passengers, protecting motormen and conductors from the vagaries of the English climate, and utilising all the space possible for seating accommodation, the reversed type is undoubtedly the best, the chief drawback being that it to some extent obstructs the motorman's view of the traffic on one side; the writer has overcome this difficulty by inserting a small sheet of ¼in. plate glass in the riser of the staircase level with the motorman's head. This device has now been in use for a considerable time, and has proved very effective. The efficient ventilation of the car is one of the things that until quite recently has not had sufficient attention devoted to it, and many of the earlier cars leave much to be desired in this respect. To remedy this defect as much as possible, the writer has had the four corner side ventilating windows, which were originally hinged at the bottom, pivoted vertically at the centre, so that the end of the ventilator nearest the platform swings outward, and the other end inward, thus giving two openings on each side of the car, through which a supply of fresh air is admitted at the front, above the passengers' heads, the foul air being forced out through the two corresponding openings at the rear end. The size of the openings can be regulated according to the state of the weather. With cars having rheostats fixed inside under the seats the question of ventilation becomes still more important, and for this reason, if no other, the writer considers all rheostats should be fixed in some outside position. A folding step is being given a trial in some towns. The writer, however, is unable to give particulars of this device, but hopes something will be said on this subject by the members present who have been trying it. The writer does not propose to touch upon such controversial subjects as top deck covers, dry seats, wind shields, route indicators, and lifeguards, which for some time past have been so much in evidence.

Motors.—To ensure a satisfactory service, it is necessary that cars should be equipped with motors designed to meet the varying conditions of the particular system they have to operate, and be capable of developing sufficient power to enable them to climb the steepest gradient thereon without being unduly overloaded, as, although the initial cost may be lower and the average consumption of current per mile kept a fraction less, with a smaller motor, the additional cost of repairs will more than counterbalance this, to say nothing of the extra risk of breakdowns on the road, with its consequent interruption of traffic. Given a properly designed and sufficiently powerful motor, the important thing is to see that it is well taken care of. This can only be done by having it systematically inspected, and maintained in its most efficient condition. The writer has tried several methods of inspection and reporting upon the condition of the car motors, also of carrying out the repairs, and the following system has been adopted as a result thereof. The commutators, brushes, and brush springs are examined nightly, and where any commutator shows signs of undue sparking or heating, it is carefully examined by the night foreman, and if no cause for it can be discovered, it is cleaned and the car again put into service; instructions are given to the chief motor inspector to test the car on the road during the following day, and if then found to be working unsatisfactory in any way, it is sent into the works to be thoroughly tested and the defect put right. Armature and motor bearings, with their lubricating boxes, are also examined nightly, and any defect discovered is reported to the night foreman, who in every case uses his discretion whether such can efficiently dealt with by himself, or whether the car shall be kept in for it to be dealt with by the day staff. The writer has tried several kinds of white metal for lining motor and armature bearings, also solid gunmetal armature bushes of different mixtures; the latter, however, are not being renewed, but when worn down are bored out and run up with white metal, instead of being scrapped. This has been found to answer well, besides effecting the following saving in the cost of renewals under this head: gunmetal bushes for one armature, including boring and turning, after allowing for their scrap value, 18s. 1¼d.; boring out old bushes, filling with white metal, and boring, 5s. 8d.; each subsequent relining and boring, 1s. 8d, or a difference of 16s. 5¼d. in favour of white metal lining. The average life of the gunmetal bushes has been 25,086 miles, and that of the lined bushes practically the same. A further advantage is found in the fact that, should a bearing run hot, there is not the same danger of the shaft being scored with white metal as is the case with gunmetal. A metal is now being tried for lining, composed of three parts virgin spelter to one part block tin, which is considerably harder than any other white metal tried. This has not been in use sufficiently long to enable particulars to be given of the mileage to be obtained from bearings so lined; but so far they have given good results, the journals being in excellent condition, and the writer has no hesitation in saying they will give a considerably increased mileage. Armatures, field coils, and leads are thoroughly examined, tested, and coated with insulating compound, also commutators turned up, if required, every time the car passes through the repair shops for overhauling the bearings. The writer believes that considerable advantage would result from having commutators ground true instead of being turned up in the lathe, and is now experimenting in this direction. The condition of the armature bearings of each car is determined at least once a month by the night foreman, who tests the clearance between the armature and bottom fields, for which purpose he is provided with a set of steel feelers, numbered, and varying in thickness from $\frac{3}{16}$in. to $\frac{1}{32}$in. The exact clearance of each armature is recorded and sent to the works superintendent, who decides when it is necessary for the bearings of a car to be renewed. After being repaired, each armature undergoes an insulation test, and before being put under a car it is also tested at full load by being run for a period of 15 minutes in either direction. This shows up any defects in the repairs, and ensures it being in perfect working order when again put into service.

Controllers.—Controllers are all examined at the end of each day's work; all contacts are cleaned and thinly coated with vaseline, also adjusted or renewed as found necessary. The whole of the inside is kept perfectly clean, and the parts which require it are periodically coated with insulating compound, with the result that it is a very rare thing for a controller to give trouble.

Automatic Cut-outs.—These appliances from time to time gave considerable trouble on the road, and it was found advisable to calibrate them every time a car passed through the shops for overhauling. This has effectively dealt with that particular trouble.

Trolleys. — All trolleys are examined daily, whilst the poles are also tested for tension, and adjusted (if found necessary) once a month. Experiments have been made with several kinds of trolley-wheel bushes, and one composed of solid graphite has been found to give the best results. The bush, wheel, and spindle, now submitted for your inspection, has run 5,762 car miles, and, although the wheel is nearly worn out, the bush and spindle are very little the worse. They can be put into, and will last the life of, a second wheel. The cost of the bush is 1s. 2d., compared with 1s. paid for the metal-cased graphite bush, of which two are required during the life of one wheel. The protection of passengers from electric shock is an important matter, and to ensure this as far as possible by the immediate detection of a leakage, ruby lamps are being used in the leakage circuit, so that they shall not be confused with the platform lamps. All leakage lamps and circuits, also lightning arresters, are examined and tested at least once a month. Some undertakings have had their cars fitted with a patent "trolley earth indicator," which consists of a short-circuiting switch, held open by means of a fine-

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wire fuse. This wire is connected in shunt with the switch, and as the whole apparatus is in circuit between the trolley base and earth, immediately upon the standard getting alive the fuse is melted and allows the switch to close by means of a spring. This connects the standard directly to earth, and causes an electric or mechanical bell to be set ringing.

Brakes.—The question of brakes is an important one on every undertaking, but where cars have to negotiate gradients of 1 in 11·5, and carry some of the heaviest rushes of holiday traffic over them, as is the case on the Nottingham system, it becomes a very important one indeed, and the writer considers that too much attention cannot be given to assure their being maintained in the highest possible state of efficiency. It is not proposed to discuss the merits or demerits of the various types on the market, but only to emphasise the importance of having motormen properly instructed in the best way to use the brakes at their disposal, and a systematic inspection and overhauling of such brakes by trained and competent men. Money so spent can be considered as a first-class insurance premium against accidents. All the cars under the control of the writer are equipped with either a mechanical or magnetic track brake, in addition to the ordinary ratchet wheel brake, all of which are carefully examined nightly, and the necessary adjustments or renewals executed. In addition to this, all the brakes of every car are examined and tested once a month under the direct supervision of the works superintendent or his chief assistant. A number of the cars are fitted with an automatic adjusting device for keeping the blocks set to the proper distance from the wheels. These are acting very satisfactorily, and effect a saving in labour. During the time the Nottingham electric system has been in operation—nearly four years—there has not been a single case of a car running away, which of itself fully justifies the great care that has always been bestowed upon this part of the equipment.

Wheels and Axles.—As to the vexed question of steel *versus* chilled-iron wheels, sufficient has been heard of this recently to excuse a comparison of their merits being entered upon in this paper. Like many others, the writer has been experimenting with steel-tyred wheels, but considerable difficulty has been caused by the flanges. Possibly this may be attributed to the fact that they have a large number of curves to negotiate. On one route of about three miles there are seven curves of a radius ranging from 45ft. to about 60ft. Very good results have been obtained from chilled wheels, some having run upwards of 45,000 miles, the average life being 34,124 miles, and in only one case has a pair been trued up in the grinding machine. We have a good permanent way, which doubtless accounts to a large extent for our comparative freedom from the troubles connected with broken axles and wheel flanges. For single-truck cars the tendency appears to be in favour of increasing the size of the axles. This is undoubtedly a step in the right direction, as a much larger diameter might be used with advantage, not only for the additional strength, but also to obtain a larger bearing surface. The writer is not in a position to discuss the question of broken axles, having had but one failure in 6¾ million miles run by the cars.

Inspection and Reports.—To avoid as far as possible breakdowns on the road, and for assisting motormen who might be in difficulties, a motor inspector is stationed at a point on the system where all the lines converge. Defects reported to him are dealt with on the road, or the car changed if necessary, and a daily report of all such cases is made by him. He is in direct telephonic communication with each depôt, which enables him to arrange for the changing of cars at the most convenient point. Definite instructions have also been given that under no circumstances shall a car be allowed to remain in service with its brake in the slightest degree defective. In addition to this, every motorman before going off duty enters in the report book at his depôt particulars of any repairs requiring attention, and attaches his signature thereto. These reports are compared with that of the motor inspector, and a return of all repairs executed during the night is handed in to the works superintendent each morning. The running condition of each car is tested periodically by the chief motor inspector, who himself operates it both up and down the heaviest gradient of the route upon which it is running, and the result thereof is also reported to the works superintendent. This has proved a very effective way of detecting faults and having them dealt with on the "stitch in time" principle, as the inspector being trained to look for defects, and able to compare the running of the different cars over the same route, is much better qualified to detect incipient troubles and express an opinion thereon than is the average motorman, whose reports are often misleading and require to be examined with great care. None but brake and trolley renewals and light repairs are executed at the branch depôts, all cars requiring other attention being sent to the works, by which arrangement the work is carried out under the most economical, expeditious, and efficient conditions.

Equipment of Repair Shops.—To deal with the repairs and upkeep in an economical and satisfactory manner, it is necessary that the shops should be equipped with up-to-date labour-saving machinery, testing machinery, and instruments; and for an undertaking operating from 100 to 150 cars using chilled wheels the following has been found adequate: In the fitting shop—a five-ton electric travelling crane, two lines of shafting (each belt-driven by a 10-h.p. motor), 10in. screw-cutting gap lathe, 6in. screw-cutting lathe with universal chucks, vertical wheel-boring machine, wheel-grinding machine, hydraulic press, radial drilling machine, small sensitive drilling machine, universal shaping machine, power hack saw, screwing machine, acme grinder, grindstone, moulding jigs for lining bearings, lifting jacks, and armature bogies, with various small tools as found necessary. In the armature-room—armature stands, wire drums with tension brakes, furnace, formers, taping machine, drying oven, testing machine, and insulation testing set. In the smiths' shop—two forges, anvils, swage blocks, set of levelling blocks, small power hammer, and "Roots" blower driven by independent motor. In the woodworking shop — line of shafting driven by a 5-h.p. motor, circular-saw bench fitted with boring apparatus, band saw, planing machine, mortising machine, and universal trimmer. The buildings should be constructed, and the machinery arranged, so as to avoid undue handling of the car and different parts of the equipment whilst undergoing repairs. Pits should extend the full length of each track, and communicate with each other; also be fitted with hydraulic platforms for removing wheels and axles from under the cars. To obtain the best results, all the shops should be concentrated as far as possible, have plenty of light and ventilation, and be provided with good heating and sanitary arrangements.

Cleaning and Painting.—As the amount of the painting bill undoubtedly depends largely upon the method of cleaning in operation, these two processes should be considered together. The writer is not sure that the cleaning ought not to be under the control of the foreman car painter, instead of the night foreman, being satisfied that considerable economy can be effected in the painting department by paying every attention to the methods of cleaning; besides which, a well-cleaned and smart-looking car is highly appreciated by the passengers, as well as being a credit to the undertaking. He has always had the cars cleaned with oil, and the amount paid in cleaners' wages is somewhat above the average of other undertakings, but as a number of cars have been in service nearly four years, and the outsides required nothing more than touching up and revarnishing, he considers this course is justified. The insides are kept clean with soap and water, and, with the top seats, are revarnished as required; whilst the top decks are given two coats of best oil paint at least once a year, to ensure their being kept watertight.

General.—To enable a check to be kept upon the repairs bill, which by its tendency to increase appears to be always trying to take a more prominent place in tramway matters, also to decide upon the best methods and materials to be used in connection therewith, full and accurate records should be kept of all matters connected with the running, inspection, and repairs of the cars; as only by a careful study of these can the many points coming under consideration be adequately dealt with. In conclusion, the writer wishes to say he is afraid there is very little new or of a

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substantial nature contained in the paper, but feels that comparisons of the methods of working, and also the operating expenses of different systems, are always interesting, if not conclusive. A manager whose system consists mainly of steep gradients has reason to feel envious of the low cost, to say nothing about the minimised risk of accidents, at which other systems can be operated whose routes are all practically level. Not only is the consumption of current much heavier with steep gradients, but the writer finds the cost of maintenance also increases in practically the same ratio. No conclusions, therefore, should be drawn from such comparisons without taking into consideration the many different conditions under which the undertakings have to be operated.

Overhead Equipment: Notes on its Construction and Maintenance.

BY MR. J. M. McELROY, GENERAL MANAGER, MANCHESTER CORPORATION TRAMWAYS.

The opinion has often been expressed that many modern inventions—of which our electric tramways systems may be considered a type—have to a large extent had the effect of subduing or rendering less active the æsthetic side of our nature and of bringing into greater and increasing prominence the utilitarian side. In the present "hustling" days it is urged that we have neither time nor inclination to appreciate those things which add to the beauty of our cities and towns, and that we appear to be perfectly satisfied with any modern invention, however inartistic, which brings with it anything in the shape of material advantages. The great benefits, therefore, which our tramways have afforded to the community in the shape of cheap and rapid transit have appealed strongly to the utilitarianism which characterises our modern civilisation. Notwithstanding its ornamental scroll work, tastefully painted poles, gilt finials and rosettes, by no stretch of the imagination can the forest of steel poles and the network of wires which we describe as the "overhead equipment" be considered an embellishment of our towns. It represents a condition of things in which utility absolutely predominates, and æsthetic considerations occupy a very minor place. So say the critics. But with all the objections urged against it, we—in the provinces at any rate—have been driven on economic and other grounds to adopt the overhead system as being the only one commercially possible at the present time. It is, therefore, desirable that we should consider and compare notes as to the best and most suitable methods of constructing and maintaining the equipment.

Points to be Observed in Erection.—The four principal points which ought to be observed in the equipment are: (1) its general stability; (2) its adaptability to the safe, reliable, and easy running of the cars; (3) its erection, so as to be the least objectionable from the æsthetic standpoint; (4) its erection, so as to reduce the wear and tear to a minimum. Each of these points requires careful consideration. Opinions differ as to their relative importance, as will be seen by the replies to the list of queries embodied in the report accompanying this paper.

Centre Running v. Side Running Trolleys.—The general types of construction adopted in this country may be divided into two—namely: (1) those adapted for side running trolleys, and (2) those adapted for centre running. Twenty-six towns have adopted the former and nine the latter type, and 10 have adopted both types. A glance at the replies will show that several towns which have adopted side running now express their preference for centre running lines. The reasons in favour of side running as opposed to centre running equipment are that (1) it is neater in appearance; (2) it is less costly to construct; (3) it is safer for passengers on the cars; (4) it is more easily adapted for running round curves and through junctions, etc. The reasons in favour of centre running as opposed to side running equipment are that (1) it is more flexible, and there is less liability of the trolley leaving the wire—in other words, it is more adaptable to the reliable and easy running of the cars; (2) the pressure of the trolley wheel on the wire need not be so great, and in consequence there is less wear and tear.

Centre-Pole Construction.—The principal reason which has led towns to adopt centre-pole construction is, I believe, that it is or can be made more artistic than span-wire construction. Opinions, however, differ widely as to the desirability from a practical standpoint of adopting this form of construction. It is urged that (1) it is not so elastic as span wire, and (2) the poles form an obstruction to the ordinary vehicular traffic. On the point of elasticity there can be no two opinions, but on the question of obstruction 17 towns report that they consider the poles *do* form an obstruction, and nine towns think otherwise, and, in fact, some urge that they tend to regulate the traffic. This question of obstruction is one which local conditions of traffic must largely enter into; also the width of the streets in which the centre poles are erected. In very wide streets, like Oldham-road in Manchester, which is in parts 72ft. between kerb and kerb, we have not found much to complain of in the way of obstruction, but in streets 35ft. to 40ft. wide the obstruction is apparent to those who drive about the streets.

Trolley Wire.—The size of the trolley wire adopted varies from 0 to 0000. It would be interesting to learn the reasons which led to the adoption of the several gauges. Several towns have adopted or experimented with phono-electric wire. It appears to be giving good results, but the replies indicate that it requires more careful handling during erection than copper wire. It is stated, also, that it has a higher resistance than copper wire. Some further information on this point would be interesting.

Automatic Frogs.—With the exception of Glasgow, and, I think, Aberdeen, who use fixed trolley heads and rigid frogs, all of us are interested in the subject of automatic frogs. From the replies it will be seen that experiments have been and are being tried with some amount of success in many towns. Samples of some of the frogs in use will be exhibited.

Lightning Arresters.—The principal lightning arresters in use are the Garton, the Wurtz, and the British Thomson-Houston. No trouble appears to have been experienced by the majority of the towns due to the arresters being burnt out and rendered useless. Cardiff, however, appears to have had difficulty in this direction, and this has been our experience, too, in Manchester.

Automatic Devices for Cutting off Current in Cases of Falling Wires.—The replies to the query as to the adoption of devices for automatically cutting off the current in case of trolley wires falling show that little has been done in this direction, and that nearly all the towns depend solely on the circuit breakers. In Oldham they have adopted a device described as follows: "Insulated guard wire connected to rails through a solenoid which trips the circuit breaker in the feeder pillar. An arrangement on the guard wire at each arm or span wire to make the guard wire alive if the trolley wire drops." In Leeds they have six poles fitted with Hall's patent mechanical ear, but up to the present these have not been operated. In Dundee a bamboo pole and piece of cable is carried on each car to make a "dead earth" in case of emergency. In Nottingham they adopted a patent short-circuiting device, which gave considerable trouble, and had to be discarded.

Anchoring of Section Insulators.—The question as to the best method of anchoring section insulators is one which ought to receive careful consideration. Several towns—Aberdeen, Sunderland, Leicester, Bradford, Preston, and Dundee—do not anchor their section insulators at all They consider it unnecessary. Many towns—principally those with side running systems—anchor vertically by suitable attachments to the bracket arms. Very few of those who anchor horizontally admit that they form a trap for the trolley.

Insulation of the Line.—To maintain the perfect insulation of the trolley line is an important matter. The replies show that several well-known makes of insulating material appear to be chiefly adopted. It is interesting to notice that double insulation is resorted to by all the towns except three. In Manchester we have adopted triple insulation throughout. In Wallasey they are adopting triple on reconstruction work, and in East Ham they adopt triple on

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the part of the line exposed to fumes from chemical works. Very few towns appear to have experienced any serious trouble owing to the failure of the insulation.

Inspection of Line.—Careful and constant inspection of the line is of paramount importance if we are to satisfactorily maintain the equipment and to prevent accidents. "Nightly," "daily," "weekly," "fortnightly," "monthly" inspections—these are the replies under this head from the various towns.

Standardisation of Various Types of Poles.—The replies to the query indicate almost a consensus of opinion in favour of the standardisation of poles on the lines suggested by the Engineering Standards Committee. In Cardiff, however, they prefer the single-section taper pole much better than the three-section telescope type, and in Glasgow they state that the dimensions of the poles as agreed upon by the Standards Committee do not suit their requirements in every respect. The recommendations of the Standards Committee are appended.

Pressure of Trolley Wheel on Wire.—It is claimed by some of the advocates of centre running trolleys that one of their advantages is that less pressure may be used by the trolley wheels on the wire. In actual practice we find that for side running trolleys the pressure varies from 18lb. to 32lb., and for centre running trolleys from 16lb. to 25lb., although many towns with side running trolleys are running at less pressure than towns with centre running trolleys. The pressure considerably affects the wear and tear of the equipment, and the figures given by the various towns indicate that this is a subject which ought to claim our careful attention.

Ears.—The type of ear adopted and the method of suspension has a most important bearing upon the wear and tear of the equipment. An ear which firmly supports the wire, and yet at the same time possesses no appreciable thickness, is the desideratum. The ordinary type of ear, which is clipped round the wire and soldered, is by no means perfect. No matter how well the ears are tapered, they cause the trolley wheels to "jump" to a greater or lesser extent each time they travel under them. The consequence is that the wire at the trailing ends of the ears soon begins to show signs of wear. It behoves us, therefore, to consider whether this defect can be remedied, and if so, how? Several types of mechanical ears are exhibited, and may prove of interest to members.

Guard Wires.—All guard wires we must assume are fixed and "earthed" so as to comply with the Board of Trade regulations. Some towns, however, "earth" them at less distances than the maximum prescribed by the Board of Trade. In only one town are the earth wires disconnected when linesmen are working on "live" wires.

Section Insulators, etc.—The general type of section insulator adopted is the air-gap. I have requested all our members who have adopted or experimented with any special type of section insulators, frogs, crossings, or other line material to forward me samples for exhibition at the conference.

Wear of Trolley Wire.—The wear of the trolley wire is an important matter, and some reliable data from the various towns would be valuable. In Liverpool we are informed that the life of their 0 wire is about five years. In Glasgow the records show that their 00 wire has a life of three years with a service of 2½ cars per minute. In Dover the reply is: "Portions of the 0 wire taken from curves near depôt had flattened near ears, and that at point of greatest wear, instead of a sectional area of ·082448 square inch there remained only ·054964 square inch after four years and two months with a six minutes' service and constant shunting operations." In Oldham we are told that the wire is wearing flat in the sides at the ends of the ears. In Cardiff, where they use 000 wire, they have found the wear very great in places, and renewals have taken place. In Burnley the experience is: "No appreciable wear in three years except close to section insulators." The Leeds experience is remarkable. Here they use 0000 wire, and on their oldest line, which has been in operation over seven years, and on portions of which there is a maximum service of 1½ minutes, the wear on the wire on straight line is imperceptible. The wear on curves is very slight, and will not necessitate renewal of the wire for a considerable time yet. In Bradford the wear on their 0000 wire is inappreciable. In Blackburn the oldest line is five years. They use a 0 wire, and the wear on straight track is very slight. In Dundee it is stated that up to the present no wear in the trolley wires is noticeable.

Motor Tower Wagons.—The adoption of motor tower wagons in lieu of horse wagons for emergency work is gradually taking place, and they appear to be giving satisfaction. Mr. Hamilton, of Leeds, states the advantages of the motor wagons very tersely as follows: We prefer a motor tower wagon for emergency calls for the following reasons: (1) Can reach scene of breakdown more quickly. This is especially the case on a long run. (2) It deteriorates horses to gallop two or three miles with a load approaching two tons, and then stand for a considerable time whilst the repairs are being executed. (3) There is always the possibility that, no matter how well trained, horses may start suddenly whilst the men are at work on the derrick; in fact, unless carefully watched they are very likely to be restive, as there is nearly always a crowd gathered where a breakdown has occurred.

Span Wire.—The action of the atmosphere on span wires, and the means adopted to prevent it, was inadvertently omitted from my list of queries. We in Manchester are finding that the atmosphere is seriously affecting our span wires, especially in one district, where there are a number of chemical works. We have used vaseline, and also several so-called "rust-preventing" mixtures, but nothing so far has been effective. It would be interesting to have the experience of other towns on this matter.

Working of Trolley Lines Separately.—In operating a tramway system, it is desirable from a traffic point of view that the trolley lines should be worked separately, and this appears to be the general practice. In the large cities, however, the practice appears to be to work in parallel the lines in the busiest routes.

Trolley Wheels.—Fixed trolley heads are in use in Glasgow and, I think, in Aberdeen. All the other towns, I believe, use the swivelling head. The principal objection to the fixed head is that it tends to produce greater wear and tear on the overhead work at curves. On the other hand, it admits of the adoption of rigid frogs, and that is an advantage. The swivelling head has been constructed in a variety of forms. This is one of the parts of tramway equipment upon which inventors have been particularly keen. I should not be at all surprised to learn that no two towns have adopted precisely the same type of trolley head. The samples exhibited show some of the varieties. For the same gauge of wire the grooves vary considerably. The make of trolley wheel and the groove adopted has an important bearing on the life of the wire, and daily attention ought to be given to the examination of the trolley wheels with a view to renewing those which have become worn. This has an important bearing on the life of the overhead equiqment.

Conclusion.—In conclusion, it is needless for me to point out that I have not attempted to deal with all the possible questions which could be raised in connection with the construction and maintenance of the overhead equipment. What I have done is to present to you some of the points which have from time to time presented themselves to me in the construction and maintenance of the Manchester equipment, and I trust they will lead to an interesting and instructive discussion.

British Standard Specification for Tubular Tramway Poles.

1. The poles shall be of mild steel, free of all defects, and shall be of three classes—light pole, medium pole, heavy pole.

2. The sectional poles shall be either solid-drawn or lap-welded wrought steel, free from all defects, made up in three sections, swaged together when hot so as to make a perfect joint. The lap-welded seams in the sections shall be set at an angle of 120deg. to each other. The taper poles shall be of wrought steel, free of all defects, rolled in one length and butt-welded the entire length. The butt-welding shall be carried out at an even temperature without overheating, and no pole shall show any signs of burning at the weld.

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3. The over-all length of poles of all classes shall be 31ft.

4. The length of the telescope joint in the sectional poles shall be 18in.

5. The length of the sections shall be: top section, 8ft. 6in.; middle section, 8ft. 6in.; bottom section, 17ft.

6. The outside diameters, in inches, of the three classes of both sectional and taper poles shall be

Sectional Poles.

Class.	Top.	Middle.	Bottom
Light	5½in.	6½in.	7½in.
Medium	6½in.	7½in.	8½in.
Heavy	7½in.	8½in.	9½in.

Taper Poles.

Class.	Top.	Outside diameter 9ft. 6in. from base.
Light	4⅜in.	7½in.
Medium	5⅜in.	8½in.
Heavy	6⅜in.	9½in.

7. The thickness of metal in any pole shall not be less than ¼in.

8. The completed poles shall be straight and true over their entire length to within ½in.

9. The section of any pole shall be as nearly circular as possible, not varying in diameter by more than $\frac{1}{16}$in. from the adopted standard.

10. Five per cent. of each class of sectional pole shall be subjected to the following drop test: The pole shall be dropped vertically, butt downwards, three times in succession, from a height of 6ft., on to a hard wood block 6in. thick laid on a concrete foundation, without showing any signs of telescoping or loosening of joints.

11. Five per cent. of each class of both sectional and taper pole shall be subjected to the following bending tests: The pole shall, in each case, be rigidly supported for 6ft. from the butt, and loaded, as a cantilever, 18in. from the top, the load being applied at right angles to the axis of the pole, which shall be fixed horizontally. Upon the application of the following loads in pounds, the temporary deflection and permanent set, measured at the point of application of the load, shall not exceed the figures stated in the tables.

Class of pole.	Load in lbs. for temporary deflection not exceeding 6in.	Load in lbs. for permanent set not exceeding ½in.
Light	750lb.	1,000lb.
Medium	1,250lb.	1,750lb.
Heavy	2,000lb.	2,500lb.

12. In the event of any pole of the above-mentioned 5 per cent. not fulfilling the test requirements, a further 5 per cent. shall be subjected to the tests enumerated above. Should any further failure occur, the whole parcel from which the poles have been selected shall be liable to rejection.

13. The maker, at his own expense, and to the satisfaction of the engineer, shall provide all the necessary testing apparatus at his own works for carrying out the above-mentioned tests.

BRITISH VERSUS FOREIGN JOISTS.

We have had complaints from time to time of the alleged apathy of the British manufacturer, and one of the favourite instances as showing the want of enterprise on the part of the British manufacturer was his inability to supply rolled-steel joists or beams. This trade was in the hands of the Belgians and Germans, and the steel joists or beams, while varying in quality and workmanship according to the maker, were usually of the "cheap and nasty" order.

When English engineers began to impose tests and inspection on Belgian iron joists the "reputation" of Belgian iron joists did not last long, and a year or two of experience with steel joists promptly killed the iron joist trade. To-day Great Britain has a number of steelworks all capable of supplying a full range of sizes of first-class rolled-steel beams. The complaint urged by engineers that in specifying English joists or beams they never knew the properties of the section, and were likely to be in the hands of one maker only, from whom delivery might be difficult to obtain, has disappeared.

Thanks to the laying down of properties of sections for British standard beams by the Engineering Standards Committee, it is now possible to get joists or beams from several works simultaneously, which enables stocks to be kept and prompt deliveries obtained from any girder merchant or manufacturer. But the British steelmakers, having given proofs of their enterprise in laying down mills and plant for the production of rolled-steel beams, may fairly ask the engineer and architect to encourage this enterprise by using the beam or joist shape freely in their designs, and by stipulating in their specifications that beams shall be of British manufacture. Something of this kind is necessary for two or three reasons.

First and foremost, the quality of British rolled-steel beams is always superior to that of any foreign make; secondly, the sections of British standard beams will carry a higher load per pound of metal employed than any beam of similar size of foreign make; thirdly, British steel beams are made by the Siemens-Martin open-hearth (acid) process, which is to to be preferred for all steel shapes where the best quality is wanted. Some steelmakers employ the Siemens-Martin (basic) process. Engineers, therefore, can indulge their fancy for steel made by the Siemens-Martin open-hearth process, leaving it to the individual maker to supply Siemens (acid) steel or Siemens (basic) steel.

At the present time there are not sufficient orders for rolled-steel beams to fully occupy one works, let alone all the various works who have suitable plant. It is certain that there is so much competition amongst British steelmakers, that no user to-day would be inconvenienced by having to wait for delivery or would fail to get low prices. The more British engineers stipulate for British steel beams to be used in their structures, the sooner will the steelmakers find out means of reducing their cost. To-day, however, the British engineer can include British beams in his designs with the certainty that they will be furnished at lower cost than is involved to the American engineer who confines himself to American steel beams; or to the German engineer who confines himself to German steel beams.

As a matter of fact, foreign engineers help their own countrymen in matters of this kind to a greater extent than is found in this country. Unless engineers specify for British material, there are always to be found second-rate producers of constructional ironwork, who will put in any foreign material if they can only gain a little more money than would be the case by using safe and reputable British steel. The ordinary builder, unless he is controlled, presses the girder merchant to supply him with something cheap, and the girder merchant buys and stocks, with a few rare exceptions, the cheapest material he can find.

The lists which are usually circulated showing the carrying capacities of foreign-made beams or joists are usually untrustworthy, and do not seem to be based upon safe practice or trustworthy working stresses. Where a man has a cheap job to do and wants English sizes and foreign material, it would be only prudent on his part to stipulate that the web and flange thicknesses and other properties of the section should be those of British standard beams. Furthermore, it should always be insisted upon that the steel shall be equal to a tensile breaking stress of from 28 to 32 tons per square inch, with an elongation after fracture of not less than 20 per cent. on original datum points, 8in. apart. If these things are insisted upon, a standard of quality and workmanship will be kept up, which is at present being lowered to the detriment of all those who like to see sound and good work.

THE MAGNETIC RESISTANCE OF AIR-GAPS.*

It is difficult in certain calculations to obtain even approximately correct results, owing to the unknown amount of the spreading of the magnetic lines passing between two pole-faces. The author has, therefore, had a series of experiments made on the simplest case of this

*Translation of an article by G. Benischke in *Elektrotechnische Zeitschrift*, Sept. 15, 1904.

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nature—viz, a flux passing between two parallel square pole-pieces with the exciting coils wound close up to the pole-faces (Fig 1). The faces of the coils were actually about 1cm. from the pole-faces, and the iron core was from 2mm. to 5mm. from the winding surrounding it.

Alternating current was employed for the measurements, as the determination of the flux is simpler with this than with direct-current excitation. The core was made up of

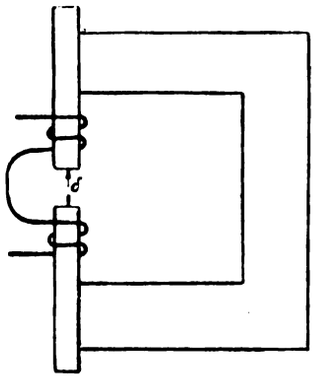

FIG. 1.

·5mm. iron laminations. The magnetic resistance, w_g, of the path is obtainable from the two following equations:

$$Z = \frac{E \times 10^8}{4{\cdot}44\, n\, N} \text{ and } Z = \frac{{\cdot}4 \times \pi \times I_m \times N}{w_g}$$

Z being the total flux, I_m the maximum instantaneous value of the magnetising current, N the number of turns, and n the frequency. The E.M.F. and the $\sqrt{M S}$ value, J_m, of the magnetising current are obtained by measurements of the terminal voltage, the watts absorbed, and the current. I_m is then obtained by multiplying J_m by the form factor of the current wave, which, in the case of a choking coil with unsaturated iron (B about 5,000) and comparatively large air-gap, is very nearly the same as the form factor of the E M F. wave. As the latter was sinusoidal, the form factor has been taken as 1·4

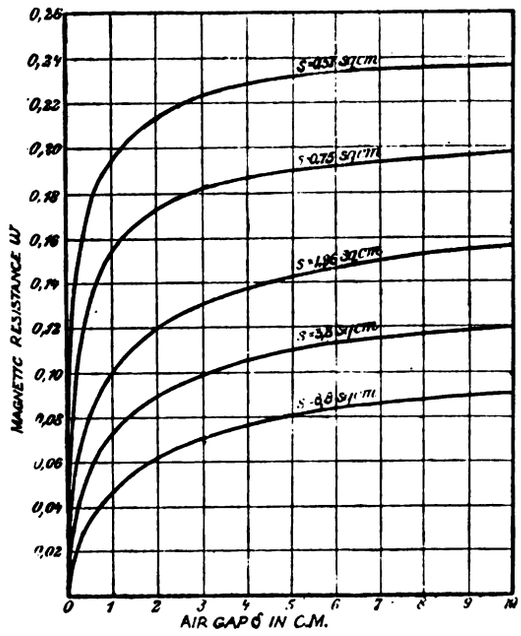

FIG 2.

The magnetic resistance of the iron path was in all cases subtracted from the total resistance, w_g, and in this way the curves of air-gap resistance, w, shown in Fig. 2 were obtained for pole-faces of the areas s = ·37, ·75, 1 96, 3·8, and 8·8 square centimetres respectively with different lengths of air-gap, δ. From these curves the equivalent air-gap area, S—*i.e.*, the area which the magnetic path would have if the lines were parallel and of uniform density—can be calulated from the formula $w = \frac{\delta}{S}$.

This has been done, and the result is shown in Fig. 3. It will be seen that these curves are approximately straight lines of the form $S = s + K\,\delta$, where s is the height at which the line cuts the ordinate axis for $\delta = 0$—*i.e.*, it is the actual section of the pole-face. The factor K, which is the tangent of the lines, is different for different pole-face areas.

The different values of K in relation to the pole-face are:

s	·37	...	·75	...	1 96	...	3·8	...	8·8
K	4·3	...	5·2	...	7·2	...	9 2	..	11·8

and these values are plotted in Fig. 4.

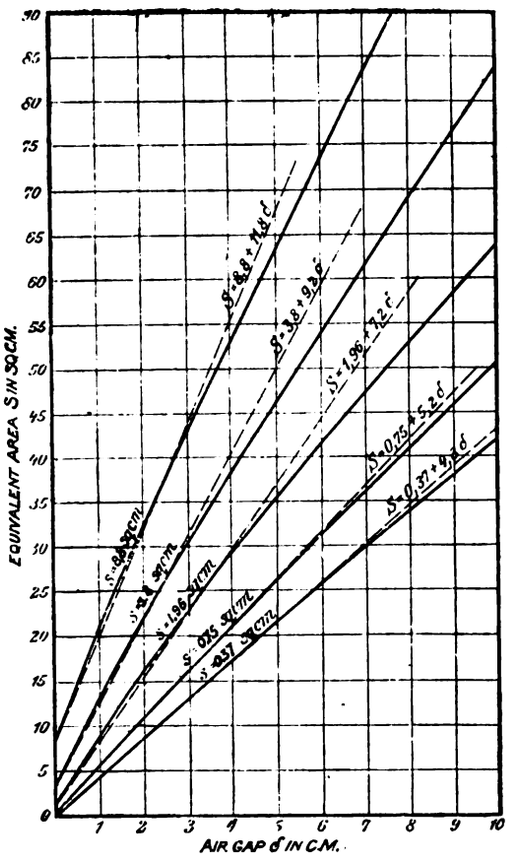

FIG. 3.

By means of these curves and the above equation it is possible to calculate the equivalent air gap area, S, up to an air-gap length of 8cm. in the case of the smallest pole-piece, and 4cm. in the case of the largest pole-piece, with fair accuracy.

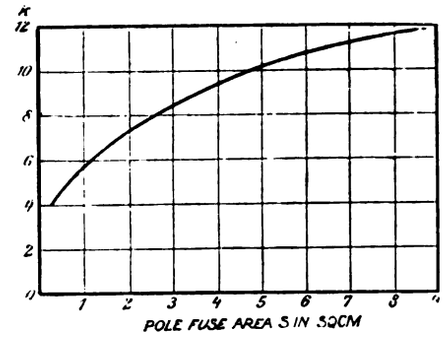

FIG. 4.

For greater air-gap lengths it would be necessary either to work out fresh values for the equation by means of Fig. 3, or to obtain the required value of the resistance by interpolation or extrapolation from the curves in Fig. 2.

The curves are equally applicable to circular pole-pieces, but are only approximately correct for rectangular ones with one side decidedly greater than the other.

The writer hopes to show the application of the above results to the calculation of the magnetic leakage in induction motors in a future article.

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TO CORRESPONDENTS.

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THE LATE MAJOR-GENERAL WEBBER.

We deeply regret to have to announce the death of Major-General C. E. Webber, C.B., R.E, who died on Friday last, having just completed his sixty-sixth year. The electrical engineering profession can ill afford to lose one by one the pioneers under whom so much progress has been made. Major-General Webber was in May of this year elected an honorary member of the Institution of Electrical Engineers. This election was a mark of the high appreciation in which the Council held the deceased member, and we hoped that he would be spared to enjoy the honour for many years. His sudden and, to us, unexpected death from angina pectoris ended an active and most useful life. For instance, it was only in our issue for Sept. 16 that we had a long letter from Major-General Webber on the organisation of the mechanical section of the British Association. We give elsewhere in this issue the list of the very numerous communications to the Institution of Electrical Engineers of which the late engineer was the author, and he contributed largely to the other learned societies also. When it is remembered that in practically every case he described for the benefit of the members and associates work actually carried out under his supervision, the extent of his experience as a pioneer in numerous branches of electrical engineers can be appreciated. When the first meeting of the Society of Telegraph Engineers was held in February, 1872, under the presidency of the late Sir William Siemens, Captain C. E. Webber, R.E, was already appointed a member of the council. Ten years later he reached the highest office in the then society—*i.e.*, that of president. A recent perusal of the presidential address delivered by Major Webber in January, 1882, affords a key to his whole professional life. In it he dealt with the true commercial principles underlying telegraphic advancement. He explained, for instance, that "the competition for efficiency in telegraph transmission is not international, as in the case of artillery, in which the work of one year's trial may have to be thrown aside and fresh expenditure undertaken because another nation has made an important advance. In telegraphs, what each country has to do is to keep up to the demands of its public life." He went on to describe the reason why the high cost of the typewriting telegraph instruments at that date prevented their general use as commercial instruments. He concluded that "technical societies are of more value in giving opinions on such points than international exhibitions." By the last expression was meant the judges' reports on international exhibits. Later on, in the same presidential address, the then Major Webber offered some virile criticisms of the defects in electric lighting as employed on her Majesty's warships, and gave practical advice as to the line in which improvements should be made. Speaking of the Society of Telegraph Engineers, which has since become known by the wider title of the Institution of Electrical Engineers, it was pointed out that liberal principles were the mainspring of such organisations. To quote Major-General Webber verbatim: "Whether in his desire to learn or to teach, each finds here a place where he can ventilate his ideas, so that he is often saved disappointment, annoyance, and expense by having them first subjected to the friendly criticisms of his fellow-members. In this lies the liberality of our society, that the platform of our qualification for membership and association is as wide as the field of application and use of electricity—a field which we are daily realising embraces all nature, on the margin of which our baby experiments have only as yet given us a foothold." The liberality so ably expounded in this address, delivered as long ago as 1882, has been the

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keynote of Major-General Webber's professional life. He was always ready to place at the disposal of others his technical experience. This, quite apart from the large amount of pioneering work carried out by him in telegraphy, electric lighting, electro-chemistry, and telephony, renders his death most deeply felt by all who were honoured by his acquaintanceship. His friends have a still deeper cause for regret.

"THE TRUTH."

It may seem strange to anyone on their first visit to a court of law that the form in which the oath is administered does not stop at the first clause, which binds the witness to speak "the truth." Instead of this it goes on to say that he shall speak "the whole truth, and nothing but the truth." We would commend this common form of oath to our contemporary the *Journal of Gas Lighting*. In its last two issues it has had a good deal to say on the Wood Green case, which was commented on in our leading article of Sept. 16. One of our electrical contemporaries commenting on the same issue that week expressed opinions which are diametrically opposed to our own. We are more concerned, however, with our gas lighting contemporary, who for the past two weeks has committed itself to statements that only one electrical paper gave special attention to the matter, and that this paper applauded the action of the Local Government Board. In its last issue the editorial comments on Mr. Hawtayne are supposed to be exceedingly stringent, and criticisms are made as to his estimate of the probable number of the lamp connections in Wood Green. Mr. Hawtayne, in these estimates, is well within actual results obtained in similar places, of which Ilford is one, as we stated in our leading article Our contemporary, however, accuses him of selecting his comparisons unfairly. It says: "It would have been more to the point if Mr. Hawtayne had referred to Erith, although that is, according to those capable of making the comparison, a far more favourable district for electricity supply than Wood Green. There is also some appropriateness about Erith, because it happens to be one of Mr. Hawtayne's own progeny, and it ended its last financial year with a deficit of £781. But though the undertaking is not in a position yet to make the income cover the outgoings, the Council are now involved in more capital expenditure on extensions, which will mean a further addition to interest and sinking fund charges." There is nothing that is not true in this extract, but it is not the whole truth. Our contemporary hides up the fact that the last financial year at Erith, which ended with a deficit of £781, happened to be the first financial year of a young undertaking, and that the deficit, after paying capital charges, amounted to £1,801. 16s. 8d. If the undertaking were run by a company financed as most electrical companies in this country are, it could and would have paid a dividend of over 2 per cent. The fact that the Council are now extending is surely ample evidence that they have confidence both in Mr. Hawtayne and in the financial success of their electrical undertaking. We regret to see that the editor of our electrical contemporary adopts the same doubtful method of special pleading when referring to the Erith figures, and thus leaves the general reader to infer that this undertaking is an old-established and unsuccessful one. We would strongly recommend both our contemporaries in the future to remember the second clause in the form of oath referred to above, and that "the whole truth" is even more important than a part of it. We are sending a copy of this to the *Journal of Gas Lighting*, and shall be pleased to see what its editor has to say of the whole truth when it is forced on him.

OBITUARY.

Major-General Charles Edmund Webber, C.B., R.E. (retired), died at Margate on Friday last suddenly from angina pectoris. The funeral service was held at 10 a.m. on Wednesday last at the Brompton Parish Church, and was attended by a number of his professional friends. The Institution of Electrical Engineers was represented by Mr. Alexander Siemens, president-elect; Prof. W. E. Ayrton, F.R.S, Prof. Carey Foster, F.R.S., Dr. J. W. Swan, F.R.S., and Prof. S. P. Thompson, F.R.S., past-presidents; Dr. J. A. Fleming, F.R.S, Mr. J. E. Kingsbury, Mr. W. M. Mordey, and Mr. W. H. Patchell, vice-presidents; Mr. F. Gill and Mr. S. Morse, members of council; and by Mr. P. F. Rowell, assistant secretary. The following were also present at the interment at St. Margaret's, Lee: Mr. A. Siemens, Dr. J. W. Swan, Mr. W. M. Mordey, and Mr. P. F. Rowell.

THE LATE MAJOR-GENERAL WEBBER, PAST-PRESIDENT, INSTITUTION OF ELECTRICAL ENGINEERS.

Major-General Webber had just completed his sixty-sixth year, and was well known to electrical engineers in consequence of the large amount of electrical work for which he had been responsible. The following notes show that in military circles his experience was equally wide. Thus, during the suppression of the Indian Mutiny, he served with the 21st Company of the Royal Engineers throughout the Central Indian campaign in 1858 under Sir Hugh Rose (afterwards Lord Strathnairn, and was present at the siege and storming of Chandairie, and in charge of the only successful ladder party at the escalade of Jhansie, where he was one of the officers who led the assault. From 1870 till 1879 he commanded the Royal Engineers employed on postal telegraphs, and in May, 1879, accompanied Sir Garnet Wolseley to South Africa on special service, serving till the end of the war in Zululand and Natal as assistant-adjutant and quartermaster-general of the western lines of communication, and during the operations against

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Sekukuni in the Transvaal, which again obtained for him mention in dispatches and a second medal with clasp. Becoming a lieutenant-colonel in January, 1880, he took part in the Egyptian war of 1882 as assistant-adjutant and quartermaster-general at headquarters, in charge of the telegraph lines, when he was present at the battle of Tel-el-Kebir, was mentioned in dispatches, and received the medal with clasp, the bronze star, the Companionship of the Bath, and the 3rd Class of the Medjidie. He also served in the Nile expedition of 1884-5, for which he was awarded a clasp to his Egyptian medal.

In electrical matters Major-General Webber took a most active part, as is evidenced by his association with the Institution of Electrical Engineers. He was one of the original members when the old Society of Telegraph Engineers was formed in 1872, and since then regularly contributed papers for discussion. The following list of these is worthy of careful study as showing the range of his practical work. We have added the date before each paper: Nov. 13, 1872, "On Military Telegraphs in Connection with the Autumn Manœuvres"; Feb. 12, 1873, "On the Application of Iron to Telegraph Poles"; Nov. 27, 1878, "On Multiple and other Telegraphs at the Paris Exhibition"; Jan. 10, 1882, Presidential Address; Nov. 23, 1882, "Notes on the Telegraphs used during the Egyptian Expedition of 1882"; Nov. 12, 1885, "The Telegraphs of the Nile Expedition"; June 22, 1891, "Electric Lighting from Central Stations, with special reference to the Chelsea System"; Feb. 8, 1894, "Some Notes on the Electric Lighting of the City of London"; Jan. 27, 1898, "Electrochemical Treatment of Ores containing the Precious Metals"; August, 1900, "Notes of Exhibits Illustrating Applications of Electricity in Paris Exhibition."

Besides these numerous papers, the deceased engineer regularly took part in the discussions on papers read by others, so that he will be greatly missed when the Institution meets this next month. He was always ready to co-operate in any step for the advancement of the industry of which as a pioneer he did so much to establish.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COMMUTATION OF CONTINUOUS-CURRENT GENERATORS AND MOTORS.

SIR,—I see that in your issue of Sept. 23 you have printed copy of our paper on "Commutation of Continuous-Current Generators and Motors." This article has apparently been taken from uncorrected copy of the paper, a few of which copies accidently got into circulation. I, therefore, send you a list of corrections, which I should be glad if you would kindly print in your next issue:

Page 444, line 1: "leading pole-tip" should read "trailing pole-tip."

Page 445, second column, line 5: "cross over" should read "meet."

Page 446, line 8 of section headed "Reactance Voltage," "opposing" should read "assisting."

Page 446, line 10 of same section, should read: "Result of this induced E.M.F. will be to retard the rise or fall of the original current," instead of the reading given.

Page 446, lines 20 and 21 of same section, the formula of induction expressed in henries should read: "Lines surrounding one turn × total number of turns × 10^{-8} ÷ number of amperes."

Page 447, second column, third line from bottom: "Fig. 5" should read "Fig. 6."

Page 448, first column, fourteenth line: "Fig. 6" should read "Fig. 7."—Yours, etc., G. A. NEILD.

A SPORTING OFFER

SIR,—In your issue of 16th inst. you have reproduced a statement made by Mr. Hammond in his recent letter to the Municipal Council relative to an estimate of "total costs" which I prepared for the Lord Mayor in January, 1901, and as the comparison of 2½d. and 1½d. per unit is not accurate, I have felt it to be my duty to address a letter to the town clerk of Dublin setting forth textual extracts from my report of 1901, which speak for themselves. I may say, in passing, that while I did *not* include in my forecast of 1901 a "substantial sum" to cover the "vagaries of municipal administration in Dublin" or the "muddling" of either the then or present Electric Lighting Committees, I did include in my 2d. estimate such items as the cost of carboning and trimming 500 public arc lamps, etc., which must first be deducted from the 2d. referred to before any true comparison can be obtained between my estimate and Mr. Hammond's of 1·5d., which admittedly left out of account altogether one item at least—viz., £2,000 for carbons and trimming—£4 per arc lamp has to be paid by the Corporation, in addition to the £18 set forth in Mr. Hammond's scheme. If this one item alone of £2,000 be deducted, my forecast will stand at 1·81d.—Yours, etc.,

M. RUDDLE, City Electrical Engineer.

Electric Light Station, Dublin, Sept. 24, 1904.

SAND IN ENGINE BEARINGS.

SIR,—I should be glad to hear the name of any enamel suitable for the insides of enclosed engines—one which will fix any foundry sand, and will not be destroyed by either an oil and water bath, or by the oil used for forced lubrication.—Yours, etc., SANDY.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

IX.—ON SOFT SOAP.

MY DEAR YOUNG 'UN,—I must confess that the opening paragraph of your last letter "fetched" me. You refer to my letters in a really touching manner. You speak of their "racy" nature, "so different from the solemn platitudes that my pater sends"; you touch incidentally on their "sound common-sense," and you finally leave me an impression that, on the whole, you prefer me to all your natural relations put together, and that it is only want of spare cash that prevents you from giving me a substantial testimonial of your regard. Now, as I have somewhat the same opinions of my letters as those you mention, it naturally touched me to find in you such evidences of rare discrimination.

But the truth came home! When I was fairly in the ambush you opened out on me with "I know, by-the-bye, you have much influence with Messrs. ——. Could you manage to induce them to give me a berth?" . . .

Oh, my young friend, who taught you the use of soft soap? Of course I will write to Messrs. ——; not because you have flattered me, you understand, but because I have a very high opinion of your intelligence.

Soft soap is one of the most useful articles known to the engineer. When you want to draw in a cable through a pipe with a nasty bend, what do you use?—Soft soap. When you want to wash your hands at your employer's expense and can't find the oil barrel, what do you sneak?—Soft soap. And when you want to squeeze a job out of an innocent and unsuspecting small-scale potentate, what, again, do you employ?—Soft soap.

The art of ingratiation is almost as valuable to the engineer as the differential calculus. I don't care who the boss is; he may pride himself on being the infernallest martinet going, and may rap out his orders like a petulant Pom-pom, yet, other things being equal, he will be bound to give his mental preference to the assistant who is pleasant and civil over his work, rather than to the man who looks as melancholy as a washing-day, and jumps out his answers as if he grudges the carbon dioxide he uses on them. Only don't crawl. It is only the very worst kind of boss who is taken in by the Uriah Heeps who are externally beseeching him to place his foot on their necks.

When you go into the shops you will rub up against men who all want their own little bit of standing room—men with the funniest angles in their construction you ever dreamed of. Don't get trying to correct their faults and elevate their intelligences. You would need to be a combined hydraulic press and ten-ton crane to do that. Soft-

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soap them. Humour their idiosyncrasies. If a man comes in to work on Monday morning with a head as big as a flywheel, nothing suits him better than to exchange some really acid remarks with the first fool who takes him seriously. Only, on Tuesday morning he forgets the head and remembers the remarks; and that's the way bad blood is made in the shops. Don't bring your slide-rule in your pocket in order to give the fitter at the next bench some Higher Education. The fitter will probably think you are merely monkeying, and the foreman will damn you for wasting time. What you want to do is, firstly, to make them think you allow that they may be better types of humanity than yourself, and, secondly, to make them tell you all they know in order to prove it.

If ever you are given charge of men, you will find a modicum of soft soap highly useful. If you have a hundred men under you, there will be fifty ways of getting the best work out of them. Your first object should be to lay down sound, inflexible by-laws to which you must bind yourself as strictly as every man under you. But closely following on this, you must grasp the peculiarities of temperament belonging to each man.

They all have their own opinion of themselves. If by working on that opinion you can get them to put forth their energies for you, you will be repaid for your soft-soap bill manifold. I knew a chief of a station who didn't have that idea. His notion of discipline was starvation wages and cat-o'-nine-tails. He had three shift engineers under him, and he made them slave—prided himself on being a holy terror to them—made a point of degrading them before the men they were paid to command. Well, they worried through the winter shifts, and kept the place going in good style. No thanks for that; when summer came he gave them extra jobs and extra bullying, because he knew that other stations were slack. But *that* wasn't the reason they were hanging on; they were waiting for the holidays. They worked extra shifts for each other till they had all had their fortnight, and then—one got another station job at twenty pounds less, another took up a sphere of usefulness in a manufacturing firm, and the third, who had money, flung up his job, and in doing so carefully explained to the chief what they all thought of him And that chief had to go through the next winter with three men who didn't know the details of the place any more than himself, and the amount of grovelling he did to his drivers and stokers was more than he would care to have mentioned. Give a man his place; make him have a suspicion that you respect his opinions. Humour his eccentricities if they don't interfere with discipline. In other words, apply soft soap.

Workmen often fall foul of one another, and when that occurs they go—to use an auctioneer's phrase—absolutely without reserve. The average workman is a whole-hogger. He LIKES or he LOATHES, with capital letters. He is like a municipal water-cart, which either doesn't water at all and so induces the surface layer of the street to come and lodge in your eye, or else waters so lavishly that the roadway is strewn with profane and prostrated cyclists. When two men of this calibre get at loggerheads with each other, a rumpus of the largest dimensions is usually formed, and you, as the boss, are probably made a Court of Appeal. One man will in gaudy language point out that the other is subverting the discipline of the whole shop. Temporise! Soft soap him! Indicate that you will give the matter your earnest consideration, but that affairs of such magnitude cannot be settled in a moment. And the man will go down to his bench comforted. Probably the other man will also come and give his version. Dose him in the same way. Smother him with soft soap. In two days go and talk the matter over quietly with them if you think it necessary, and tell them what gorgeous fools they made of themselves. Or else let sleeping dogs lie.

You will probably agree with me that engineering is no good unless there is money in it. And you don't get money unless somebody hands it over. The money-shoveller for the firm which employs you is the customer. Now if you are put into contact with the client in the way of business—as, for example, if you become an outside engineer—remember that if you can coax him into paying the firm more than he originally meant to lay out, you are indirectly paying yourself your own wages. It is the man with the smile and the blarney that is sent outside, providing that he knows his business. Lay on the soft soap. Get your man into a good humour, and then come to grips. You will be admired, first, by your employer, next, by your customer, and last, by yourself.—Yours,

THE OLD 'UN.

THE DISTRIBUTION OF MAGNETIC INDUCTION IN MULTIPOLAR ARMATURES.*

BY W. M. THORNTON, D.SC.

The progress of the constructional development of dynamo-electric machines has been characterised by the utilisation of all parts, copper or iron, to their fullest temperature limit, with the result that the weight of a machine for a given output is much less than what it was 10 years ago. A comparison of many machines will, however, show that in one point—the radial depth of the armature core—there is still a wide difference of practice, arising, no doubt, from the fact that there has been little or no direct investigation of the distribution of magnetism within the core upon which to base a scientific treatment.

The most suitable radial depth for the armature core of continuous or alternating current machines can be found by a consideration of the manner in which the induction is distributed from the periphery inwards at a section midway between the poles. This depends upon the pole spacing, the length of the air-gap, the flux density within it, and upon the radial depth of the core. The following investigation is a study of the effect of each of these upon the flux density in the core. For this purpose the magnetic circuit of a multipolar machine was reproduced in miniature (Fig. 1). Each of the four poles could be adjusted by

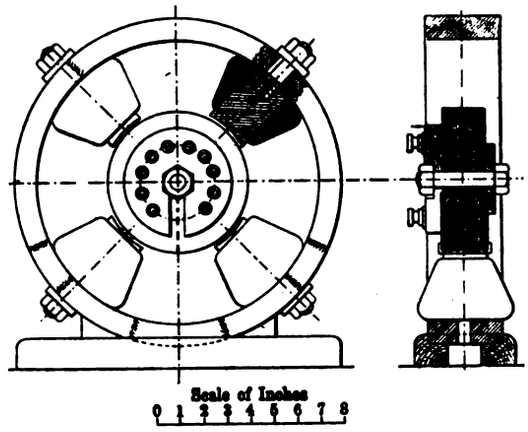

FIG. 1.—Experimental Magnetic Circuit.

means of slots in the cast-iron yoke, and the length of the air-gap varied by thin sheet-iron washers inserted between the pole and the yoke. The pole-tips were well rounded, and the flux density in the gap, as explored by the bismuth spiral, was found to be the same at all parts of the pole-face.

The armature, which in this case was not intended to revolve, consisted of stampings of the usual thickness and 6in. diameter, threaded on a mild-steel bolt. To guard against the distorting influence of the nut and bolt-head, thick hardwood washers were used, so that the magnetic path was confined to the stampings. Along a radius of the core small holes were drilled, and five search coils wound to enclose successive areas at different depths. Each coil had 10 turns of fine double silk-covered wire, with the ends brought to terminals on one of the wooden washers, from which connection could be made to a ballistic galvanometer. The field-magnet windings were of specially insulated wire, and were excited in parallel from large storage cells with a resistance in series with each. The four coils had not quite the same resistance, and the flux densities in each gap were set to equality by adjusting the exciting currents. Once set, the densities remained relatively the same, and

* Paper read before Section G of the British Association at Cambridge, August, 1904.

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any desired flux density in the gap could be obtained by changing the number of cells. In all the experiments the flux densities in the gaps were tested for equality before each set of readings.

The pole-spacing and air-gap length having been set as desired, and the line of the search coils placed midway between the poles, the cell current was switched on and the magnetisation allowed to become steady. The circuit was then quickly broken, and the throw of the ballistic galvanometer read. The residual magnetism was in all cases too small to be accurately measured by the bismuth spiral, and has not been taken into account in drawing the curves. The error in any case will not exceed 2 per cent., on account of the large demagnetising effect of the gap.

The experiments were divided into three sets. In each the air-gap was kept the same throughout, the pole-pitch and current varied. For each different pitch from four to six readings were taken, with flux densities increasing gradually from 2,000 to 11,000 lines per square centimetre. The results are recorded graphically in Fig. 2. These curves show how the core flux changes when that in the gap is varied.

There are several points of interest which are at once evident. Thus, the depth at which the maximum density is found is *independent of the intensity of magnetisation* except when the air-gap is small and the density great, in which case the maximum is slightly deeper at the higher values. Again, the position of the maximum is *independent of the length of the air-gap*, depending only upon the pole-pitch. The wider the pole-pitch the deeper is the maximum and the greater the flux density towards the centre.

The ratio of the maximum density to that in the gap is *greatest when the pole-pitch is small*, as shown by the following table:

TABLE I.—Ratio of Maximum Core Flux to Flux Density in Air-Gap. Length of Air-Gap, 0·114cm.

Flux density in air-gap.	Angle between centre line of poles.		
	51deg.	65·5deg.	81deg.
3 500	1·28	1·14	0 86
4,000	1·35	1·15	0·92
5,050	1·35	1·19	0·97
6 260	1·37	1·23	0·99
8 500	1·3	1·2	0·96
11,000	1·34	1·12	0·97

There is also a value of the air-gap density for which the ratio is a maximum, in this case a little over 6,200 lines per square centimetre. In other words, there is one particular value of it which makes the core distribution most unequal.

Since the area included between the axes and any curve represents the total induction through the core midway between the poles, it is seen from the curves of Fig. 2 that by reducing the polar arc from 81deg. to 51deg. more lines enter the core (other things being the same) when the air-

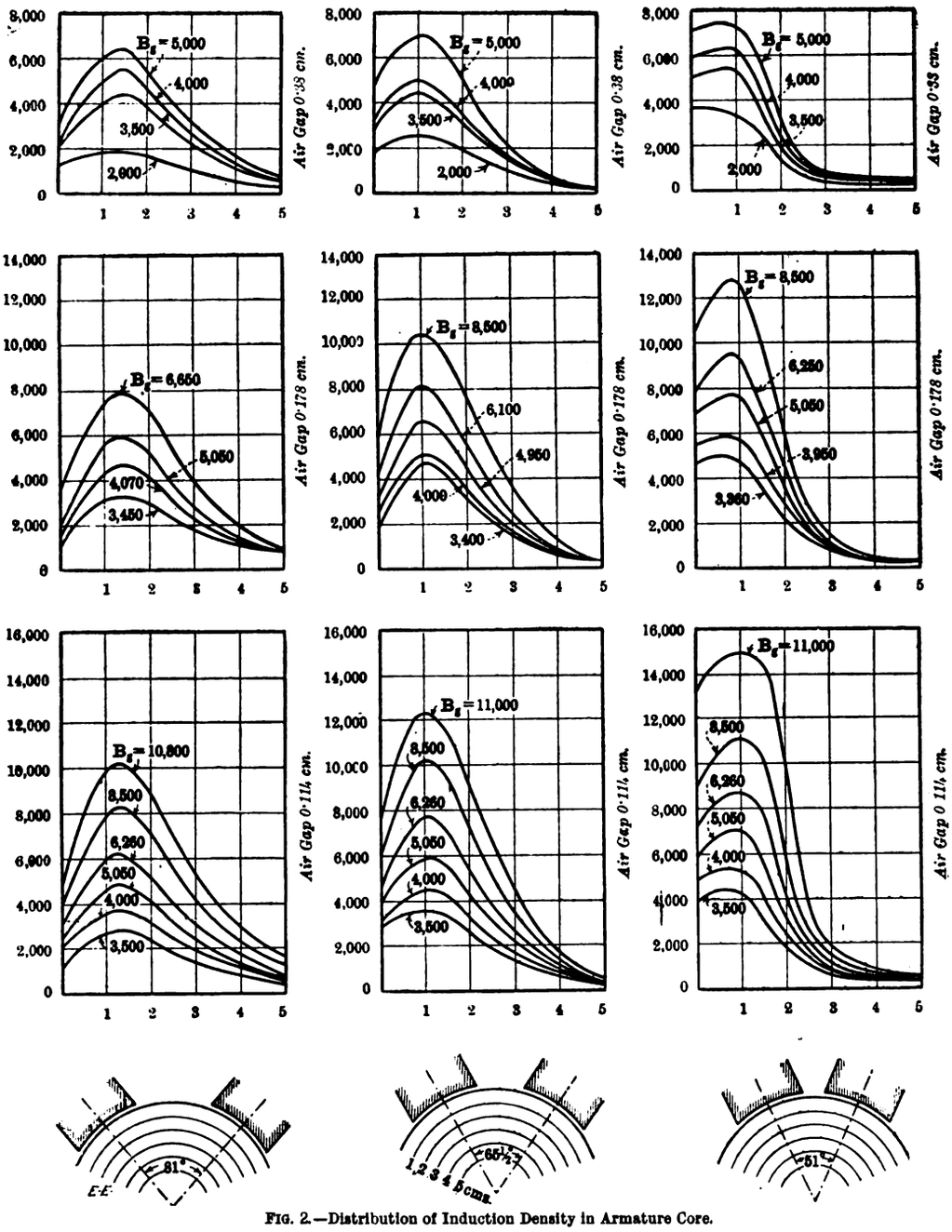

FIG. 2.—Distribution of Induction Density in Armature Core.

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gap is small, but when it is large fewer lines enter. Thus, with an air-gap of 0·38cm. and a flux density in it of 5,000 lines per square centimetre, reducing the polar arc from 81deg. to 51deg. causes a decrease of 17 per cent. in the total core flux. When the air-gap is 0·178cm. and the flux density the same the reduction is only 2 5 per cent., but with a gap of 0·114cm. and the same flux there is an *increase* of 3 per cent. Raising the flux density to 11,000, the increase with the smallest air-gap is 10 per cent. The flux crossing the air-gap is the same in each case, the change is, therefore, in the leakage. Turning to Fig. 5, the total flux at Section A is 12 per cent. greater than at B. Thus 12 per cent. of the total induction enters the core as a fringe from the pole-tip. That this should increase with

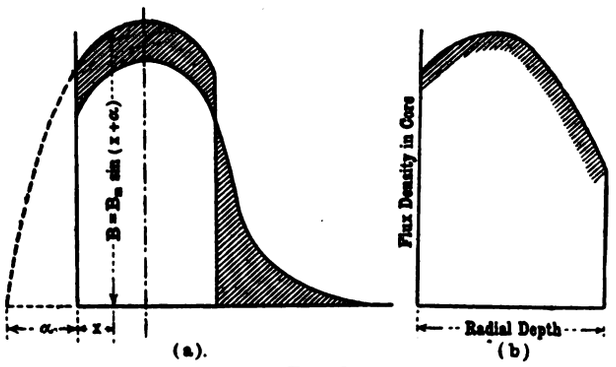

FIG. 3.

the pitch is to be expected, but that it decreases in certain cases points to the conclusion that the reluctance of the outer layers of the iron cannot be neglected in the consideration of core flux. The path through the iron between the pole-tips is four times longer when the pole-pitch is 81deg. than when it is 51deg. The increase in leakage between the poles in the latter case is more than counteracted by the decrease of the reluctance of the core, which permits more lines to enter.

The induction through the inner portion of the core is in all cases low, and where the pole-pitch is small falls off rapidly after the maximum is passed. When the pole-pitch is large the tops of the curves of distribution are nearly

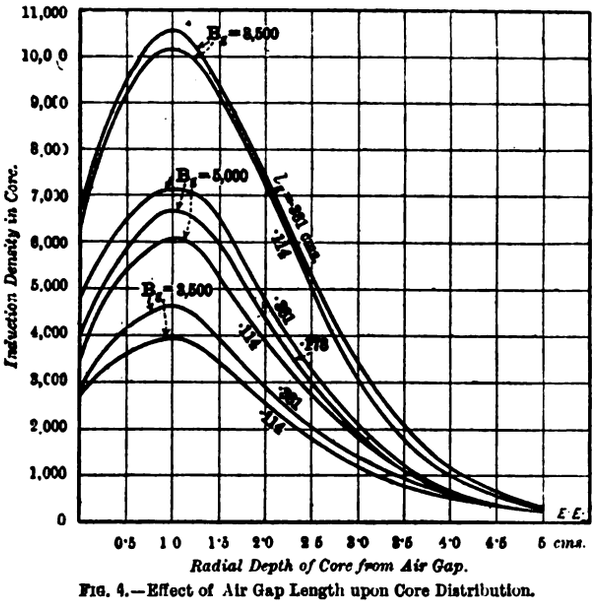

FIG. 4.—Effect of Air Gap Length upon Core Distribution.

sinusoidal, so that by stopping the core at twice the depth of the maximum from the periphery and keeping the total flux the same, the curve of density would be somewhat as follows, Fig. 3A, the portion added being equal to that cut off.

It is not, however, the intermediate but the smallest pole-pitch used in the experiments which corresponds to the usual conditions of practice, the ratio of pole-face to pole-pitch being 0·72. If a straight line is drawn joining the points where the centre lines of the poles cut the armature periphery, it will form a chord whose greatest depth from the arc corresponds with the observed depth of the maximum flux density. In small smooth-core armatures this may be used as a guide to the position of the maximum. The distribution in slotted cores is the subject of an investigation now in progress, but it may be inferred that the maximum will lie not far from the middle of the chord joining the intersection of the centre lines of the poles and the arc through the bottom of the slots. The

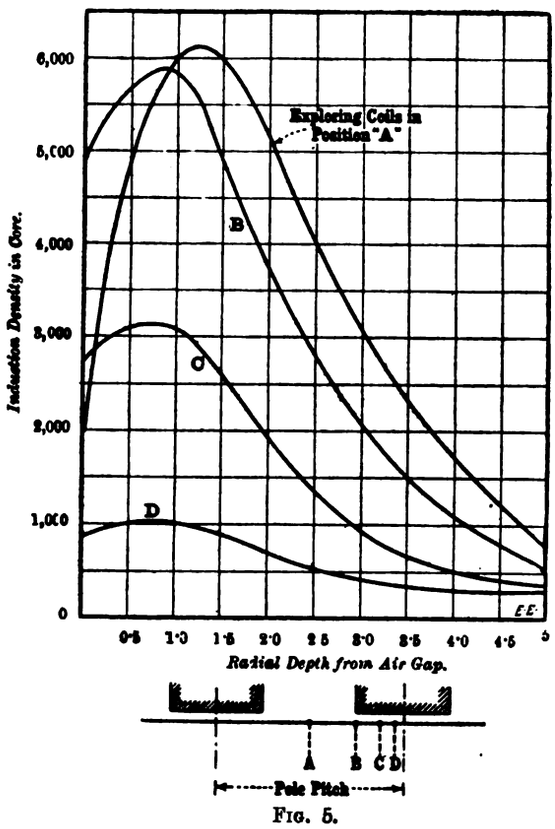

FIG. 5.

curve of distribution will be in general of the form shown in Fig. 3B. To illustrate the importance of this in practice, consider the curve corresponding to a gap flux density of 6,260 lines per square centimetre. In the experimental model the half pole-face is 2·54cm. wide, so that if an average armature flux density is desired equal to 0·7 of that in the gap it is, on the assumption that the flux density is inversely proportional to the area, equivalent to making the core 3·6cm. deep. But by inspection of the curve in the right-hand bottom set in Fig. 2, it is seen that nearly one-half of this depth is inefficient, the two outer centimetres carrying 80 per cent. and 2·5cm. 90 per cent.

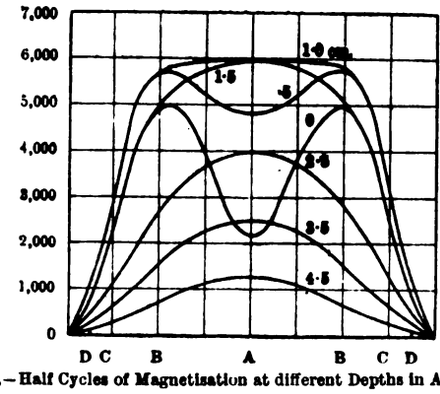

FIG. 6.—Half Cycles of Magnetisation at different Depths in Armature Core.

of the total magnetism. Increasing the radial depth beyond this latter value does not lower appreciably the flux density in the outer portions of the core, the total flux being kept the same.

The path of each line of force is that of least reluctance. There is, therefore, greater concentration along the shortest chord until the permeability there falls, owing to the increased density, and a longer path with higher permeability offers less reluctance. If the ratio, l/μ, remained constant for all lines in the core, there would be uniform flux density over the section midway between the poles. The effect of increasing the pitch of the poles upon the

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armature distribution can be well seen by comparing curves for the same air-gap and air-gap density in each set of curves of Fig. 2. In the same way, the effect of changing the air-gap can be examined by grouping corresponding curves in each case, as in Fig. 4. One sees that when the gap is long more lines enter the core than when it is short, though the flux density in the air-gap is the same. The total pole-tip fringe must therefore be greater.

The curves so far considered show the distribution midway between the poles, the position of maximum total induction. To examine it between this position and the pole centre line, where, if there is symmetry, the flux density is zero in the core, the latter was moved so that the radial line of the exploring coil occupied in turn the positions A, B, C, D (Fig. 5), and the readings taken as before with the pole-pitch, air-gap, and flux density in the air-gap kept constant. The curves obtained are in Fig. 5. From them one is now able to see how each point of an armature core passes through its cycle of magnetisation. Take, as in Fig. 6, a convenient base to represent the pole-pitch, and mark the positions occupied by the coils. At each of these set up ordinates which are the values of the ordinates of the corresponding curves of Fig. 5, A, B, C, D, at the periphery, and at 0·5, 1·0, 1·5, 2·5, 3·5, and 4·5 centimetres depth. Joining respective points the curves of magnetic change at each depth are obtained. At the circumference there is a large third harmonic, which is also seen with a smaller amplitude at 0·5cm. At 1cm. the curve is flat topped, at 1·5 more rounded, and approximates to a sine wave at 2·5cm.

Both hysteresis and eddy-current losses are affected by the shape of the cyclic curve, but not, according to a calculation, sufficient to appreciably change the efficiency of a machine as compared with that obtained on the assumption of uniform distribution. There will, however, be more heating in the outer layers below the slots; and since deepening the core does not much reduce the outer flux density, the inner layers are positively harmful by shielding the hotter layers from the cooling effect of windage and by acting as a heat reservoir.

The tendency of modern practice to reduce the mass of iron in the armature of both continuous and alternating current machines to a minimum determined only by the local heating is, therefore, in the right direction. The best value for the radial depth becomes then a question of ventilation, especially with armatures of small diameter. Its maximum, consistent with the full utilisation of all the metal in the machine, will be seen from the curves of Fig. 2, taken with an air-gap of 0·114cm. and pole-pitch 51deg., to be about 1·75cm. or 2cm.—that is, from 0·23 to 0·26 of the radius of the armature. Except for considerations of mechanical construction it would be well never to allow the radial depth even of small cores to exceed this. If, however, many of the machines whose details have been published are examined, it will be found that the ratio of radial depth to radius varies from 0·45 in high-speed machines with few poles to 0·08 in very large machines of the flywheel type. In three modern examples of English practice recently published, these values are 7in./37in. = 0·19, 5·7in./16·4in. = 0·35, 7·5in./18in. = 0·42. Mr. E. Kilburn Scott in his paper before the Institution of Electrical Engineers last year gave 0·4 as a suitable ratio for high-speed machines of the first class, 0·26 for the flywheel type with many poles.* Continental practice averages about 0·15 for machines under 1,000 kw.

It is in steam turbo-generators that the ratio is most important, where the diameter of the armature must be kept small and there is more core loss. In Plate XV., sixth edition of Prof. Silvanus Thompson's "Dynamo-Electric Machinery," a Parsons machine is illustrated. In it the ratio of radial depth between slots and ventilation holes to the radius is 0·45. Here, however, the pole-pitch is 90deg., and the pole-face only 53·5 per cent. of the pole-pitch. The conditions are then nearer to the middle set of curves of those obtained with 0·178cm. air-gap in Fig. 2. From these it is seen that the core might be stopped with advantage at about 34 per cent. of the radius. Considerations of rigidity and mechanical construction are, however, in these machines of the first importance.

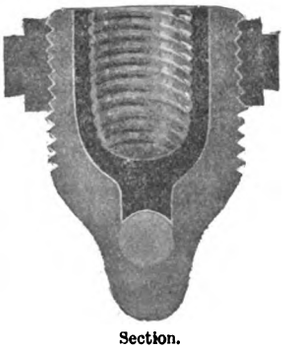
It is proposed, further, to examine the influence of current in the armature conductors upon the distribution of magnetism in the core with different air-gaps, and under all conditions of excitation.

TRADE NOTICES AND NOVELTIES.

"Tetrad" Trolley Ears.

Through the courtesy of Messrs. William C. Yuille and Co., of 17 and 19, West-street, Tradeston, Glasgow, we are able to illustrate this week the new "Tetrad" trolley ears which this firm are putting on to the market. It will be seen from these illustrations that the trolley ear in question is a radical departure from the ordinary type now in general use. The characteristic difference is that with the "Tetrad" ear the trolley wire is inserted in the upper part of the ear instead of into a groove in the lower part, as is the case with the ordinary type. In consequence of this the trolley wheel runs on the metal of the ear itself, and not on the exposed surface of trolley wire and solder, as is ordinarily the case. The details by which this is possible are seen in the accompanying illustrations. It is claimed for these ears that they will outlast three renewals of trolley wire, and that they are much more durable than the usual soldered ear. It is also claimed, and we think rightly, that they are more easy to erect and adjust. The ear also always presents a uniform and even surface to the trolley wheel, which tends to do away with the bumping frequently experienced at the points of support and the consequent undue wear. We shall await with interest the results of practical trial with this new construction of supports for overhead trolley wires.

Straight Line, Curve, or Anchor Ear.

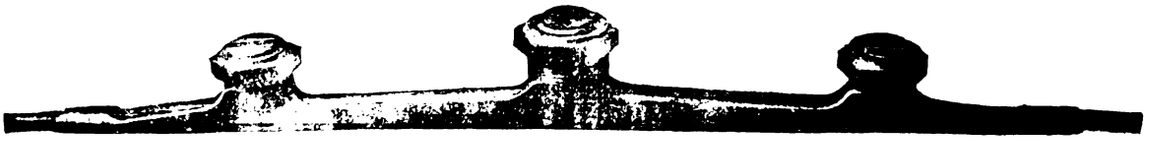


Section.

Anchor Part or Splice.

Feed Part.

Ordinary Wedge Part



Feed, Anchor, or Splice Ear.

* *Journal* Institution of Electrical Engineers, vol. xxxii., pp. 385, 386, and the *Electrician*, vol. l., pp. 589, 646, 769, and 816. If Figs. 21 and 22 of the paper are drawn to scale, the 0·2D, 0·13D should be 0·2 and 0·13 of the *radius*, bringing his values into line with Continental practice.

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MIDDLESBROUGH DOCK ELECTRIC AND HYDRAULIC POWER PLANT.*

BY VINCENT L. RAVEN, MEMBER, CHIEF ASSISTANT MECHANICAL ENGINEER, NORTH-EASTERN RAILWAY.

(Concluded from page 456.)

The electrical switchgear presents many points of interest. It consists of a controller with magnetic blow-out, and with overload release gear. The controller is worked by a pedal projecting above the capstan case by about 4in. This pedal is removed when the capstan is out of use. The pedal is connected to a dash-pot which prevents the controller being operated too rapidly when a driver is starting the capstan, but at the same time, by means of valves in the plunger, allows the controller to return rapidly to the off position. The return to the off position is effected by means of a weight, which is lifted as the pedal is depressed. In the event of the capstan being pulled up by sudden overload, the release gear works instantaneously and breaks the main circuit. Upon the pressure being removed from the pedal, the return of the controller to the off position automatically replaces the release switch, and the capstan is ready to start again. The whole of the gear is contained in a watertight cast-iron case sunk in the ground, the top of which consists of chequered plates flush with the quay-side. The trials of these capstans are shown on Table 3.

Cables.—The distribution of current is effected by a network of feeders and distribution cables laid below ground. These cables are fibre-insulated and lead-sheathed; they are laid in wooden troughs on the solid system, and are at a depth of about 2ft. from the surface. Watertight junc-

TABLE I.—Work Done by Hydraulic Cranes, Middlesbrough Dock, May 24, 1903.

Note.—Each crane lifted each and every load 20ft., slewed through a hook travel of 103·5ft., lowered load 20ft., lifted light chain 20ft., slewed back through a hook travel of 103·5ft., and lowered the light chain 20ft., thus completing each cycle of evolutions.

No. of crane.	Capacity of crane.	No. of rails per lift.	No. of lifts.	Gross weight of rails.	Water-meter reading at start.	Water-meter reading at finish.	Total gallons used.
				T. C. Q. Lb.			
1	35 cwt.	5	70	100 6 1 0	34,280	35,900	1,620
2	5 tons	7	50	100 11 2 12	12,360	15 280	2 920
3	10 ,,	7	50	100 16 3 24	660	3 610	2 950
4	35 cwt.	5	70	100 0 3 16	150	2,170	2,020
5	35 ,,	5	70	100 11 2 12	110	2 030	1,920
6	5 tons	7	50	99 18 0 19	100	3,240	3,140

First Part of Test.—Totals: 360 lifts; gross weight of rails, 602 tons 5cwt. 1qr. 27lb.; total gallons used, 14,570.

No. of crane.	Total No. of lifts at two rails per lift.	Gross weight of rails.	Water-meter reading at start.	Water-meter reading at finish.	Total gallons used.
		T. C. Q Lb.			
1	29	17 1 3 4	35,900	36,600	700
2	17	10 0 1 12	15,280	16,290	1,010
3	17	10 0 1 12	3 610	4,630	1,020
4	29	17 1 3 4	2,170	3,010	840
5	29	17 1 3 4	2,030	2,780	750
6	17	10 0 1 12	3,240	4,390	1,150
—	138	81 6 1 20	—	—	5,470

Second Part of Tests.—Total number of lifts, 465.

No. of crane.	Total No. of lifts at four rails per lift.	Gross weight of rails.	Water-meter reading at start.	Water-meter reading at finish.	Total gallons used.
		T. C. Q. Lb.			
1	29	34 3 2 8	36,600	37,310	710
2	17	20 0 2 24	16,290	17,380	1,090
3	17	20 0 2 24	4,630	5,600	970
4	29	34 3 2 8	3,010	3 820	810
5	29	34 3 2 8	2,780	3 540	760
6	17	20 0 2 24	4,390	5,570	1,180
—	138	162 12 3 12	—	—	5,520

Total weight, 608 tons 2cwt. 3qr. 12lb. (made up of four totals in second part of tests). Total gallons used, 19,500 (made up of four totals in second part of tests).

No. of crane.	Total No. of lifts at six rails per lift.	Gross weight of rails.	Water-meter reading at start.	Water-meter reading at finish.	Total gallons used.
		T. C. Q. Lb.			
1	29	51 5 1 12	37,310	37,990	680
2	17	30 1 0 8	17,380	18,410	1,030
3	17	30 1 0 8	5 600	6,660	1,060
4	29	51 5 1 12	3,820	4 640	820
5	29	51 5 1 12	3,540	4 360	820
6	17	30 1 0 8	5 570	6,770	1,200
—	133	243 19 1 4	—	—	5,610

* Paper read before the Institution of Mechanical Engineers, Chicago meeting, 1904.

No. of crane.	Total No. of lifts at eight rails per lift.	Gross weight of rails.	Water-meter reading at start.	Water-meter reading at finish.	Total gallons used.
		T. C. Q. Lb.			
1	—	— — — —	—	—	—
2	17	40 1 1 20	18,410	19,440	1,030
3	17	40 1 1 20	6,660	7,330	670
4	—	— — — —	—	—	—
5	—	— — — —	—	—	—
6	17	40 1 1 20	6,770	7,970	1,200
—	51	120 4 1 4	—	—	2,900

Summary of Tests.

No. of crane.	Gross total weight of rails.	Gross total No. of gallons used.
	T. C. Q. Lb.	
1	202 16 3 24	3,710
2	200 15 0 20	7,080
3	201 0 2 4	6,770
4	202 11 2 12	4,490
5	203 2 1 8	4,250
6	200 1 2 27	7,870
	1,210 8 1 11	34,070

CAPITAL CHARGES.

Particulars of Capital Charges.

	£ s. d.
Value of hydraulic plant £17,787. 19s. 10d. @ 5% interest per annum; @ 5 % for repairs and depreciation	1,778 16 0
Value of buildings (proportion) £5,707 @ 5 % interest per annum; @ 5 % for repairs and depreciation	570 14 0
Rates and taxes (proportion)	81 13 4
	£2,431 3 4

	£ s. d.
£2,431. 3s. 4d. ÷ 365 days—per day	6 13 2
£6. 13s. 2d. ÷ 24 hours—per hour	0 5 6·58
£0. 5s. 6·58d. × 7 hours—time of test	1 18 10
£1. 18s. 10d. ÷ 59,000 gallons—per 1,000 gallons	0 0 7·9

Cost of Power per 1,000 Foot-Tons of Work.

Total tons dealt with	1,210·4 tons.
Total gallons of hydraulic power water used	34,070 gallons.
Total gallons used per 1,000 foot-tons of work	1,407 gallons.
Total cost for power only per 1,000 foot-tons of work	£0. 1s. 6d.

POWER STATION RECORDS AND COSTS.

No. of hydraulic engine at work		No. 3.
Time started for tests		7 a.m.
Engine counter reading at start		4,818,441
Time finished for test		2 p.m.
Engine counter reading at finish of test		4,829,455
Total revolutions made		11,014
Load factor (per cent.)		14·4
Total gallons pumped (displacement)		59,002
Total gallons used by cranes as above (displacement)		34,070
Total gallons used by capstan as measured by water-meter		14,110
Total gallons run through drains as measured		8,720
Total gallons run through momentum valve as measured		2,100
Total gallons accounted for		59,000
Coal burnt during seven hours' test, in pounds		3,584
Ashes and clinker left after test, in pounds		330
Gallons pumped per cwt. of coal burnt		1,844
Gallons pumped per cwt. of combustibles		2,034
Cost of coal at 8s. 3d. per ton	£0	13 2
Cost of wages in power house during test	£0	8 7·6
Cost of oil stores and water during test	£0	2 5
Total station cost during test	£1	4 2·6
Total station cost per 1,000 gallons pumped during test	£0	0 4·92
Capital charges during test	£1	18 10
Capital charges per 1,000 gallons pumped during test	£0	0 7·9
Total cost at station per 1,000 gallons pumped	£0	1 0·82

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TABLE II.—Work done by Electric Cranes, Middlesbrough Dock, May 31, 1903.

First Part of Test.

No. of crane.	Capacity of crane.	Number of lifts at— 4 rails per lift.	3 rails per lift.	2 rails per lift.	5 rails per lift.	6 rails per lift.	7 rails per lift.	Total No. of lifts.	Total weight of rails. T.	C	Q.	Lb.
	Tons.											
1	3	60	5	5	—	—	—	70	102	9	0	12
2	3	60	5	5	—	—	—	70	102	9	0	12
3	3	60	5	5	—	—	—	70	102	9	0	12
4	10	—	—	—	40	5	5	50	101	13	3	20
5	3	—	—	—	40	5	5	50	101	13	3	20
6	3	—	—	—	40	5	5	50	101	13	3	20
Totals		180	15	15	120	15	15	360	612	9	0	12

Total Board of Trade units used, 75.

Second Part of Test.

Total lifts at 2 rails per lift.	Total weight of rails. T.	C.	Q.	Lb.	Total lifts at 3 rails per lift.	Total weight of rails. T.	C.	Q.	Lb	Total lifts at 4 rails per lift.	Total weight of rails. T.	C.	Q.	Lb.	Total lifts at 6 rails per lift.
30	22	15	1	12	30	34	3	0	4	30	45	10	2	24	—
30	22	15	1	12	30	34	3	0	4	30	45	10	2	24	—
30	22	15	1	12	30	34	4	0	4	30	45	10	2	24	—
17	12	18	0	4	17	19	7	0	6	17	25	16	0	8	4
17	12	18	0	4	17	19	7	0	6	17	25	16	0	8	4
17	12	18	0	4	17	19	7	0	6	17	25	16	0	8	4
141	107	0	0	20	141	160	10	1	2	141	214	0	1	12	12

Total weight of rails. T.	C.	Q.	Lb.	Total lifts at seven rails per lift.	Total weight of rails. T.	C.	Q.	Lb.	Total weight of rails. T.	C.	Q.	Lb.
—	—	—	—	—	—	—	—	—	102	9	0	12
—	—	—	—	—	—	—	—	—	102	9	0	12
—	—	—	—	—	—	—	—	—	102	9	0	12
9	2	0	16	13	34	10	2	14	101	13	3	20
9	2	0	16	13	34	10	2	14	101	13	3	20
9	2	0	16	13	34	10	2	14	101	13	3	20
27	6	1	20	39	103	11	3	14	612	9	0	12

Summary of Second Part of the Test.—Electrical cranes. Total number of lifts, 474. Total weight lifted, 612 tons 9cwt. 12lb. Total Board of Trade units used, 99.

Summary of Tests.

Gross total weight of rails. T.	C.	Q.	Lb.	Gross total Board of Trade units used.	Remarks.
204	18	0	24	174	Each crane lifted each and every load 20ft., slewed through a hook travel of 103·5ft., lowered load 20ft., lifted light chain 20ft., slewed back through a hook travel of 103·5ft., and lowered the light chain 20ft., thus completing each cycle of evolutions.
204	18	0	24		
204	18	0	24		
203	7	3	12		
203	7	3	12		
203	7	3	12		
1,224	18	0	24	174	

tion boxes are provided at the junction of the feeders. The crane connection boxes are in two portions, the bottom of which contains the positive and negative distributing cables, and the top the connection apparatus for the cranes. The connection socket consists of a circular gunmetal hood, which accurately fills the aperture in the cover of the box, and is so shaped as to shield the joint from wet. The interior of this hood contains two gunmetal tongues which meet the two clip contacts in the interior of the box. A stud and groove ensures that the socket shall enter the aperture only in the correct position. The flexible crane cable enters the hood of the socket through a trumpet mouth, and the whole apparatus is shaped so as to obstruct the quayside as little as possible. There are 52 boxes in all, placed 20 yards apart. They have withstood the test of the severest weather, and have given no trouble. The cost of cables complete is only about 50 per cent. of the cost of hydraulic mains for the same power.

POWER STATION RECORDS AND COSTS.*

No. of electric engine at work	No. 3 No. 3
Time started for test	No. 3, 8 30 a.m. No. 3, 11.30 a.m.
Time finished test	No. 3, 10.45 a.m No. 3, 2.30 p.m.
Meter reading at start of test in Board of Trade units	No. 3, 180,080 No. 3, 180,158
Meter reading at finish of test in Board of Trade units	No. 3, 180,158 No. 3, 180,344
Total Board of Trade units used	No. 3, 78 No. 3, 186
Total Board of Trade units used by lamps in cellar at power station	No. 3, 3 No. 3, 3
Total Board of Trade units used by arc lamps on lighting circuit as per meter	No. 3, nil No. 3, 84
Net total Board of Trade units used by electric cranes	No. 3, 75 No. 3, 99
Coal burnt during test in cwts.	No. 3, 12 No. 3, 14
Coal burnt per Board of Trade unit in pounds	No. 3, 17·3 No. 3, 8·4

Load factor, 7·3 per cent.*

Average coal burnt per Board of Trade unit in pounds	11
Ashes and clinkers left on conclusion of test	2cwt. 2qr.
Cost of coal at 8s. 3d. per ton during test	10s. 9d.
Cost of wages net time of test	6s. 5·7d.
Oil, stores, and water during time of test	2s. 1d.
Total station cost during time of test	19s. 3·7d.
Total station cost per Board of Trade unit	0·87d.
Capital charges, depreciation, interest, repairs, rates, during test (see summary)	£1. 5s. 9·75d.
Capital charges per Board of Trade unit	1·17d.
Total cost per Board of Trade unit	2·02d.

CAPITAL CHARGES.

Particulars of Capital Charges.

	£	s.	d.
Rates	81	13	4
Value of buildings, £4,507 (@ 5 per cent. for interest; @ 5 per cent. for repairs and depreciation)	450	14	0
Value of plant, £16,219 (@ 5 per cent. for interest...; @ 5 per cent. for repairs and depreciation)	1,621	18	0
	£2,154	5	4

	£	s.	d.
£2,154. 5s. 4d. ÷ 365 days—per day	5	18	0
£5. 18s. ÷ 24 hours—per hour	0	4	11
£0. 4s. 11d. × 5·25 hours—time of test	1	5	9·75
£1. 5s. 9·75d. ÷ 264—per Board of Trade unit	0	0	1·17

Cost of Power per 1,000 Foot-Tons of Work.

Total tons dealt with	1,224·9 tons.
Total Board of Trade units used	174 units.
Total units used per 1,000 foot-tons of work	7·1 units.
Total cost of power per 1,000 foot-tons of work	1s. 2·3d.

Lighting.—About half a mile from the power station a sub-station, fitted with switchboard for the lighting, has been put down. There is only one cable for supplying the power both for the electric machinery and the lighting of the docks, offices, and station.

Summary.—The traffic department (see Table 4) find the electric cranes to be a great advantage. There is very little time required for oiling, as the crane has ring lubricators to all main bearings, and the wheels run in oil baths, which only require attention about once a month. The oil bath effectually prolongs the life of the wheels and deadens any noise, which is a great advantage to the drivers in hearing instructions. The controlling of the crane by one handle is also a distinct advance both over the steam and the hydraulic cranes. With the steam cranes the driver had to attend to four levers and a foot-brake, in addition to the feed pump and the firing of the boiler. In the case of the hydraulic crane two levers are in use, which require considerable force. The automatic cut out in the electric cranes cuts off the current in one case at 3 tons 5cwt. and the other at 10 tons 10cwt, and this device prevents an overload upon the crane. Should the current fail at any time the brake on the lifting gear is applied automatically, and will hold the full load in any position with safety. To obtain some definite idea of the speeds of the various cranes when working under ordinary conditions they were tested separately. The steam crane had a load of two tons put on, and this was lifted

* This figure represents the load factor in proportion to the three electric engines working at maximum speed.

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TABLE III.—ELECTRIC *VERSUS* HYDRAULIC CAPSTAN TESTS, MIDDLESBROUGH DOCK, AUG. 19 AND 20, 1903.

Weight of load.	Distance hauled.	Time occupied.		Speed per minute.		Power used in units and gallons.		Power required theoretically taking tractional force at 23lb. per ton.	Actual power used by machines.		Efficiency of machine.		Cost of power.		Cost of 1,000 foot-tons of work.	
		Elec.	Hyd.	Elec.	Hyd.	Elec.	Hyd.		Elec.	Hyd.	Elec.	Hyd.	Elec.	Hyd.	Elec.	Hyd.
Tons.	Ft.	Sec.	Sec.	Ft.	Ft.				Foot-lb.	Foot-lb	p.c.	p.c.	d.	d.	d.	d.
174	100	47½	361	126	17	0·51	45	400,200	1,354,764	807,300	30	50				
145	100	40	115½	150	52	0 51	45	333,500	1,354,764	807,300	25	40				
116	100	37	74	162	81	0·31	40	266,800	823,484	717,600	32	36	4·1467	4·3	6·63	6·88
87	100	35	65½	171	93	0·31	80	200,100	823,484	1,435,200	24	14				
58	100	33½	46	179	130	0·26	65	133,400	690,664	1,166,100	19	11				
29	100	33	29½	182	203	0·21	65	66,700	567,844	1,166,100	12	5				
				mean	mean						mean	mean				
—	—	226	691½	161	96	2·11	340	1,400,700	5,605,004	6,099,600	25	23	—	--	—	—

Power used by *electric* capstan running light for 10 minutes—0·5 unit, or 1,328,200 foot-pounds. Value 0·985 pence.
" " *hydraulic* " " " " " 570 gallons, or 10,225,800 " " 7·2 "

NOTE.—These tests were made with ordinary dock wagons in bad weather. The wagons had the usual grease-boxes to axles. Lines very badly laid, but level.

TABLE IV.—SUMMARY OF RESULTS.

Description of cranes.	Total number of lifts made.	Total weight of rails lifted.	Total time occupied in loading.	Total coal burnt at power station during test.	Total cost of working at power station during test.	Total cost of working at station, including capital, interest and repairs during test.	Total cost of men's wages handling cargo during test.	Total cost of handling cargoe.	Total cost per 100 tons.	Total saving effected by electric cranes.	Total saving effected by electric cranes.
		Tons.	Hr. Min.	Lb.	Pence.	Pence.	Pence.	Pence.	Pence.	Per 100 tons.	Per cent.
Hydraulic	825	1,210·4	7 0	3,584	167·34	436·74	3 528	3 964·74	327 5	—	—
Electric	834	1,224·9	5 15	2,912	151·38	351·48	2 646	2,997·48	244·7	—	—
Saving effected by electric cranes	—	—	1 45	672	15·96	85·26	882	967·26	82 8	82·8	25

30ft, slued through 106 5ft., lowered 30ft., light hook lifted 30ft., slued 106·5ft., and light hook lowered 30ft. The total time for these operations was 1 minute 44 seconds, or at the rate of 34 cycles per hour. The hydraulic cranes, under precisely the same conditions, occupied 1 minute 40 seconds per cycle, or equivalent to 36 cycles per hour. The electric cranes did the same work in 64 seconds per cycle, or 56 cycles per hour, and this is capable of being increased beyond even this point with a good driver. Therefore, in ordinary working the electric cranes are doing 50 per cent. more work per hour than the hydraulic or steam cranes. On actual test it was found that the electric cranes can be released from the rails, travelled 30ft and refixed to rails in three minutes. When it has been necessary to move the hydraulic cranes to suit the working into the various ships' holds, six men have had to be called one hour earlier in the morning to set the four cranes which are required for each vessel. With the electric cranes the men have not to be called earlier, as two men in summer and four in winter can disconnect and connect up four cranes in 15 minutes. In winter, on frosty nights, four men have been employed six hours each for the purpose of keeping fires to prevent water in the cylinders of the hydraulic cranes from freezing; on the other hand, the electric cranes have no need of this. When a steam crane had to be got ready for work, the driver had to commence one hour earlier in order to obtain steam, whereas the hydraulic and electric cranes are ready for work at any moment. In 1903, when the steam cranes were superseded by the electric cranes, the quantity of traffic dealt with at this dock was:

	Tons.
Coal and coke exported	259 746
Merchandise exported	297,304
Merchandise imported	33,696
Total	590,746

To do this work, the quantity of coal burned at the new power station, which, as previously stated, supplies both the electric power, lighting, and hydraulic power water was: 3,428 tons 4cwt., or the total merchandise worked per ton of coal burned was 172·3 tons, or a gain of 47·2 per cent.

THE DOG AND THE BONE.

Once upon a time there was a station engineer who, being dissatisfied with his lot under a company, cast around to see how he might increase his banking account, and also how he might become boss in his own department. For he objected to being under a board of inquisitive directors, and having to render account to a stupid secretary, none of whom understood the meaning of Ohm's law. So he answered an advertisment from a borough council, and, lo and behold, he was surprised and overjoyed to receive a summons to appear before the committee. And having answered all their questions satisfactorily he was duly appointed, and it gave him pleasure to shake the dust of the company's service off his feet and to feel that at length he was a public servant and master in his own house.

And being with the borough council but a short time, the engineer discovered that there were many tendings towards Socialism in the district, but he would have none of this amongst the men he employed. Now of all these, none was more insistent on the rights of the poor British working-man than a certain navvy whose function it was to dig hard all day to make trenches for the cables that convey the current. And so the engineer, having found the navvy many times addressing his fellows to the neglect of the work, for which he paid them the wage as fixed by the union, presented him with the sack and told him to come back no more.

Now about this time it befell that the local elections were about to take place, and the engineer saw the navvy ofttimes addressing the crowds; but he scoffed and passed by, taking no interest in the whole affair. But, to his great surprise, he found that the navvy had been elected a councillor, and later on when he appeared before his committee, behold, the navvy likewise had a seat at the table. Then the engineer felt passing sore within himself, and this feeling was in no wise removed when he found that the rest of the committee were also Socialists. And when with one accord they all wanted to know why the wheels went round, and whether it could not be done more cheaply, the spirit of the engineer waxed obstinate, and he said unto them, "Have you not engaged me as engineer, and do I not know best about all these things?" Then

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arose the navvy and said, "Oh, councillors, this fellow speaks not the truth when he says we have appointed him; but as he is contumacious, let him say that we have discharged him. Therefore I move that he receive three months' notice from this day." And the motion was carried with only two dissentients.

Moral.—You never know when you are well off; also, you may be entertaining a king unawares.

LEGAL INTELLIGENCE.

AN ELECTRICAL COMPANY'S AFFAIRS.

In the City of London Court on Friday last, his Honour Judge Rentoul, K.C., heard an action brought by Mr. J. W. Record against Brooker and Goss, Limited, electrical engineers, 50, Broad-street House, E.C., to recover £19. 4s. 6d. wages and commission. There was a counterclaim for £50.

Mr. Owen Thompson, plaintiff's counsel, stated that the defendants were seeking to enforce specific performance of a contract for the plaintiff to take 50 shares in the defendant company, representing the qualification for a director. As a matter of fact, shares were allotted to no one, because the company proved entirely abortive, but now, after 18 months, the defendants were attempting to compel the plaintiff to take up 50 £1 qualification shares, although they had never been issued. The plaintiff was employed by Brooker and Goss in 1902, before the business was converted into a company. He had a salary of £2 a week, and 1¼ per cent. bonus on all instruments calibrated in the plaintiff's department. A new agreement was made by which his salary was raised to £2. 5s. a week, and from Jan. 1 there was an agreement that it should be raised to £2. 10s. a week. That had not been paid. During the last part of the time while the plaintiff was working for the defendant company he only received a portion of the salary, and some weeks it was as little as 10s. The plaintiff gave notice to leave, but he stayed on and worked until Aug. 6. He was now, however, compelled to sue for his wages. The company was incorporated on Feb. 18, 1903. The first directors were Mr. Brooker, Mr. Goss, Mr. Cruttenden, and the plaintiff. They all signed a consent to act as directors as required by Section 2 of the 1900 Act, and the plaintiff acted for a short time. Mr. Thompson further stated that the plaintiff joined the company on the first prospectus, which was subsequently altered, and the terms on which the shares could now be issued were entirely different. At the end of two months, the statutory limit for acting as a director without taking up the qualifying shares, the plaintiff ceased to be a director, and became a paid electrician simply.

Mr. Brooker, on behalf of the defendants, said the plaintiff was never engaged at £2. 10s. a week definitely, but only provisionally.

His Honour gave judgment for the plaintiff on claim and counterclaim, with costs.

COMPANIES' MEETINGS AND REPORTS

DICK, KERR, AND CO.

The ordinary general meeting was held on Tuesday at the Cannon-street Hotel, Mr. John Kerr, M.P. (the chairman of the Company), presiding. Particulars of the report for the year ending June 30 were published in our last week's issue.

In moving the adoption of the report, the **Chairman** alluded to the Company's policy in making ample allowance for depreciation. Proceeding, he remarked that, beside the Far East and India, Australia, South Africa, Canada, and Argentina had proved good customers. Europe and America were practically closed markets owing to the protective tariffs, for which the chairman stated he attached small blame to those countries. Having referred to the successful outcome of the Company's contract for electrifying the Liverpool-Southport branch of the Lancashire and Yorkshire Railway, the chairman remarked that there was a possibility of considerable development in this direction in the near future. The Company had no apprehension in regard to competition from foreign or other rivals; they were closely studying every possible means of reducing cost of manufacture without lowering the high standard the Company had always aimed at. In conclusion, he paid a tribute to the services of the staff and workmen.

The report was unanimously adopted.

Messrs. D. C. Ellis and G. Richardson, the retiring directors, were re-elected; also the auditors, Messrs. Gane, Jackson, Wells, and Co.

The proceedings terminated with a cordial vote of thanks to the directors.

MERSEY RAILWAY.

The half-yearly meeting was held on Tuesday, Mr. James Falconer presiding.

The **Chairman** said the accounts for the half-year showed a substantial improvement, but the Board were by no means satisfied that they had reached anything like a final conclusion. The number of passengers carried, excluding season-ticket holders, had increased 1,300,000, or nearly 40 per cent., and the receipts had increased by £7,579, or 29 per cent. In considering the effects of the change from steam to electricity, and comparing the half-year with the corresponding half-year, it was necessary to take into account the fact that they had given the public a greatly improved service, and for the increased expenditure of £1,530 (without taking into account the exceptional charges for pumping and ventilation) they had practically doubled the working of last year. The train mileage was 411,683 against 218,308—that was to say, the Company had doubled the facilities for the travelling public. The cost per train mile formed a proper basis for comparing the cost of steam traction and electric traction, and in that respect the figures were very striking. During the half-year ended June, 1903, steam was used for four months and electricity for two. A comparison of the cost per train mile during the period of the half-year under review showed that cost had decreased from 30·1d. to 17·35d., or a reduction of 42 per cent.; while if including the exceptional charges mentioned, the decrease was from 35·25d. to 19·58d.—a very striking reduction arising from the change. These figures conclusively established the extraordinary superiority of electrical traction over steam in dealing with such a railway as theirs. The cost per train mile at which the existing traffic had been carried practically represented also the cost at which they could carry double the traffic. They had now reached the point of earning power per train mile of something like 2s., and the future of the railway depended upon increasing that figure by doing everything possible to give confidence to the public, and by affording every facility desired.

Replying to a shareholder, the **Chairman** said that roughly the revenue was now £80,000, and whenever it exceeded £130,000 payment on the ordinary stock would begin. If the revenue were doubled, there would practically be £30,000 for distribution to ordinary stockholders.

The report was adopted.

WILLANS AND ROBINSON.

In submitting the accounts for the half-year ending June 30, the directors of Willans and Robinson, Limited, deeply regret that the results are so unfavourable. Apart from losses at Queen's Ferry, which, under the circumstances, were inevitable, the Company's operations at Rugby have, for the first time in its history, resulted in a loss. After making a somewhat increased allowance for depreciation, amounting to £7,601, there is a loss of £3 345 in respect of Rugby. The loss at Queen's Ferry, after writing off £9,937 depreciation, is £25,902, and there is, further, a debit balance of £7,932 brought forward from the preceding half-year. The loss at Rugby is attributable chiefly to the extreme badness of trade, under the stress of which orders are taken by many firms at prices which make profit impossible. As they have before explained, the directors have striven to open up new branches of business, with a growing success upon which they found strong hopes for the future, but such work cannot yield a profit at first, and, in fact, in its initial stages it is bound to be a source of loss. This affects not only the half-year under consideration, but also the current half-year, and probably the next half-year as well. Nevertheless, the directors are satisfied that in developing these new branches of work, of which steam-turbines and gas-engines are the chief, they are taking the surest course for the ultimate revival of the Company's prosperity. They are also endeavouring to economise in every way, and have effected large reductions in expenses, though the evidence of this will not be apparent until the accounts of the current half-year are presented. The utmost is being done to maintain the reputation of the Company for excellence of manufacture, and to keep the Willans engine in its old position of supremacy. In their efforts to this end the Board feels that it is greatly strengthened by the additions made to it last spring. It is not possible to operate the Queen's Ferry works upon a sufficiently large scale to make a profit, or even to pay expenses, without raising more capital for plant and for working. This is out of the question at present, and therefore the works are kept employed only to the extent necessary to complete one important contract. While the works are thus maintained as a going concern (except the steelworks, now closed, but capable of being readily restarted), the directors are endeavouring to find a purchaser for them—subject, of course, to the assent of the trustees for the debenture-stock holders. Negotiations to this end are in active progress. The increased loss at Queen's Ferry is largely due to the increase in depreciation (£2,688 more than last half-year). An unexpected source of loss has also arisen in the necessity for rejecting, and valuing only as "scrap," a quantity of material made in the earlier stages of the work, and believed at the time to be satisfactory. This source of loss is not likely to recur, but under present conditions at Queen's Ferry some loss cannot be avoided, even if the works be closed entirely. Everything that is possible is being done to reduce expenses and to increase efficiency. The directors have given constant attention to the improvement of the financial position of the Company, which is the dominant factor in the situation. New business, and even the best-founded hopes of future profits, will be fruitless unless the Company can pay its way and has working capital at command. The directors are glad to say that the financial position during the past few months has much improved. Money has come in comparatively freely from debtors, and shares in other companies (received in part payment under contracts) have been sold at favourable prices. The debt to the bank has been paid off, and an ample balance created, without selling the whole of the reserve fund investments; investments remain at this date which, at cost, represent £27,053. The loss upon realising the securities sold at the present low prices has been charged against the reserve fund account, which has also been debited with an amount written off from other investments of the Company, which the directors have rigorously valued down to what they believe to be thoroughly safe figures. The opinion was expressed at the last meeting that the remuneration of the additional directors should be provided by deductions from the salaries of the existing directors. As the directors are remunerated under separate agreements for service, and not collectively, this question, as was

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explained at the meeting, could only be dealt with by the directors individually, and not by the Board as a whole. Mr. Robinson and Sir Gilbert A. Clayton East accepted reductions as from March 31 last, equivalent to their *pro rata* proportions of the new directors' salaries. Mr. Arthur Lazenby expressed, and still desires to express, his willingness to follow the same course; but, at the wish of some of his colleagues, he has deferred action until they could bring the matter, as affecting him, before the shareholders at the ensuing meeting.

SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER.

The shareholders have received notice of an extraordinary general meeting to be held on Oct. 7 for the purpose of considering the advisability of winding-up the Company, in view of its contemplated reconstruction, and, if thought fit, passing a resolution for voluntary winding up, and the appointment of a liquidator. The accounts of the Company for the year ended June 30 show a profit of £2,573, making, with the balance brought forward, £3,351, but liabilities to contractors for works not certified by consulting engineers, and the accrued dividends from date of allotment to June 30, 1904, on the preference shares have not been provided for. There is also a debit in the accounts of £58,702, being interest on debenture stock and calls paid in advance for the two years ended June 30, 1904, less credit interest of £12,347. The directors report that the whole of the tramways and light railway constituting the first constructional scheme of the Company have been in operation since Easter, 1903 (portions of the scheme being in operation earlier), but the receipts on the working of these lines have not quite come up to expectations. It must be remembered, however, that the districts served have passed through a crisis in the cotton industry, and that trade generally has been extremely depressed, and certain sections which would no doubt form valuable feeders have not been constructed. The arrangements for raising further capital, which were sanctioned by the debenture stockholders and authorised by the shareholders at the latter end of last year, were actively proceeded with by the directors, who were, however, frustrated largely owing to the financial depression, and on an application by a debenture-holder the Court appointed receivers and managers. Negotiations are pending, however, and there is reason to hope that a scheme of reconstruction will be practicable, and that the additional capital required to proceed with the construction of the lines may be obtained at a satisfactory rate. Sir John A. Willox, M.P., has, through continued ill-health, retired from the directorate, and Mr. Joseph Beecham and Mr. H. R. Hogg have joined the Board. The Hon. Arthur Stanley, M.P., and Mr. C. E. Maples offer themselves for re-election.

PERSONAL.

The Caerphilly District Council have appointed Mr. A. H. Preece as the electrical engineer.

The Luton Town Council have increased the salary of the electrical engineer from £204 to £250 per annum.

We note that the borough engineer of Ealing, Mr. J. Douglas Knight, M.I.E.E., has this week returned from his visit to America.

The Willesden District Council have appointed Mr. John Geo. Bruce, assistant distributing engineer to the St. Pancras Borough Council, resident electrical engineer.

The Huddersfield County Borough Council have appointed Mr. R. H. Wilkinson, Oldham, general manager and engineer of the tramways at the salary of £350 per annum.

The Portsmouth Town Council have increased the salary of Mr. Foale, the engineer and manager of the electric lighting station, from £325 per annum, as at present, to £400 per annum.

The Blackburn Electricity Committee have accepted the resignation of the borough electrical engineer, Mr. A. J. Giles, as he has been offered an engagement abroad at a salary of £1,800 per annum, more than twice that now received for his present office.

Mr. Bertram S. Giles, M.I.E.E., who was for many years responsible for the design of Messrs. Mather and Platt's electrical machinery, and acted as their technical representative and adviser, has now joined Messrs. Johnson and Phillips as manager of their electric light and power works.

Mr. John McMillan, resident electrical engineer to Falkirk Corporation, has been presented with a handsome silver tea service, a silver tea caddy, and a silver-mounted tea tray by the senior burgh officials as wedding gifts. Mr. A. Balfour Gray, town clerk, presided over the presentation, which was made at the burgh buildings by Mr. Wm. McCrae, gas manager.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Buenos Ayres.—The Municipality of Chivilcoy require tenders for installation of electric lighting.

Salford.—The Electricity Committee invite tenders for paper-insulated cables. Tenders to the Town Clerk by Oct. 6.

Crejour (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Blackheath.—The County Council require tenders for electric wiring and fittings, etc., at the ranger's house. Tenders by Oct. 11. See advertisement.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Wandsworth.—The Borough Council require tenders for electric lighting and ventilation of Council House. Tenders by Oct. 18. Full particulars in advertisement columns.

Espinar (Spain).—The Municipality require tenders for construction and working of an electric tramway for 20 years. Particulars from the Alcalde. Tenders by Oct. 12.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

Great Western Railway.—The Directors of this Company are prepared to receive tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1905 Tenders by Oct. 17. See advertisement.

Almendralejo.—The municipal authorities require tenders for the electric lighting of the town for 10 years. Particulars may be obtained from the Alcalde of Almendralejo, province of Badajos, Spain. Tenders by Oct. 13.

Ilford.—The Urban District Council invite tenders for the supply and erection of balancer and switchboard panel, and reversible traction booster and switchboard panel. Tenders by Oct. 4. See advertisement.

Canterbury.—The Drainage Committee invite tenders for electric light fittings in the engine-house at the sewage farm. Particulars may be obtained of Mr. Arthur C. Turley, A.M.I.C.E., city surveyor, Guildhall-street, Canterbury. Tenders to the Town Clerk by 10 a.m. on Oct. 3.

Cumberland and Westmoreland Lunatic Asylum, Carlisle.—Tenders are required for plant. Copies of tender may be inspected at the office of the Consulting Engineer, Electricity Works, Northallerton, Yorks. Tenders to the Clerk to the Committee of Visitors by Nov. 1.

Weymouth.—The Town Council invite tenders for the wiring of 12, Gloucester-row, in accordance with specification and conditions which may be seen at the offices of the Borough Electrical Engineer, Sunnybank, Westham. Tenders to the Guildhall, Melcombe Regis, by 3 p.m. on Oct. 3.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of three electric car traversers at certain of the Council's tramway depôts in the South of London. Specification, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Rochdale, Lancs., of three ejector condensers, three electrically-driven circulating pumps, and the necessary extensions of the steam, exhaust, and water pipes, valves, and accessories. Tenders by Oct. 10. See advertisement.

Philippopolis (Roumelia).—The Municipality requires tenders for a concession to construct and work electric lighting and tramways for 50 years. A guarantee of £6,000 is required. Tenders by Oct. 15. On the next day a second adjudication will take place in case there is an offer of £5 per cent. less per kilowatt-hour than the minimum.

Tschatschak (Servia).—The Electricity Company Owtschar und Kablar in this town require two turbines of 750 h.p. each, two generators for three-phase currents, and other plant for the erection of a hydro-electric central station, and equipment of lines of distribution within 40 miles, by Oct. 2. Specifications, etc., may be obtained from the Manager of the Company.

Craivo (Roumania).—The *Moniteur des Intérêts Matériels* (Brussels) announces that the adjudication will take place at 4 p.m. on Oct. 25 (Nov. 7) at the Mayoralty of Craïova, of the concession for construction and working of a line of tramways (mechanical traction) in the town of Craïova. The duration of the concession is fixed at 50 years. A provisional deposit of £200 is required.

Manchester.—The Electricity Committee invite tenders for the supply of ampere-hour and watt-hour meters. Specifications and forms of tender may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester, on payment of fee of £2. 2s., which amount will be refunded on receipt of a bona fide tender Tenders, addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall by Oct. 4.

Greenwich.—The London County Council invite tenders for the manufacture, delivery, and erection at the tramways electricity generating station at Greenwich of the following plant: two 24in. centrifugal pumps and motors, one 3in. centrifugal pump and motor, two 8in. by 8in. three-throw air-pumps and motors, one 3in. artesian well pump, fixed and rotary strainers, etc. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 4.

Antwerp.—The Municipality of Ghent invite tenders for the construction of 10 electric cranes at that port in accordance with the specification, a copy of which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C. An initial deposit of 2,000fr. (£80) is required to qualify

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each tender, and for the tender accepted a further deposit of 18,000fr. (£720). Tenders, in registered envelopes, addressed "Au Collège Echevinal de la Ville de Gand," must be posted not later than Oct. 17. The adjudication will take place on Oct. 19.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49 21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it. 8m. (26 4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

RESULTS OF TENDERS.

Croydon.—The County Council have accepted the tender of Mason, Scott, and Co., Limited, at £519, for water purification plant in connection with the electricity works.

South Wales Collieries.—Messrs. Monté Callow and Co., 6, Ludgate-broadway, E.C., report recent orders for three 40-h.p., four 75-h.p., two 100-h.p., and three 250-h.p. "Perfecta" polyphase controllers for haulage gear.

Ballinasloe (Ireland).—The Joint Committee of the District Asylum have accepted the tender of the Edison and Swan United Electric Light Company, Limited, 12, Dawson-street, Dublin, at £258. 6s. 9d., for the supply and erection of a set of accumulators.

Power-Gas.—The Government of Bolivia have placed a contract with the Power-Gas Corporation, Limited, of 39, Victoria-street, Westminster, for one of their patent gas plants of 600 h.p. capacity. This forms part of the equipment of the generating station at La Paz, Bolivia, which is to be installed for electric tramway and lighting purposes. The equipment of the station includes also two Premier gas-engines of 400 h.p. capacity each.

Curtis Turbines for Japan.—Recently a large contract for Curtis steam-turbines for supplying power to a Japanese street railway was placed with the General Electric Company of America. Information has just come to hand that the Nagoya Electric Light Company's plant is to be extended, and for this purpose the British Thomson-Houston Company, the holders of the patent rights of the Curtis turbine for Great Britain and Ireland, inform us that a contract has been placed through the Japanese house of Mitsui and Co. for a 500-kw. Curtis turbine set.

BUSINESS NOTES.

TRACTION.

Govan.—New tramway routes are in contemplation.

Hartlepool.—The company have reconstructed about a third of the system leased from the Corporation.

Huddersfield.—The question of a medical examination of the tramway employés has again been referred back to committee.

Liverpool.—The Corporation have now decided that 100 cars shall be fitted with top covers, 10 of them to be of the permanent type.

Norwich.—The Norwich Electric Tramways Company have given notice of appeal in the action recently brought by the Corporation.

Paris General Traction Co.—This company announces the abandonment of the Diatto surface-contact system on its tramways from financial considerations.

Luton.—The plans for the tramways have been approved. A suggestion has been made that a service of motor 'buses should be introduced to act as feeders.

Calcutta Tramways.—The directors have declared an interim dividend of 3s. per share, being at the rate of 6 per cent. per annum, on account of the half-year to June 30.

Cleethorpes.—The Urban District Council are to purchase the tramway company's power station at £17,000. The company are to take energy from the Council, the price to be fixed by an independent engineer.

Rosario.—A movement is now on foot to organise a company for the purpose of building an electric railroad at Rosario, a city of about 122,000 inhabitants, in the province of Santa Fé, Argentina.—*Western Electrician.*

Maidstone.—A special meeting is to be held to consider the question of extensions. It has been decided that from Oct. 1 to April 1 the cars shall not run on Sundays between 10.30 a.m. and noon and between 6.30 and 8 p.m.

Middlesbrough.—The Corporation have decided to institute further proceedings for excessive speed on the company's tramways, and also for overcrowding. A committee is to inspect the cars, as the lifeguards are said to be unsatisfactory.

London County Council.—The Council have addressed a communication to the Camberwell Borough Council adhering to their decision not to apply for powers in the 1905 session in reference to the proposed tramway from Forest Hill to the Crystal Palace.

Belfast.—It is reported that Mr. Luke Livingstone Macassey, M.I.C.E., barrister-at-law, has been appointed by the Board of Trade to act as arbitrator in reference to the transfer of the tramway between the Belfast Street Tramways Company and the Corporation.

Tipton.—At the monthly meeting of the District Council a member enquired why the tramway company were allowed to suspend their passenger traffic on the Bloomfield route, and yet use it for the conveyance of oil-tanks, etc. A committee is to consider the matter.

Newcastle.—The line to Ponteland, leaving the existing system at Gosforth, has been completed, and is stimulating building operations along the route, which extends for some eight miles.

Croydon.—The town clerk has been instructed to include in the Corporation's Bill the following provision: "That there be an extension of the tramway system from Thornton Heath, along Grange-road and Church-road, to the borough boundary near the Crystal Palace."

Bath.—The Rural District Council and the Bath Electric Tramways Company are to enter into an agreement under which the latter will pay £20 per mile per year for the keeping in repair of the 18in. margins on either side of the metals for the whole district, commencing Sept. 29.

Cheltenham.—Everything is in readiness for a commencement of the work of extending the Cheltenham light railway to Charlton Kings and Leckhampton. The total length of rail to be laid is six miles, and it is anticipated that the cars will be running over a part, at any rate, of the extended route by Christmas.

Portsmouth.—The Corporation have decided that the surplus from the tramways for the past year of £16,028. 11s. 5d. be carried to a reserve fund. The Corporation have confirmed the negotiations for acquiring premises with a view to their demolition, in order to do away with the "S" curve referred to in these columns some time ago.

Erith.—The Tramway and Electricity Committee, who inspected the Ilford tramways a week or two ago, are to examine other systems, accompanied by the resident engineer, the idea being to study the equipment, rolling-stock, and methods of working. Wood paving is to be used for certain portions of the rack, and a widening of West-street is to be effected.

Swansea Improvements and Tramways Co.—Including £1,037 brought forward, the net profit for the half-year ended June 30, after deducting debenture interest, amounted to £5,072. It is recommended that £1,000 be transferred to reserve in reduction of the amount due to the British Electric Traction Company, and that the usual dividends be paid on the preference shares, carrying forward £2,773.

Lancaster.—The route to the Castle Station only awaits the Board of Trade inspection. It will be remembered that parliamentary powers were obtained by the Lancaster Corporation, under their 1900 Act, to construct a network of tramways in the borough at an estimated cost of £70,000. The first two sections to Scotforth and the Park were completed some time ago, and have been running several months.

Blackpool.—The receipts on the Corporation tramways for the period ending 15th inst., as compared with the corresponding period of last year, show a total increase from all sources of £4,859. 3s. 5d. No less than 771,380 more passengers were carried during the same period, and 46,680 more miles were covered. The increase on the Promenade and Lytham-road route was £3,555. 2s. 8d., on the Marton route £588. 3s. 10d., and on the New-road section £2. 17s. 1d. From annual and other tickets the increase in receipts was £702. 19s. 10d.

York.—It is stated that the company have named a price from £3,000 to £4,000 in excess of the figure (£12,000) suggested when negotiations were entered into three or four years ago, and the rolling-stock to be taken at a valuation. The company's contention is that the difference represents the amount they have since expended on the undertaking, but the Corporation are disinclined to buy at the price, and have given instructions for a valuation to be made by an independent expert, whose report they will be prepared to make the basis of negotiations.

Cardiff.—As a car was proceeding along Cathedral-road on Monday afternoon the overhead wire fell into the roadway. The conductor, having donned his rubber gloves, secured it and wound it about the standard. In a short time the officials had the broken wire tied up again with a rope, and the traffic was at no time disturbed. During the afternoon, however, the conductor had to disconnect the trolley of each car as it passed, the cars "free wheeling" over the section between the standards. The breakage was presumably caused by the wire becoming worn out by the constant "sparking."

Pontypridd.—At a meeting of the Electricity Committee a letter was read from Sir Colin Scott-Moncrieff, who has been appointed arbitrator in connection with the purchase by the Council from the British Electric Traction Company of the old horse tramway, stating that he proposed inspecting the line on Oct. 21. The date was accepted, and the clerk stated that the company were now prepared that the arbitration proceedings should be held in Pontypridd, and not in London. It was decided to advertise for a resident electrical engineer to manage the generating station and tramways, the salary to start at £300 per annum.

Rishton.—The District Council having received a notice from the solicitors to the Blackburn, Whalley, and Padiham Light Railway Company, stating that they intended to apply to the Board of Trade for an 18 months' extension of the time limited for completion of the works, it was resolved that representatives be appointed to attend any conference with the Clayton-le-Moors and Great Harwood Councils for the purpose of agreeing upon united action in regard to the above application. It transpired, however, that as the Clayton-le-Moors Council were well supplied with trams by Accrington, they had decided not to be represented at the meeting.

District Railway.—The Tower Station, which has not been used for nearly 20 years, is, states the *Railway Times*, being demolished under the scheme for the electrification of the company's system. The station was constructed about 25 years ago, and was used as a terminus before the circle was completed. When the circle was finished the station was found to be useless, and it had since been used as a wine-store. Two or three years ago the company, when seeking for certain powers, were able to get provisions made for enlarging the railway at that point. The platforms are being removed, the vacant space facilitating the work of electrification.

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Swindon.—The Corporation's electric tramway system was opened last week. The 3½ miles of route have been equipped with the overhead system and seven cars have been obtained at a cost of about £38,000, and a further three miles of route have been sanctioned. At a luncheon given by the Mayor, Lord Edmond Fitzmaurice, M.P., proposed "Success to the Swindon Corporation Tramways," and expressed the opinion that the venture would be an increased source of prosperity to the town and convenience to the inhabitants. Mr. A. W. Deacon, vice-chairman of the Tramways Committee, replied.

Battersea.—On the reassembling of the Borough Council last week, the Law and Parliamentary Committee submitted a recommendation that the Council concur in the views of the Association of Metropolitan Borough Councils, which provide: "That, when a widening becomes necessary solely by reason of the construction or reconstruction of the tramways, the expense should be entirely borne by the London County Council out of the tramway account"; and that "when an improvement is urgently required irrespective of tramways, the contribution of the local authority should vary according to the importance of the improvement to the borough apart from the tramway traffic."

Glasgow.—The Tramways Committee have approved the following extensions: Paisley-road Toll to Pollokshields and Govan-hill, Pollokshields (present terminus) to Dumbreck-road, Parkhead Cross to Dalmarnock-road, Garngad-road to Blochairn-road, Wilton-street to North Kelvinside, University-avenue to Hyndland-road (Clarence-drive), Dumbarton-road to Broomhill-drive *via* Crow-road, Kirklee-road, Oran-street, Bilsland-drive, Hawthorn-street, etc., Possilpark to Lambhill, Barrachnie to Baillieston, and Tollcross to Uddingston. The proposal to extend from Spiersbridge to Barrhead was defeated. These decisions will come up for confirmation by the Corporation at their meeting on Thursday next.

Trans-Siberian Railway.—The authorities are considering a proposal to establish electric motors on the line. At present the passenger and goods traffic is so great that the number of trains in operation—now totalling 40 to 50 per day—has proved inadequate. Owing to the particularly light construction of the line and weight of rails, together with the limited water supply, it is not possible to accelerate speed, and such a heavy expenditure of time and money would be involved in relaying the lines, that it is thought preferable, notwithstanding the difficulty of obtaining a sufficient staff having the requisite technical knowledge, to introduce an electric motor service, erecting power stations at intervals of 60 to 120 miles, the energy to be distributed over the system in both directions at a tension of 100 000 volts.

Birmingham.—At the meeting of the Tramways Committee on Tuesday, a communication objecting to the Harborne tramway scheme was received from the Opposition Committee. The report stated that a canvass of the ratepayers by the committee resulted in an adverse vote of the proportion of two to one. The Tramways Committee decided that the figures should be carefully analysed and reported upon. Prior to the meeting the members paid a visit to the Miller-street depôt, where, in company with Mr. Baker, the general manager, they inspected a new pattern of cover for the top of the cars, which has been constructed from the designs of Mr. Baker, and which has already been described. The members were favourably impressed with the cover, which is to be put into service, so that its practical utility may be tested before its adoption is finally decided upon.

Swansea.—The Corporation appear to be dissatisfied with the wood blocks used by Messrs. Dick, Kerr, and Co. on a portion of the track, and also with the progress made by them, notwithstanding the assurances of Mr. Prusmann, the borough electrical engineer. Eventually the following resolutions were passed: "That the town clerk be instructed to send a letter to the contractors expressing disappointment and dissatisfaction at the manner in which the work was being carried out, and to say that unless they gave some satisfactory assurances as to the future, the Corporation would have to seriously consider the position"; and "That Messrs. Dick, Kerr, and Co. be informed that the time for the completion of the Bryn-road section expired on Sept. 1, and that the terms of the contract will be enforced." As the result of a deputation of residents from a portion of the main road and from Fabian-street, it was decided that, subject to the approval of the company, in those thoroughfares the tramway track should be paved with wood instead of granite.

Handsworth.—It is reported that the difficulty which arose between the Handsworth District Council and the South Staffordshire Tramways Company respecting the line which has been constructed between the West Bromwich boundary and the New Inns for the purpose of connecting Birmingham with the Black Country is now practically settled. A conference was held last Friday, the company being represented by Mr. J. A. Lycett (managing director) and Mr. B. Kingsford (secretary), and the District Council by Councillor E. J. Abbott (chairman), Councillor F. Tibbitts (chairman of the Tramways Committee), Mr. H. Ward (clerk), and Mr. E. Ward (assistant clerk). After a lengthy discussion, the representatives of the company expressed their willingness to compromise the question in regard to the expenditure incurred on road improvements, and eventually it was agreed to divide this outlay equally. The other points in dispute were dealt with in detail, and finally such good progress was made that all difficulties between the two bodies are understood to be practically at an end. It is hoped that the lease will be sealed to-day, and that arrangements will be made for the Board of Trade either to inspect the lines or to grant a temporary authority to run the cars forthwith. The company are anxious to run a 2½ minutes' service in connection with the cable trams.

Exeter.—The electrical engineer has reported to the Town Council as follows: "The construction of the generating plant for the tramways is well in hand, and some of it will shortly be delivered. A great deal of damage has been done to our cables by the recent excavations in all directions of the telephone and gas companies and of the water department in preparation for the tramways, in spite of constant watching by our men. Over 20 damaged spots have been discovered and made good, but a small interruption of the supply to several consumers in Paris-street on Sept. 10, and a more serious one on Sept. 16, affecting the St. Leonard's and the Alphington-street districts, have occurred from this cause. I am endeavouring to avoid further trouble by constant tests of the cables, and by providing a duplicate supply in the main streets where possible." He further reported that the erection of the tramway poles, which would shortly begin, would enable the committee to do away with some of the existing arc lamp posts, or remove them elsewhere, and rearrange and improve the present lighting and extend it if desired, and that he should be ready to put details and estimates before a joint meeting of this committee and the Lighting Committee at any time. The town clerk reported that the Lighting Committee had recommended to the Council that the joint conference should take place after the reconstruction of the committees in November.

Leicester.—The Tramways Committee reported at Tuesday's meeting of the Town Council that for the summer service next year 121 cars will be necessary for the actual service without providing any spare cars. The Council have an option till Dec. 28 of ordering 50 additional cars on the lines of those now being built, and they recommend that 20 should be ordered forthwith, making the total delivered and on order 120. The committee are of opinion that immediate steps should be taken for putting down an additional engine and generator at the power station, and that this generator should be capable of producing 1,000 kw. It is also considered necessary to provide additional boilers and to extend the car-shed, and it is further proposed to provide an oil store, and to roof in the coal-storage and coal-conveying plant when provided. The estimated cost of the proposed additional plant and cars and works is as follows: 1,000 kw. engine and electrical equipments, two boilers, etc., £22,000; roofs for coal storage shed, coal-conveying plant, and water softener, and new oil store at generating station, £1,000; additional bay to car-shed, track work at car-shed, tower wagon house, etc., £9,000; 50 additional cars and some canopy tops, £28,000. The committee request authority to apply to the Local Government Board for sanction to a loan for this amount, to proceed with the work without delay, and to do by direct labour the engine foundations and track work at the car depôt.

The Life of Tramway Wheels.—In a report presented to the Liverpool Corporation Tramways Committee, the experience with various types of wheels is brought out, the following account of which is given by a North Country journal: "The wheels of the German cars, which were the first to be used in Liverpool in 1898, were steel tyred, and those of the American cars, which followed, were chilled cast iron. The steel tyres, it was found, 'spread' in running, became loose, and were abandoned in favour of the chilled wheel, which was giving much better results on the United States cars. About 1900 the British manufacturers commenced the production of special steel-tyred wheels for street railway service, and experiments with those wheels were carefully watched. In 1902, and subsequently, a number of selected tyres were used in Liverpool. Fifty-two trams are now fitted with steel-tyred wheels, none of which has yet worn out, and therefore final figures cannot be quoted. Very divergent results have, however, been obtained. The mileage per unit of wear has varied to the extent of 50 per cent., indicating the importance of selecting tyres of suitable composition. The average life of the steel-tyred wheel is estimated at 60,000 miles, and of the chilled wheel 35,000 miles. The engineers are now engaged on the design of a new steel-tyred wheel, which, it is thought, will cost 50 per cent. less than the price at which such wheels can at present be bought in the market, and which, it is believed, will afford a life considerably in advance of the average of the former steel-tyred wheels."

Heywood.—The question of the terms upon which the Heywood tramways shall be worked was again before the Rochdale Tramways Committee last week, when the terms suggested by Heywood (described in our issue of the 16th inst.) as an alternative to those advanced by Rochdale and Bury were considered. The first set of the proposals sent in by Heywood was to the effect that Rochdale and Bury should bear the capital charges on Heywood's share of the purchase price of the company's undertaking, and the cost of reconstructing the lines and making certain street improvements. Heywood was to supply current and to have the option of taking over the undertaking at the end of 21 years on payment of £7,000. Adopting the recommendation of their sub-committee, the Rochdale committee declined to accept such terms as these, but they agreed that there was probably the basis of a settlement to be found in another set of proposals in which Heywood suggested that each authority should reconstruct and equip the lines within its own boundaries, maintain the reconstructed system in its area, and supply current for the cars. Rochdale and Bury would run cars over the Heywood lines, and the receipts be pooled and divided on some equitable plan. A meeting of the Bury Corporation was held on the same day, and the conclusion arrived at substantially agreed with that of the Rochdale Corporation. The Bury committee replied that they could not consider the first proposal, but they were prepared to discuss the second one. They would furnish the cars and the staff, and the receipts within Heywood borough would be handed to Heywood, less working expenses and a commission upon the receipts. A further conference between the three authorities subsequently took place, when the lines of Heywood's second proposal were accepted as an approximate basis for an agreement, some details being left over for further discussion. On the question of working expenses, Rochdale and Bury suggested that the payment should be 5d. per car mile run, but this and other matters of detail were left over for consideration by the committees of the respective Corporations. At a meeting of the Heywood Tramway Committee in the evening the town clerk was instructed to suggest that another meeting be held at an early date to deal further with these details.

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Newcastle.—The following is a summary of the information which has been circulated (in accordance with the request of Councillor Cail) among members of the Corporation in regard to the question of depreciation and the preparation of estimates. The report of Mr. le Rossignol states that the total depreciation going on in the present electrical equipment is at the rate of £14,898 per annum. In eight years, which Mr. le Rossignol estimates is the average "life" of the greater part of the items enumerated, this will amount to £119,184, and this can be met by laying aside yearly out of revenue the sum of £12,700. and allowing it to accumulate at compound interest at 3½ per cent. The city engineer (Mr. F. Edge) estimates that renewals to the permanent way can be met by laying aside annually a sum of £12,000, and accumulating same at compound interest. These amounts apply to the present total of capital expenditure—namely, £889,779—and will require to be increased as that capital expenditure increases. The city engineer estimates that special work, junctions, and such portions of the track as receive the greatest wear will require to be renewed in eight years, at an estimated cost of £51,154; that a large proportion of the track will require renewal in 12 years, at an estimated further cost of £88,581; and that the remainder of the track will require renewal at the end of 15 years, at an estimated expenditure of £9,694. At the end of 16 years the first portion of the track will again require renewal, at an estimated cost of £51,154 At the end of 24 years the first portion will require renewal for the s cond time, and the second portion of the track, which was renewed at the end of 12 years, will again require renewal—the total estimated expenditure at this period being £139.735. The Finance Committee present the following resolution: "That the estimates for the year ending March 25, 1905, as recommended by the sub-committee on annual estimates, be confirmed; and that a renewal fund shall be created, and that last year's surplus shall form the nucleus of the said fund; and the committee hope by a thorough revision of the whole system to considerably augment the renewal fund year by year." There appears to be no provision for depreciation as required by the Corporation's Act of 1899. The city treasurer recommends that an addition be made to cover same. The estimates for the year ending March next give—car mileage, 4,600,000; total receipts, £206,400; expenses, £70,919; stores, £89,085; sundries, £18 210; and maintenance, £31,830.

Cardiff.—Mr. Arthur Ellis, Cardiff borough electrical engineer and manager, has issued his report on the working of the tramways for the year ending March last. The total income from all sources is set down at £108,442, and the working expenses at £69,478, leaving a gross profit of £39,964. The actual net surplus balance was £7,724. There was a total disposable balance of £14,976, in addition to £5,796 allocated to a loans fund suspense account, and these amounts represented the excess income over expenditure since the inception of the system. The working expenditure per car mile was equal to 5·818d. per car mile. The ratio of working expenses to receipts worked out at just under 62 per cent. The greatest burden arose in the amount required to be paid out of revenue for loan charges, which alone absorbed 3·053d. per car mile, the capital at the end of March amounting to £687 222. The receipts from fares alone total £101,794, but, says Mr. Ellis, "we are really not getting what we are entitled to receive," and "if you wish to see larger profits it can only be done by increasing or equalising the fares upon the various sections. If, on the other hand, the convenience of the public is considered the most important, then the results obtained cannot well be criticised. You cannot, however have both." The impression that the expenses were heavy was not, he considered, warranted. It is hardly fair, remarks Mr. Ellis, to make one given route return more per car mile than another by having unequal fares. "The public cannot reasonably expect the tramways to support the rates, and at the same time have the benefit of low fares," the report proceeds. "If they want the former they can only obtain the same by subscribing towards it by paying higher fares." Then he goes on, "The tramways have had to withstand a great deal of criticism both fair and unfair, but I think it a pity when some of our critics compare the net profits of the municipal undertaking's with the gross profits of the public company. Prepared on the basis of a public company the tramway accounts would show a profit last year of over £41,325, equivalent to a return of 60 per cent. on the capital, assuming the full amount to have been expended at the commencement of the year, which is not so, the capital at the time being £601.487." The passengers carried numbered 23,574,204, equivalent to 143 times the population, as against 17 718,992 in the previous year. The accident list is thus tabulated: collisions, 1,071; persons knocked down by cars, 81; falling when leaving or boarding cars, 457; miscellaneous, 82—total, 1.153. A supplementary report will be issued before the matter comes up for consideration. Mr. Ellis has been instructed to prepare a report as to the space which could conveniently be let for advertisements without disfiguring the cars, after which tenders will be invited for advertising.

LIGHTING AND GENERAL.

Belfast.—A cable is to be extended to Malone-park at a cost of £175.

Southend.—The Town Council have decided upon extensions of the electrical plant, mains, etc., at a cost of £56,000.

Kanturk.—A public meeting is to be called to consider the advisability of taking practical steps towards promoting an electric lighting scheme.

Dollar.—Messrs. Crompton and Co. are extending their electric wires in various parts of the burgh. Additional Nernst lamps are to be erected.

Crowbrough.—Subject to certain restrictions, permission has been given to the National Telephone Company, Limited, to put down underground wires.

Sunnybrow.—It having been decided to light Sunnybrow by means of electricity, a start was made with the works on Tuesday.

Swansea.—Arrangements have been made to instal both the National and Swansea municipal telephones at Skewen. It has been resolved to apply for telegraph facilities at Dynevor Post Office.

Carnarvon.—A commencement has been made by the National Electric Construction Company with the work of laying down cables in the streets for the purpose of supplying the town with electricity.

Weybridge.—The Urban District Council are asking the Board of Trade not to grant the Urban Electric Supply Company a license to supply current to Walton without giving the Council an opportunity of objecting.

Coventry.—The Corporation have received the sanction to the borrowing of £30,388 for the extension of the electricity works, and also to the borrowing of £160 for purposes connected with the supply of electrical energy.

Cleethorpes.—The Council have agreed to purchase the Cleethorpes generating station and plant for £17,000, these figures to be verified by an accountant to be appointed by the Council, the purchase to be completed on April 3, 1905.

Guildford.—The electric light failed on Sunday evening about eight o'clock, some of the churches where the services had not concluded being plunged in darkness. It is reported that the current was not restored until Tuesday evening.

Lancashire.—A conference is to be held with regard to concerted action of the various councils through whose districts the Lancashire Electric Supply Company propose to lay their electric mains. The company have offered 2½ per cent. on the takings.

Electric Meters.—We hear that the British Westinghouse Company have recently commenced an action against the Ferranti Company for infringement of their alternating-current meter patents. The case will be heard probably early in the New Year.

Wellington.—A special meeting of the Urban District Council is to be called to consider the report of Mr. R. A. Felton, M.I.C.E., and Mr. Maclean Wilson, M.D., B.Sc., on the sewage-disposal schemes, and the surveyor's report on electric lighting and refuse destructor.

Tewkesbury.—Several notices of intention to apply for a provisional order having been received, the town clerk has been instructed to take all such steps as may be necessary to obtain a provisional order enabling the Council to supply electricity within the borough.

Brush Bulletin.—The miniature edition of the Brush Electrical Engineering Company's bulletin No. 4 has just been issued, and deals with incandescent lamps, fittings, and accessories, giving at the same time views of a number of different classes of installation carried out the firm.

Basingstoke.—An enquiry has been held into the Town Council's application for sanction to borrow £16,450 for purposes of electric lighting. Various figures were placed before the inspector, including the following: population about 11,000; rateable value, £48,868; other loans outstanding, sanctioned, or in contemplation, £60,346. A petition from a number of the leading business firms who would be willing to use electric power and lighting was put in.

Luton.—The electrical engineer's last report states that since July 15 last 25,162 units had been generated, an equivalent to 937 8-c.p. lamps and five motors of 20¼ h.p. connected, making a total of 189 consumers, with 11,927 lamps and 58 motors of 199 h.p.; and that the units generated showed an increase of 48 per cent. over the corresponding period of last year. The report was received as very satisfactory. An extension of cable is to be made in the High Town-road district, at a cost of £142.

Eltham.—The Electricity Committee of the Borough Council have recommended the Council to sanction the expenditure of about £30,000 for the purpose of electric sub-stations, cables, etc., to Eltham and Lee Green. The Council at present are taking a supply of electricity for the Lee district of Eltham from Blackheath and Greenwich Company, under an agreement dated Jan. 31, 1902, and the total consumers number only 23. There are 203 electricity consumers in Woolwich and 84 in Plumstead.

Electrical Contractors' Association (Incorporated).—This association has been registered with an unlimited number of members, each liable for £1 in the event of winding-up. The objects named are to promote and protect the trade of electrical engineering in Great Britain, and to take over (so far as the same may be legally vested in this association) the property of the unincorporated association known as the National Electrical Contractors' Association. The word "Limited" is omitted from the title by license of the Board of Trade.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Callender's Cable and Construction Company's further issue of £100,000 4½ per cent. first mortgage debenture stock, and to allow the following securities to be quoted in the official list: Metropolitan Railway Company's 3½ per cent. preference stock, 3½ per cent. "A" preference stock, 3½ per cent. debenture stock, and 3½ per cent. "A" debenture stock; Urban Electric Supply Company's further issue of 16,000 ordinary shares of £5 each fully paid, Nos. 34,001 to 50,000.

Constantinople.—After negotiations extending over two years, the German Telegraph Company for Eastern Europe has succeeded, Reuter says, in obtaining a concession for laying and working a cable between Custenje and Constantinople. Berlin and Constantinople will thereby be connected by a special wire, which it is proposed to extend ultimately to the Persian Gulf and the Far East. This concession interferes with the preferential rights of the Eastern Telegraph Company, which some time ago lodged a protest with the Porte, and it is now presumed that the company will demand an indemnity from the Ottoman Government.

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Scarborough.—An apprentice wireman in the employ of the electric supply company met with a fatal accident at the company's transforming sub-station, St. Nicholas-street, on Tuesday. The exact cause is not known, but it is thought that deceased, while stooping, touched the main electric wire from the works with his forehead.

Kensington.—The Post Office are about to lay pipes for telephone wires, etc., in Harrow-road (south side), Gledhow-gardens (east side), Kensington Park-gardens (north side), Oxford-gardens (north side), Earl's Court-square (west side of western section), Holland-road (west side), Kensington High-street (across), Basil-street (north-west side), Church-street (east side), Abingdon-villas (north side), Essex-villas (south side). Notices from the following electric lighting companies relative to proposed extensions of their mains, etc., in the borough have been agreed to: Kensington and Knightsbridge Electric Lighting Company, Elvaston-mews; Brompton and Kensington Electricity Supply Company, Warwick-road (two) and Alma-terrace; Notting Hill Electric Lighting Company, Royal-crescent, Aubrey-walk, and Victoria-gardens.

Dartford.—According to the last accounts, there was for the year ending in March last a deficiency of £2,316, but, taking into account outstanding credit amounts, the actual loss for the year was £1,619. The net expenditure was about balanced by the net income in the ordinary revenue account, and the deficiency represents the amounts paid for interest and repayments of loans, which had in March reached a total of £34,500. Up to the last few months the inhabitants have been slow in adopting the electric light, and, as the accounts show, only £1,418 was received from private consumers, whilst the contribution for public lighting figured as £934. One hundred and ninety-two thousand units were sold out of 264,000 generated at the works, 17,000 units were used at the works, and the quantity described as "unaccounted for" is 54,000.

Hull.—Amongst the recent applications for current is one from the North-Eastern Railway Company for 222 16-c.p. lamps for the Paragon Station, and also power for working the signals. A report on the lighting of New Jameson-street and New Clarence-street, made by the chairman and engineer, was read at the last meeting of the Electric Lighting Committee. They stated that they had obtained a price of £228 for the supply and erection of the arc lamps in New Jameson-street and £83 for the supply of the Nernst lamps in New Clarence-street, and as the prices were slightly less than those for former lamps, and owing also to the fact that it was necessary to proceed with the lighting of those streets without delay, they had instructed the two firms—Messrs. Oliver and Co., Woolwich, and the Keighley Electrical Engineering Company—to proceed with the necessary work. A brief discussion followed on the question of street-lighting by electricity.

Ormskirk.—The Urban District Council have practically adopted a scheme for the electric lighting of the town at a cost not to exceed £15,000. At the last meeting of the Guardians, however, the following minutes of the Electricity and Building Committee were confirmed: "Resolved—That estimates be obtained for the sinking of a new borehole pump and electrical motor of suitable size to drive the pump. Electric lighting question: Read letter from the Ormskirk Urban District Council enclosing copy of letter from the National Electrical Construction Company offering current for lighting at 4d. per unit, and for power at 1½d. per unit, and if they gave better terms to other parties, they would reduce those terms. The electrical engineer was heard in explanation of the same, and on the terms offered by the Electrical Construction Company. It was resolved that it was desirable that the Board of Guardians should themselves undertake the electric lighting and motive power required for the workhouse, and the scheme prepared by Mr. Peers be proceeded with."

Battersea.—The cost of the public lighting by electricity of the Shaftesbury and Beaufoy Estates, which is now to be carried out, is above the previous estimate by £447, owing to the price of copper having considerably advanced since the original estimate was prepared, notwithstanding that reductions have been effected in the other items. The following particulars are available relative to applications for the supply of electrical energy to premises within the borough, including the Council buildings—viz.: quarter ended Sept. 30, lighting, number of applications, 685, June 14 638 + 47; actual, 658 (589) + 69; applied for, 50,424 8-c.p. (47,385) + 3,039; actually supplied, 46,973 8-c.p. (41,085) + 5,888; motive power* applied for, 696¾ h.p (638¼) + 58½; actually supplied, 609½ (450⅛) + 159¾. * 48 amperes for charging accumulators applied for and 28 amperes connected; 78 amperes for heating and cooking applied for and 48 amperes connected; 10 amperes for medical apparatus applied for and connected. All worn-out lamps at the libraries are to be replaced by new Ediswan lamps.

Fire.—We are informed that the fire which occurred at the Metropolitan Electric Supply Company's Tower-street sub-station, W.C., at 10.15 a.m. on Saturday last (24th inst.), arose through the short-circuiting of copper strip laid in compound, the strip leading up to the direct-current switchboard. Large quantities of gas poured off the compound owing to the heat, became ignited and destroyed the whole of the direct-current Ferranti switchboard and some E.C.C. boards, putting them entirely out of service. The copper strip bending in all directions caused short-circuits on the low-tension 'bus bars. A large part of the supply on one side of the company's network is consequently laid off, the other side fortunately standing. The fire was extinguished at 10.45 a.m. and some part of the supply was restored by that time, the whole being put in order by 12.50 (noon). With regard to the narrow escape of an employé, we learn that the smoke poured upstairs into the high-tension room (which is approached by means of an iron staircase) and was so dense that the man in charge could not get down the steps; he was compelled to make his exit through the window, and, very fortunately, was not seriously injured. Had it not been for the presence of compound but little damage would have been caused, as the station itself is practically fireproof throughout.

Hammersmith.—We understand that the Council have agreed to an application by the Society of Motor Manufacturers and Traders for a supply of electric current to Olympia in connection with a motor exhibition they intend holding there in February next. The society have concluded a contract with the proprietors of Olympia whereby the building will be altered and properly fitted up for exhibition purposes, including the wiring for lighting the premises by electricity. It is estimated that the lighting will involve the use of between 10,000 and 20,000 8-c.p. lamps, and the society are prepared to pay at the rate of 4d. per unit for the supply of electricity, and to guarantee a minimum payment of £500 at the first exhibition, which will be held from Feb. 10 to 18 next. It will be necessary to lay a special main at a cost of £1,898 to give the required supply, and in consideration of this the society will deposit with the Council £750 as security for the due payment of the current consumed and the proper care and custody of the instruments, the deposit to be retained by the Council until the installation is disconnected from the supply mains on the close of the exhibition, when any amount due to the Council would be deducted therefrom, and the balance (if any) returned. The society are also prepared to agree to take whatever electrical energy they require for extra lighting and power at their next three exhibitions at the said premises. The lighting of Shepherd's Bush Common by means of arc lamps is being proceeded with.

London Gazette.—The partnership between Joseph Marks and Hugh Clarkson, electricians and electrical engineers, at 4, Gothic-arcade, Snow-hill, Birmingham, under the style of "Marks and Clarkson," has been dissolved by mutual consent. The creditors of the Electrical Machinery Developments Company, Limited, are required, on or before Nov. 19, 1904, to send their names and addresses to Mr. F. N. Lowther, 151, Cannon-street, London, E.C., liquidator. Frederick Stone, 47, Full-street, Derby, has been released from trusteeship in the estate of Henry John Furniss, electrician, 5A, Queen-street, Derby. A first and final dividend of 4d. in the £ has been declared in the estate of the Warrington and District Electric Light and Power Company, Limited, 115, Sankey-street, Warrington. Messrs. Barnaby and Co., Limited, College-street, Rotherham, electrical engineers, have been wound up voluntarily. Mr. Henry James Allen, of St. Peter's-close, Sheffield, has been appointed liquidator. The Bath Electric Manufacturing Company, Limited, has been wound up voluntarily; Mr. Augustus C. Comley, Albion-chambers, Bristol, has been appointed liquidator. The partnership at 39 and 40, Woodcock-street, Birmingham, by William Henry Bradbury and James Marsden, under the firm of Bradbury, Marsden, and Co., electric light fittings manufacturers, has been dissolved by mutual consent. A receiving order has been made out on creditor's petition in the estate of James Marsden, electric fittings manufacturer, 40, Woodcock-street, Birmingham. A receiving order has been made out in the estate of Henry Coles, electrical engineer, 10, York-street, Swansea.

Leeds.—An enquiry has been held into an application of the City Council for sanction to borrow £100,000 for extension of electric lighting plant. The Town Clerk (Mr. R. E. Fox) stated that the electric lighting undertaking was established by the Yorkshire House-to-House Electricity Company, Limited, under the Leeds Electric Lighting Order, 1891, and was purchased by the Corporation from the company at the price of £217,420 in the year 1898. The Corporation, in July, 1901, obtained sanction to the borrowing of £505,400 for an extension of stations, etc., and in December, 1903, to a further sum of £220,000 for extensions of mains. The forward policy of the Corporation had been justified by the progress of the undertaking. In September, 1898, the number of consumers for lighting purposes was 770; in March, 1904, the number was 3,612. The number of consumers for power and heating purposes in 1898 was six; in March, 1904, it was 376. The total number of consumers in 1898 was 776; in March, 1904, it was 3,988. In 1898 the number of 35-watt lamps (or equivalent) connected to the mains, including motors, was 65,328; in March last it was 307,849. The horse-power of motors connected to the mains was 20 in 1898 and 2,963 in March this year. The capital expenditure in 1898 was £217,420; in March last it amounted to £752,509. The kilowatts of plant installed was 2,400 in 1898; in March, 1904, it was 8,740. In March, 1899, the maximum load on plant in kilowatts was 1,500; in March last it was 5,040. The units sold in the first complete year up to March, 1900, was 2,005,840; in the year ending March last it was 6,271,186. The revenue for the year ending March, 1900, was £36,221, as compared with £76,721 in the year ending March last. The expenditure on revenue account, including interest and redemption of debt, was £27,719 in the year ending March, 1900, and in the last year it was £72,290. The surplus profits in 1900 were £8,502, and last year they were £3,431. A sum of £26,361 of the proposed loan was in respect of expenditure already incurred, or on which liability was already incurred, and £72,272 was estimated in respect of further expenditure. Generally speaking, the present application was in respect to additional plant, nothing being included for mains, sub-stations, or meters.

Erith.—The report of Mr. G. E. Heath, electrical engineer, on the electricity supply undertaking for the year ending March 31, 1904 states that the plant is now in good working order throughout, and that during the latter part of the past year a great improvement had been effected in the street-lighting, which is now reliable and efficient. The Nernst lamps have been replaced by incandescent lamps for street-lighting purposes, but, the engineer says, as such a large amount of good work has been done with the Nernst lamps in other districts, it was only just to them to mention that in this district they were worked under extraordinary and adverse conditions. When some further slight alterations had been made, he had no doubt that the arc lamps would be in a perfectly satisfactory condition. The number of 8-c.p. lamps connected March 31, 1904, was 13,588, the lamp connection at the beginning of the year being 3,088, thus showing an increase of

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10,500 8-c.p. lamps during the year. The aggregate horse-power of motors connected was 189 h.p., all of which had been connected during the past year. For street-lighting there were 17 arc lamps of 1,000 c.p. each, 87 half-ampere Nernst lamps, and 425 incandescent lamps of two by 8 c.p. each, making a total of 529 street lamps connected. The total mileage of cable laid in the district was 56·6 miles, made up of 11·44 miles of high-tension feeder, 8·96 miles of low-tension distributor, and 36·2 miles of street-lighting cable. The maximum load for the year was 233 kw. on Dec. 18, 1903, and the minimum load was 48 kw. on May 17, 1903. The cost per unit sold for wages amounted to no less than 1·001d., this being out of a total of all costs of 2·563d. per unit. The gross profit of £1,020. 8s. 5d. had to be set aside for interest and redemption of capital moneys, leaving a net deficit of £781. 8s. 3d. after meeting these charges, amounting to £1,801. 16s 8d. The price per unit obtained for street-lighting was only 1·511d. The total costs are 1·828d. per unit. The balance, being gross profit carried to the net revenue account, practically covered the amount of interest, and this, for a first year's working, was very gratifying, as all repairs and modifications to mains, buildings, plant, etc., had been paid for out of revenue account. If the undertaking were a private company, it would have been in a position to pay a small dividend of, say, 2¼ per cent., and place the sum of £159 to a reserve fund. The following figures are given: Total capital expended, £38,393. 5s. Number of units sold—private lighting, 216,133; street-lighting, 148,530—total, 364,663 units. Equivalent number of 8-c.p. connected, 13,588; number of public lamps—17 arc, 87 Nernst, 425 incandescent. Maximum load in kilowatts, 233. Gross revenue, £4,914. 15s. 10d.; gross expenditure, £3,894. 7s. 5d.; gross profit, £1,020. 8s. 5d.; interest and sinking fund, £1,801. 16s. 8d.; balance on year's working (deficit), £781. 8s. 3d.; gross profit, £1,020. 8s. 5d. Mr. Heath adds: "It is to me very gratifying that sufficient demand should have arisen during the year to warrant extensions to buildings and plant, and also to necessitate increasing the capacity of sub-stations. Such extensions now being carried out include one 500-kw. alternator and engine, with accessories, and two Lancashire boilers, mechanical stokers, economiser, etc., engine-room, boiler-house, and office extensions, and the provision of above-ground sub-stations at Erith and Belvedere main transforming centres. The coal bunker has already been enlarged to accommodate 250 tons of coal. Some small mains extensions are in hand, but in future I would strongly recommend that the present network be fully developed before any further outlying districts be taken in hand." The Council had previously resolved to apply for sanction to borrow £11,500 for extensions. It is now intended, in lieu of these several loans, to apply for £20,000 on account of the electricity supply undertaking, made up as follows: Capital expenditure in excess of loans sanctioned, £10,400; mains and transformers, £5,000; meters and house services, £3,600; electric fittings, motors, etc., £1,000—total, £20,000. The above-mentioned sums of £5,000 and £3,600 will probably be sufficient to cover the expenditure on mains and transformers and meters and house services for the next two years. As the alterations to the offices at the works are practically completed, the resident engineer is to obtain furniture and fittings at an approximate cost of £20. Messrs. Callender's Cable and Construction Company, Limited, requiring an additional 50 kw. of electrical power at their works, the necessary additional transformers to enable this supply to be given will be purchased at an estimated cost of £140. Subject to agreements the Council will undertake the wiring of a number of premises upon the terms of the assisted wiring scheme, we understand that in the future all cable troughing is to be made at the electricity works. The National Telephone Company, Limited, are about to lay their main cable underground; this will, in addition to diverting the poles at the new bridge, at Lower-road level crossing, clear the proposed tramways route of the company's overhead wires at several points.

PROVISIONAL PATENTS, 1904.

SEPT. 19.

20129. Improvements in mechanism for use in conjunction with apparatus for utilising electromagnetic or "Hertzian" waves. Michael Holroyd Smith, 5, St. Nicholas-road, Upper Tooting, London.

20134. Improvements in controlling apparatus for electric motors. John Klinkenberg, 121, West George-street, Glasgow. (Complete specification.)

SEPT. 20.

20200. Improvements in apparatus for controlling and operating the points of electric railways and tramways. Edward Cross, "Dunedin," Oxford-street, Rotherham, Yorks.

20219. Improvements in electricity meters. George Hookham, 4, New Bartholomew-street, Birmingham.

20233. An improved electric bracket made from a tube only. George Henry Ide, 154, Sherlock-street, Birmingham.

20277. Improved manufacture of incandescence bodies for electric glow lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

20278. An improved electric switch. Charles Ernest Hunter and William Hodges Warren, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20285. Improvements in fireproofing electric cables. Francis Martin, 24, Southampton-buildings, Chancery-lane, London.

20287. Improvements in or connected with the shade-holders of electric and other lamps. William James Davy, 40, Chancery-lane, London.

SEPT. 21.

20314. Improvements in and connected with electric capstans. Walter Dixon, 154, St. Vincent-street, Glasgow.

20324. A new or improved safety device for electric railways. Frank Walter Hayward and Reginald Charles Fox, 23, King-street, Norwich.

20329. Improvements in telephones. John Young, 21, Gloucester-walk, Campden-hill, Kensington, London.

20351. An improved system and apparatus for electrically operating bulkhead doors, hatches, or the like. Allen Parry Jones, 55, Chancery-lane, London. (The "Long Arm" System Company, United States.) (Complete specification.)

20363. Improvements in electric insulators. Edmund Goolding, 335, Liverpool-road, Islington, London.

20380. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

20381. Improvements in rectifying alternating current. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

SEPT. 22.

20413. Improvements in hangers and ears for electric conductor wires. Joseph Heap, James Bailey, Henry Heap, Abraham Richardson, Robert Billington, James Haydock, Thomas Smith Jones, and Thomas Brierley, Penny Bank-chambers, Waterhouse-street, Halifax.

20473. Improvements in electric transforming devices. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

20478. Improvements in and relating to telegraph systems. Reginald William James, 1, Queen Victoria-street, London. (Albert Cushing Crehore, United States.) (Complete specification.)

SEPT. 23.

20510. Improved electrical-pressure ironing machine. Albert Ernest Hacking and John Pycroft, 11, Burlington-chambers, New-street, Birmingham.

20523. Improvements in hangers or ears for overhead trolley wires. William Henry Allen and Levi Thomas Allen, 6, Bank-street, Manchester.

20528. A new or improved form of electrolytic meter. William Arthur Snape and Louisa Calvert, 62, Stoke Newington-road, London.

20531. Improvements in or relating to protectors for collectors, collector rings, and the like in electric machines. Alfred Julius Boult, 111, Hatton-garden, London. (Elektricitäts-Ges. Zschockelt m. b. H., Germany.) (Complete specification.)

20535. Improvements in electrical measuring and indicating instruments. Herbert Brandon White and James Pitkin, 53, Chancery-lane, London.

20536. An improved bath for therapeutic treatment by means of electric and other forms of radiant energy. William Johnson Smyth, 53, Chancery-lane, London.

20548. Improvements in automatic controllers, especially applicable for use in electric metering systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

20549. Improvements in dynamo-electric machines. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

20550. Improvements in and relating to the control of electric motors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

20552. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

20553. Improvements in vapour electric apparatus. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

20554. Improvements in apparatus adapted for indicating or automatically controlling or varying the flow of electric current. Guy Cary Fricker, 46, Lincoln's-inn-fields, London.

20562. Improvements in light-regulating switches for incandescent electric lamps. Pedro Cardoso de Azevedo, 47, Lincoln's-inn-fields, London.

SEPT. 24.

20568. Electro-pneumatic telegraph. John Donald Macmillan, Granston Manor, Abbeyleix, Queen's County, Ireland.

20573. Improvements in or connected with starting devices for three-phase motors and other electric machines. William Henry Eccles, 16, Worfield-street, Battersea, London.

20585. Improvements in or relating to the overhead conductor system for electric traction. Arthur Augustus Brooks and George Andrew Watson, 12, Gardner-road, Liverpool.

20609. Improvements in electric meters and measuring instruments. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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29627. A new or improved method for the electrolytic manufacture of water-jackets, casings, and the like. Alexandre François Bosquet, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 10, 1904, being date of application in France.) (Complete specification.)

29630. An improved fan or exhauster for the electrification of air or other gases. Frédéric de Mare, 72, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 24, 1903, being date of application in Belgium.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 13, 1904.

1903.

13487. Selective electrical signalling apparatus. Evans-Jackson. (American Electric Telephone Company.)

14369. Electric roasting oven. Dutertre and Nodet.

17832. Devices and apparatus for operating the tongues of points and frogs for electric and other tramways and railways. Bullough.

21240. Starting switch and automatic cut-out adapted for series-wound electric motors. Smith.

21969. Electric arc lamps. Lane and Adams.

23333. Magnetic separators for ores or like materials. Moss.

25153. Arc lamps. Cibié.

25284. Support for electric cables. Ruthven-Murray.

1904.

1128. Electric light fittings. Veritys, Limited, and Ebbutt.

2459. Compensating systems for alternating electric current generators. Creighton. (Date applied for under International Convention, Jan. 31, 1903.)

6558. Electrical signalling system for signalling on railways in case of accidents or stoppages. Wessel and Herding.

7562. Arc lamps. Nomdedeu. (Date applied for under International Convention, April 11, 1903.)

9385. Apparatus for the automatic regulation of current in electric lighting installations. Aktiengesellschaft Brown, Boveri, et Cie. (Date applied for under International Convention, April 25; 1903.)

11219. Electric switch for intermittently illuminated signs. Nusch. (Hölscher.)

11542. Apparatus for transforming a single-phase alternating electric current into single-phase or polyphase alternating electric current of lower frequency. Schulka.

12188. Method of producing electric energy by the utilisation of the chemical energy of any suitable combustible without the employment of thermal engines. Tourneur. (Date applied for under International Convention, June 11, 1903.)

12379. Adjustable support for electric light fittings. Irving.

13170. Hertzian wave projecting and receiving apparatus adapted to indicate or give warning of the presence of a metallic body such as a ship or a train in the line of projection of such waves. Hülsmeyer.

14617. Terminals for electric wires and cables. Lycett.

15472. Electric incandescent lamps. Frey.

16814. Electric installation for transmitting the time. Perret. (Date applied for under International Convention, Aug. 11, 1903.)

17167. Electric tremblers or contact breakers. Boulanger and Smith.

17285. High-tension current insulator. Kleinsteuber.

17484. Receiving system for wireless communications. Harrison. (Date applied for under International Convention, Feb. 8, 1904.)

17595. Bends, elbows, and other angle pieces for electric conduits. Conduits and Fittings, Limited, Edwards, and Brown.

17650. Electrolytic rectifier. Büttner. (Date applied for under International Convention, Aug. 13, 1903.)

18095. Telephone switchboard cords and like flexible electric conductors. Burton and Burlingham.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	98-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅞-3¼
—— 4 per cent. Mortgage Debenture Stock	100	–	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-⅝
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	94-97
—— 4½ per cent. 2nd Debenture Stock	100	–	70-75
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9¼-10¼
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	3	–	1¼-2
—— 5 per cent. Debentures	100	–	90-95
Edison and Swan United, "A" Shares, 1-93,261	3	–	⅛-¼
—— "A" Shares, 01-017,139	5	–	1-2
—— 5 per cent. Debentures	100	–	79-83
—— 4 per cent. Deb. Stock, Red.	100	–	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	93-98
W. T. Henley's Telegraph Works, Ordinary	5	–	10¼-11¼
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	18¼-19¼
—— 4 per cent. Debentures	100	–	100-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	35-38
—— 5 per cent. Bonds	100	–	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼
—— 4½ per cent. Debenture Stock. Red.	100	–	105-105
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10⅝-11¼
—— 7 per cent. Preference	5	–	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	7¼-8
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	107-110
Charing Cross and Strand, Nos. 1-70,000	5	–	8-8¼
—— 70,001-80,000	5	..	7¼-8
—— 4½ per cent. Cum. Pref.	5	–	5¼-5¼
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 40,001-80,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	102-104
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	108-111
City of London, Ordinary	10	–	10¼-10⅜
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	102-105
County of London Electric Supply, Ordinary	10	–	8-9
—— 6 per cent. Cum. Pref.	10	–	11¼-12
—— 4½ per cent. Debentures Prov Certs. All pd. Rd.	100	–	101-104
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	6-6¼
—— 6 per cent. Cum. Pref.	5	–	6-6¼
—— 4½ per cent. First Mort. Deb.	100	–	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	100-103
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7¼-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	101-105
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture stock Red	100	–	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10¼
London Electric, Ordinary	3	–	1⅜-2¼
—— 6 per cent. Pref.	5	–	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	97-100
Metropolitan Ordinary	10	–	16-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	111-115
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	–	96-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14¼-15¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	100-103
Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,310	5	–	5⅜-6¼
—— 4 per cent. Debenture Stock	100	–	98-102
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2⅜-3¼
—— 4 per cent. Debenture Stock	100	–	85-87
South London, Ordinary	–	–	4¼-4⅜
South Metropolitan Electric Light and Power Co., Ord.	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1¼-1¼
—— 4½ per cent. 1st Mort. Deb.	100	..	105-109
—— Ditto, June, 1904	–	..	–
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	14¼-15¼
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4⅜-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4⅜-5¼
Westminster, Ordinary	5	–	12¼-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6-6¼
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅜-5⅝
—— Ord.	5	..	6¼-6⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	–	139-142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	100-102
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	¾-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅝-13⅞
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.	100	–	97-100
—— Ord Pref.	100	..	100-103
—— Non. Cum. 5 per cent. Pref.	10	–	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	–	104-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9¼-10
—— 6 per cent. Cm. Pt., 30,001-60,000	10	–	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100	..	117-120
—— 4½ per cent. 2nd Deb. Stock	100	..	94-97

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Name.	Amount paid. £		Last price. £
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	–	3¼-3½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	102-105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	94-99
Calcutta Tramways, Limited, 1-102,268	5	..	7-8
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways, Nos. 1-480,000	1	–	1⅛-1¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4½-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	–	3½-4
—— 4 per cent. Debenture Stock	100	–	88-91
Kidderminster and District Lighting and Traction, Pref.	5	–	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10½-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103-105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¾-1
—— 4½ per cent. Deb. Stock, Red.	100	..	98-100
Milwaukee Electric Rail and Light. 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	5	–	½
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100	–	88-93

Name.	Amount paid. £		Last price £
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12-12½
—— 5 per cent. Cum. Pref.	10	–	9¼-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk.	100	–	102-105
Potteries Electric Traction, Ordinary 20,001-40,000	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8½-9½
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	–	1
—— £101,132 6 per cent. Preference	1	–	1
—— £528,093 4½ per cent. Debenture Stock	100p.c.	–	100 p.c

Electric Railways.—

Name.	Amount paid. £		Last price £
Central London, Ordinary	100	–	85-87
—— 4 per cent. Pref.	100	–	100-102
—— ,, ,, deferred	100	–	79-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	106-109
City and South London, Consolidated Ordinary	100	–	48-50
—— 4 per cent. Debenture Stock	100	–	105-108
—— 5 per cent. Pref. Stock '91	100	–	122-125
—— ,, ,, ,, '96	100	–	117-120
—— ,, ,, ,, '01	100	–	115-118
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10½
—— Ordinary, 1-50,000	10	–	3½-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	..	98-98½
Waterloo and City, Ordinary	100	–	86-89

Telephones.—

Name.	Amount paid. £		Last price £
National Telephone, Preferred	100	–	104-106
—— Deferred Stock	100	–	91-93
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5¾
—— 3½ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	104-106
—— 4 per cent. Prov. Cert.	—	..	67-69
Oriental Telephone and Electric Company	1	–	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1 1/16-1 3/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 24	1,451	1,248	+ 203	+27,518h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	,, 15	14,160	3,201,585	336,049	1·03	10·11	1,770	5·04
Barking Corporation	Sep. 24	42	—	—	—	1¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 25	1,055	1,154	− 91	—	23½	23½	March 31	55,0 3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Tramways	,, 24	5,396	5,629	− 233	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 23	1,0 4	8 9	+ 6	+ 2,514	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·59
Blackpool Corporation	,, 22	1,7 0	1,49	+ 265	+ 5,101	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 5	1,463	1,368	+ 95	− 40	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·24	12·75	2,001	7·05
Bolton Corporation	,, 25	1,860	1,846	+ 14	+ 478	38	38	March 31	94,151	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 21	1,311	1,193	+ 118	+ 1,788	10½	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 24	4,774	4,049	+ 725	− 21,643	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 25	1,062	990	+ 72	+ 2,940h	7½	6½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 23	5,172	5,151	+ 21	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 21	1,053	948	+ 105	—	10	7	—	—	—	—	—	—	—	—
Burton Corporation	,, 25	343	433	− 90	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 24	2,041	2,004	+ 36	+ 1,855	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 25	2 3	203	− 5	+ 287	—	—	Dec. 31g	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 21	6,397	6,083	+ 309	− 1,118	6	6	,, 31	362,471	44,933,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 25	2,673	2,642	+ 31	− 1,103h	6⅜	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	,, 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 22	519	553	− 34	—	—	—	,, 31g	25,657	6,333,823	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 23	231	334	− 3	− 106	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 24	236	253	− 17	− 27	4½	4½	,, 31	11,255	2,871,332	280,901	0·94	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 23	141	131	+ 10	— h	6¾	6¾	Dec. 31g	6,214	583,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 23	3,973	4,105	− 132	} —	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 23	1,086	978	+ 108											
Dundee City Tramways	,, 21	871	838	+ 32	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 24	707	728	− 21	+ 1,409	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 24	15,246	14,633	+ 613	+14,809h	124	124	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 21	344	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 21	3,162	2,815	+ 347	+ 3,381	33	30½	March 31	68,283	16,322,054	1,387,885	1·20	11·79	2,069	8·77
Huddersfield Corporation	,, 24	1,299	1,631	+ 332	+ 2,427	35	35	,, 31	65,545	11,894,287	1,652,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 24	2,111	1,911	+ 199	+ 7,511	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 17	481	493	− 12	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 21	147	183	− 36	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 20	247	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 24	5,845	5,755	+ 89	+10,115	81½	77	,, 25	280,552	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 17	10,646	10,440	+ 206	+12,603	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 25	1,529	1,709	− 180	— h	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 24	13,790	11,054	+2,736	+67,763	40	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 17	310	262	+ 48	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 22	183	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 24	12,685	12,610	+ 75	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 23	2,0 4	1,406	+ 658	+ 5,635h	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 24	127	107	+ 20	—	3	3	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 24	3,539	3,598	− 59	—	45	38½	,, 25	185,027	39,715,120	4,059,907	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	,, 24	498	510	− 11	+ 1,277	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,026	+ 466	+ 3,951	29	29	,, 31	94,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Sep. 22	480	521	− 41	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	Aug. 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	Sep. 24	197	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 23	4,517	4,755	− 238	+ 2,884	53½	53½	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 22	1,048	1,095	− 46	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 21	443	384	+ 59	+ 1,205	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 23	625	411	+ 214	+ 6,481	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 17	1,274	1,834	− 560	—	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Wallasey U.D.C.	,, 24	758	756	+ 2	+ 1,236	10·5	10·5	,, 31	35,861	6,564,493	757,688	1·31	11·36	3,415	7·60k
West Ham Corporation	,, 22	1,141	—	—	—	1¾	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 21	768	431	+ 337	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
j Only eight months—expenditure includes large special items incidental to starting new department. k Estimated.

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NOTES.

The Pacific Cable.—It is announced that arrangements are being made for the meeting of the Pacific Cable Conference, which is to take place in London in the early part of November under the chairmanship of Mr. Lyttleton. The object of the conference is to clear up certain difficulties which have arisen, and which have proved a cause of friction, especially on the question of terminal charges.

The "G.B." Surface-Contact System.—The Lincoln Corporation on Tuesday last sealed a contract for the reconstruction of their tramways upon the "G.B." surface-contact system, a description of which appeared in our issue of Jan. 8. The permanent way will be undertaken by Messrs. Wm. Griffiths and Co., Limited, while the "G.B." Surface-Contact Company will execute the electrical equipment.

The Chemical Society.—This institution has settled its programme for the ensuing session, the dates appointed for general meetings being Nov. 3 and 16, Dec. 1 and 14, Jan. 8, Feb. 2 and 15, March 2 and 15, April 6 and 19, May 4 and 17, and June 1 and 14. The time appointed for Thursday meetings is 8 p.m., and 5.30 p.m. for Wednesday meetings. Tea will be served at 5 p.m. on Wednesdays. The annual general meeting will be held on March 29.

The American Institute.—The September number of the *Transactions* of the American Institute of Electrical Engineers contains the report of the High-Tension Transmission Committee, with the discussion thereon, and the discussions on the following papers: "The Protection of High-Pressure Transmission Lines from Static Discharges," "The Use of Ground Shields in Transformers," "Conditions for Continuous Service over Lines Operated in Parallel," and "Protection of Cables from Arcs due to Failure of Adjacent Cables."

Electro-Harmonic Society.—The first smoking concert of the season is to be held in the King's Hall of the Holborn Restaurant on Friday, the 14th inst., commencing at 8 p.m. promptly. A varied programme has been organised, including vocal music by Messrs. S. Masters and F. Ranalow, and instrumental by Messrs. A. E. Izard, R.A.M., T. E. Gatehouse, and H. M. Higgs, while humorous recitations, songs, and sketches will also be provided. In addition, a marionette performance will be presented by Mr. W. Graham, through the kindness of Mr. Maskelyne. Messrs. Izard and Gatehouse are the musical directors, and the hon. secretary is Mr. W. E. Lane.

Electric Trams v. Railways.—From time to time the railway companies are reduced to sundry expedients for retaining their suburban traffic against the competition of electric tramways. Reduced rates, zone fares, accelerated services, and motorcars are among the remedies to which they have had recourse. None of these, apparently, appealed to the East and West Yorkshire Union Railway, who, in terminating their service between Leeds and the Rothwell district, frankly acknowledge the potency of the electric tramway. The Midland Company has been associated with the working of the system, but latterly the proprietors have had to contend with a loss of £200 per month. The Great Northern have also experienced the competition, and a reduction has been made in its fares. Naturally, the trams are very popular in the summer, and in this respect it is difficult for the trains to compete with them; but now that the Lancashire and Yorkshire and the North-Eastern Companies have shown the way in the electrification of their local lines, perhaps it will not be long before others follow suit.

Glasgow Section.—To celebrate the opening of the ensuing session, the Glasgow Local Section of the Institution will again hold an inaugural dinner, which will be presided over by the Lord Provost, president of the section, the date appointed being the 28th inst. It is requested that members intending to be present will apply as early as possible to the hon. secretary, Mr. E. G. Tidd, for tickets, the price of which is 7s. 6d. The first meeting will be held on the 8th prox., when an address will be delivered by the chairman, Mr. R. Robertson. As in previous years, the committee have secured the large hall in the building of the Institution of Engineers and Shipbuilders. The other dates appointed for meetings are Dec. 13, Jan. 10, Feb. 14, March 14, April 12, and May 10, the session concluding with the annual general meeting. In view of its success last year, the smoking concert will be repeated. Arrangements have made for printing advance copies of the papers, and the hope is expressed that members will co-operate by participating in the discussions and introducing visitors, so that past success may be maintained.

New Single-Phase Railway.—The *Western Electrician* of Chicago announces that the Kewanel, Cambridge, and Geneseo Railway Company are about to begin the construction of a 30-mile single-phase alternating-current railway system. The power-house, which is to be situated near Cambridge, will be of 1,000 kw. capacity in the first instance. Current will be generated at 2,200 volts and transmitted at 11,000 volts to the two end divisions of the line, where step-down transformers will be located to reduce the current back to 2,200 volts, which will be the line voltage. The central section will be supplied at 2,200 volts direct from the power-house. On the locomotive and motorcars the voltage will be reduced down to 500, at which the single-phase motors will operate. It is expected that 60 per cent. of the revenue will be derived from goods, but the company is taking steps to encourage passenger traffic. The road will be laid with 60lb. rails, the maximum gradient being 1 per cent. and the maximum curve 5deg It is of interest to note that the company expects to mine its own coal.

Compensating Windings on Direct-Current Machines.—The compensation of the armature ampere-turns and their distorting effect has been accomplished in various ways, probably the most successful being those employing the Ryan type of winding, uniformly distributed in slots in the pole-face, and connected in series with the armature. By giving the compensating winding rather an excess of ampere-turns over the armature, a commutating field of any desired amount can be ensured. Even without distributing the winding, if only a single slot is made in the centre of the pole-face, and a compensating coil wound through this slot and surrounding half the pole-face, a certain amount of compensation will result, though the armature is still free to distort the field across each half of the pole-face. If, further, the compensating coil is extended beyond the pole so as to embrace an additional commutating pole placed at the neutral point of the machine, a commutating field of any desired amount can be set up at the neutral point. M. Seidener, in the *Zeit. für Elektrotechnik*, points out that such an arrangement, besides compensating more or less for the armature ampere-turns and producing a commutating field, also tends to compound the machine, the excess of the compensating coil ampere-turns over the armature ampere-turns causing the flux through the half pole looped with the coil to increase as the current increases.

Single-Phase Motors.—In a paper, of which an abstract is given in the *Electrical World*, presented to the International Electrical Congress, Mr. Max Deri discusses

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with the aid of surface and performance diagrams the various types of single-phase motors, the induced compensated series motor, and the repulsion with several modifications. The author considers that the compensated single phase with damping coil to neutralise field reactance formed by short-circuit through brushes on the commutator (Latour) represents on the whole a more completly developed repulsion motor. It possesses the disadvantage of requiring a double brush system, a special transformer is necessary, as a rule, for excitation, and it is often necessary to apply also special arrangements for regulation. The author describes his arrangement, which employs series-connected field and armature coils as in the plain series motor. Certain points on the commutator are short-circuited together, thus forming a closed-circuited armature. The machine constitutes to a certain extent an externally excited and, consequently, externally controlled induction motor. The author claims the following advantages for this motor: Brushes carrying main working currents are not used; therefore all commutator difficulties at starting and low speeds disappear entirely. The commutator can be made quite narrow, and a small number of brushes may be used. In principle, this motor is an induction motor which transmits external energy by means of transformation to a simple rotor. The motor can be started with greatest starting torque, its output can be made considerable, and its power factor made nearly unity. By this combination there is obtained an externally excited, compensated induction motor.

High-Potential, Long-Distance Transmission and Control.—At the International Electrical Congress Mr. F. G. Baum read a paper on this subject, a summary of which is given in the *Electrical World*. After giving the equations for determining the charging current for three-phase lines and the inductance pressure due to any chosen current, the author discusses the rise in pressure due to the charging current, assuming for this purpose that the actual condensance of the line is concentrated at the centre and that the leading current which it consumes is drawn through one-half of the total line inductance. In investigating the surges produced by opening a line under load or short-circuit, a similar assumption is made as to the distribution of the reactances. It is shown that, due to the series connection of the line inductance and condensance, the energy stored in the magnetic field of the conductors under condition of excess current, when the terminal circuit is opened, must pass into the line condensance and later be discharged into the inductance, the surges thus produced assuming a frequency corresponding to the square root of the product of the self-induction and capacity of the line, as is well known. The rise in potential due to the surging current is as a first approximation independent of the length of the line and equal to 200 times the interrupted current in amperes. The author describes in detail the insulator selected for the greatest transmission system in existence, that of the California Gas and Electric Corporation, which operates 700 miles of 50,000-volt transmission circuits. In the construction of the pole line, iron pins are used on all new work, and towers are considered the ideal supporters for the wires, though but few are used at present. Advantage has been taken of hills and ravines to use long spans, 1,000ft. to 1,800ft., of aluminium wires. The general practice is to generate at 2,300 volts and step up to the line voltage, the primary of the transformer being connected star with grounded neutral.

Municipal Tramways Association.—At the conference held at Liverpool last week the election of officers resulted as follows: President, Mr. Alfred Baker, Birmingham; vice-president, Mr. J. B. Hamilton, Leeds; executive committee—Messrs. Bailie Paton (Glasgow), John Aldworth (Nottingham), and Alderman Ellis (Cardiff); auditor, Mr. Dalrymple, Glasgow. Rule 3 of the association's constitution was amended so as to provide for presidents, upon retiring from that position, being members of the executive committee for three years instead of one. A recommendation of the executive committee that the matter of rail corrugation should be investigated by a special sub-committee, comprising Mr. Fell (London), Mr. Spencer (Bradford), and Mr. J. B. Hamilton (Leeds), with power to add to their number, was approved. Belfast Corporation having taken over the tramways in that city, and it being necessary to include Ireland in the association, it was decided to alter the name of the organisation from the "Municipal Association of Great Britain" to the "Municipal Tramways Association." It was decided to accept an invitation from the executive committee of the Tramways Exhibition to hold the conference in London next July. With a view to increasing the income of the association, nearly £300 per annum being required, the executive committee considered that, having regard to the great benefits that accrue to municipal undertakings in connection with the association, the municipal members might reasonably be asked to arrange for an increase of their subscriptions. It was proposed that the municipalities should increase their annual subscription from one guinea to three guineas. This proposal led to a discussion anent the inclusion as members of the association of more than one member of each municipality, and the arrangement of the association upon broader lines. In the end the recommendation to ask for the larger subscription was confirmed, on the understanding that the question of increased municipal membership of the association be taken into generous consideration by the executive committee.

Standards of Light.—This subject was dealt with by Prof. E. L. Nichols in a paper presented to the International Electrical Congress, of which an abstract appears in the *Electrical World*. The author observes that the conditions demanded of a physical standard are very far from being fulfilled in the case of the existing standards of light, and we are forced by circumstances to content ourselves for the present with finding some seasonably reliable and practical unit. The major portion of the paper is devoted to a discussion of the properties of the amyl-acetate, acetylene, and acetylene-hydrogen flames. Rough preliminary trials with apparatus for properly mixing acetylene and hydrogen in proportions which correspond to the condition of minimum sensitiveness to variations have led to the belief that with the same attention to details which has been employed in the development of the amyl-acetate lamp an excellent hydrogen-acetylene flame can be secured. The use of an incandescent solid as a primary light standard would at first sight appear to offer many advantages over any possible flame standard, but the difficulties have thus far been insuperable. The three types of light source available for such a purpose are the incandescent mantle of the Welsbach type the electric incandescent lamp, and the Nernst lamp. Since the performance of the incandescent mantle depends upon the admixture of certain oxides of the rare earths with the thorium oxide which forms the principal constituent, the satisfactory standardisation of the material would probably be found impracticable. The makers of incandescent lamps have not as yet been able to furnish a filament which will meet the conditions of reproducibility. The use of a filament of the Nernst type as a primary standard has not as yet been seriously considered. While it is probable that the future will see the development of a satisfactory primary standard based upon the electrical heating to incandescence

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of carbon or of some metallic oxide, the immediate basis for standardisation of artificial light sources lies in the use of a primary standard consisting of a flame standard and the preparation of calibrated incandescent lamps as secondary standards of light.

Eighty-Thousand-Volt Transmission Line.—An experiment with an 80,000-volt transmission line, made by the Pacific Light and Power Company in connection with the Kern River system, was described by Mr. A. C. Balch at the recent meeting of the Pacific Coast Transmission Association. It appears from the account given in the *Electrical Review* of New York, that a line 16 miles in length, and consisting of three wires with an interval of 40in. between them, was under test for a couple of months, during which all sorts of weather occurred. There was an average of 80,000 volts between two of the wires and the third one. The transformers available were two of 40,000 volts each, which were connected in series, with the centre between the two grounded. Two of the wires were connected to one of the outside terminals of these transformers, and one to the other. The ammeter did not exhibit any tendency to become inoperative on account of static charge. The current to the line was approximately three amperes. This did not at any time fall more than 5 per cent The size of the wire was No. 4 B. & S. gauge. A sharp rattling sound, which appeared to be accentuated in the neighbourhood of trees and similar objects, was heard along the line at short intervals, but could never be exactly located. The sound was quite audible at a distance of 100 yards, but a reduction of 20 per cent. in the voltage caused it to practically cease. During darkness the line, and particularly the single wire, was perceived to be highly luminous, and at the tie wire on the top of the glass insulators the brilliancy was intensified. The use of the telephone line, which runs 6ft. below the other cross-arm, was found not to be impeded. The tests showed the line to operate satisfactorily as long as the insulators were new or while they were free from dust. No difference was experienced between wood and iron pins, and in no case did the current short-circuit from the wire over the insulators to the pins. The experiment has led the company to adopt a large insulator made of brown porcelain, in four pieces, and arranged so that it can easily be cleaned, and it is intended that the insulators shall be hand cleaned at least annually. Under these conditions it is believed that 66,000 volts can be used without experiencing any difficulty.

The Iron and Steel Institute.—The following particulars in connection with the American tour are supplementary to the programme described in our issue of last week. An elaborate scheme has been prepared for the tour of Pittsburg. This embraces a visit by all the members on Nov. 1 to the Westinghouse plant and to the Edgar Thomson and Homestead Steelworks, luncheon being served on the train between Edgar Thomson and Homestead. In the evening there is to be a reception at the Schenley. The second day, Nov. 2, takes in a trip to McKees Rocks to visit the plants of the Pressed Steel Car Company and the Pennsylvania Car Wheel Company, the Phœnix Glass Company at Monaca, the American Axe and Tool Company at Beaver Falls, and the great Shenango works of the American Sheet and Tin Plate Company at Newcastle. In the evening there will be a theatre party for both ladies and gentlemen. After the theatre the party will have a view of Pittsburg from the Union Club, where refreshments will be served. As an alternative, a visit will be arranged to Mount Pleasant to inspect the works and coal mines of the H. C. Frick Coke Company in the Connellsville region. Probably on the morning of the third day, Nov. 3, before leaving for Cleveland, there will be optional trips to a number of plants of all kinds in the Pittsburg district. An attractive programme has been laid out for the ladies, chiefly in form of drives. The general plan of the Reception Committee for exploring Cleveland is to take the party in a special train to Newburg on the morning of Friday, Nov. 4, visit the works of the American Steel and Wire Company, which includes the new Bessemer plant, open-hearth rolling mill and wire mill, entertain them at luncheon at the office of the works, and take the same train to the central blast furnaces of the American Steel and Wire Company, where they will see the ore-handling, furnaces, and proceed thence to the ore docks. In the evening it is proposed to entertain the members at a banquet. The ladies will be taken for a drive through the parks, and probably will lunch at the Euclid Golf Club. On Saturday morning the members will probably be split up into small parties and visit the different works. Communications intended for members during the visit may be addressed care of American Institute of Mining Engineers, 99, John-street, New York City, or care of "Aime," New York. With this programme the secretary of the institute sends us a neatly-compiled list of members participating in the tour.

The American Tour.—Having arrived at St. Louis, the members of the Institution of Electrical Engineers lost little time in repairing to the exhibition, where, on the morning of Sept. 12, the International Electrical Congress was inaugurated in the hall of the Coliseum. The numerical strength of the congress was greatly in excess of that attained by any of its predecessors, the "adhesions" approximating 2,100, of which between 400 and 500 belonged to countries outside the United States. The members actually in attendance totalled about 700. The specially-invited papers numbered over 150, of which nearly 100 were ready for distribution. It was desired by the Organisation Committee to have all of them printed in time for the opening of the congress, but there was a regrettable delay in the delivery of some of the papers. All will, however, be published in volume form and supplied to members of the congress. The congress opened with a general session, Prof. Elihu Thomson making an introductory speech, and Mr. D. R. Francis, president of the Louisiana Purchase Exhibition, delivering an address of welcome. The latter predicted that there would be fewer universal exhibitions of the Paris and St. Louis type in the future, but that there would be a greater number of exhibitions of a special character. In fact, he considered that an international electrical exhibition was likely before many years. Prof. Elihu Thomson was then elected president of the congress, with Messrs. Ascoli, Glazebrook, Gonzales, Crompton, Gray, Lombardi, Perry, and Henri Poincaré as vice-presidents. Suitable responses having been made by Messrs. Gray, Ascoli, and others, the congress resolved itself into its constituent sections and proceeded to the reading and discussion of the papers, of some of which summaries will be found in these columns. At a subsequent meeting the chamber of delegates also settled its constitution. During the week the party were entertained by the local reception committee to a number of social functions, and special attractions, including automobile rides, were provided for the ladies. Dinners were given to the delegates by Mr. B. J. Arnold, as president of the American Institute, by the congress officers, and by Mr. H. Ward Leonard, whilst Mr. George Bullock entertained the party to a luncheon. The reception held by the exhibitors was a great success, all the electrical exhibits being in operation until 10 p.m. A reception was also held at the British Pavilion, and the

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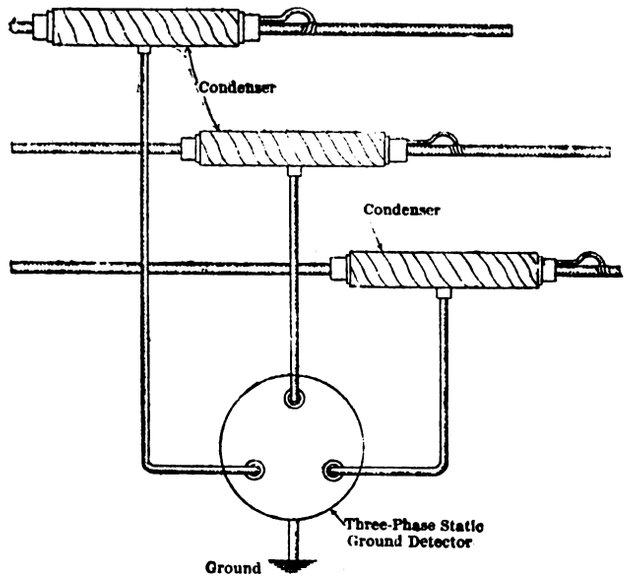
week concluded with the entertainment of a large party by Mr. R. K. Gray. The visitors afterwards left for Pittsburg.

A New Three-Phase Static Ground Detector.—Single-phase ground detectors have been found to also operate satisfactorily on two-phase circuits, but for three-phase purposes, although the practice has been to use two or three single-phase instruments either in separate cases or combined in the same case, the arrangement is open to the objection that the indications of the pointer are not direct, some time being required for a person not familiar with the instruments to determine which line is grounded. The Westinghouse Electric and Manufacturing Company have now produced a three-phase static ground detector, designed for circuits of from 1,000 to 1,500 volts potential, which enables a ground in a three-phase circuit to be indicated directly by a single instrument. The accompanying diagram of connections illustrates the method of operation.



It will be seen that each of the three fixed vanes is connected to a line of the three-phase circuit. The central movable vane is electrically connected to the case, which is grounded. When there is no ground upon the circuit, the attraction or pull upon the central vane from each of the fixed vanes is balanced, and it does not deflect from a central position. Should one of the lines become grounded, and the potential of that line become the same as that of the movable vane, there will be no pull in that direction, and the movable vane will be deflected away from the grounded line. The instrument is reliable in its indications and has no complications in its mechanism or construction. In the diagram, the three leads to the ground detector are shown with a condenser inserted between each line and the instrument. This obviates the necessity of carrying high-tension wires to the front of the switchboard. Each of the condensers consists of a brass tube covered with insulating material, and placed within a copper sheath, the line being connected to the inner tube and the lead to the copper sheath.

Technical Education—The London Chamber of Commerce recently addressed the Board of Education upon the need of raising the standard and lowering the cost of higher technical education. While recognising the excellent services of existing institutions, the Chamber indicates the necessity for more efficient and economical instruction in the advanced stages of technology, especially among those designed to officer our industrial forces. In regard to elementary education, the Chamber is satisfied that recent legislation promises to provide an adequate system, and acknowledges that the Board's lately-published code of secondary education embodies many desirable features; but in order to place British manufacturers and employés upon an equality with the foremost of their competitors, it advocates the development of higher scientific education by the establishment of technical colleges of university type in connection with each group of allied industries, facilities being afforded for specialised study and the admission of capable students of limited means, and, further, the Chamber emphasises the importance of maintaining a continuous relationship between the different grades of education. The Board's response fully sympathises with the aims of the Chamber, and, without foreshadowing any decided measures, it welcomes any definite proposals for the attainment of the objects in view. The Education Act of 1902, which relieves local authorities from many restrictions and provides for a measure of co-ordination in technical education, is regarded as forming the basis of a wider and better-organised system, and the Board doubts the need of establishing at present any large number of additions to the centres of higher scientific training, to which institutions the Chancellor of the Exchequer made largely-increased grants during the late session. Some consideration is merited of the Board's opinion that British manufacturers and their employés can only attain equality with their competitors by the co-operation of the manufacturers themselves and of parents and the public generally. Reference is made to the inadequate inducement to thoroughly capable men offered in the past by many manufacturers, and to the tendency of parents to allow their sons an insufficient period in which to prepare themselves for a technical career. Without emulating some of the colossal American concerns in paying fabulous—perhaps in more senses than one—remuneration to those in charge of their undertakings, the home manufacturer might often adopt a more liberal attitude than has always obtained hitherto, while an extension in the education of those designed for such vocations could scarcely fail to be attended with beneficial results. In fact, the position which the Board of Education appears to take up is that the existing system is not by any means so bad as it is sometimes depicted; that much can be accomplished if it be fully utilised; and that if the public evince a thorough appreciation of it, the Board will be prepared to promote further facilities, so that our manufacturers and their staffs may be as well equipped in point of training as the most progressive of their rivals.

Personal.—The news that Mr. John Young had tendered his resignation of the managership of the Glasgow Corporation tramways occasioned considerable surprise, and it appears that Mr. Young was unexpectedly offered an important post by Mr. Yerkes, whose "right-hand man" he is to be in connection with the Underground Electric Railways Company of London, Limited. Entering the sanitary department of the Corporation's service in 1875, he superintended that branch with much success, and when in 1892 the Corporation decided to work the tramways Mr. Young was appointed general manager. At that time the tramways were worked by horse traction, and Mr. Young's organising capabilities were at once seen. He was one of the first to recognise the advantages of electric traction, and after one or two experimental lines had been equipped he was authorised by the Corporation to proceed with the conversion of the whole of the system owned by the municipality. This enormous work, involving an expenditure approaching two millions, was carried out against time, and Mr. Young fulfilled his promise to have the lines working electrically at the date the Glasgow Exhibition was opened in May, 1901. The capital account for the

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horse tramways had to be taken over when they were electrified, but an inspection of the accounts such as we made in our leading article of Sept. 9 last shows the undertaking to be on a sound financial basis. The large annual profit, amounting to over a quarter of a million, is being used to write down the capital, so that there is no financial crisis to be feared in the future. Having done this good work at Glasgow, Mr. Young evidently feels that he can now leave the department in other hands and proceed with the still larger work of improving the congested means of traffic in the Metropolis. We have much pleasure in congratulating him upon his important appointment. Mr. Young, it will be remembered, was elected the first president of the Municipal Tramways Association. We reproduce Mr. Young's letter to the Lord Provost announcing his resignation: "Prince of Wales Hotel, Harrogate, Sept. 30, 1904. My Lord Provost,—I think it right that I should write to let you know that I have been unexpectedly offered an important post by Mr. Chas. T. Yerkes, chairman of the Underground Electric Railways Company of London, Limited, as his right-hand man in the control of the tubes and tramways of his companies. I was not looking for a new field of operation, but this proposition has come to me in such a way that I could not find any sufficient reason for declining it; so I have accepted it, and have accordingly another new start to make. By same post I am sending to the town clerk my formal resignation as from a month hence. Will you kindly accept from me my warmest thanks for your unvarying kindness and courtesy to me, and believe me, yours very sincerely (signed) John Young."

Insulation Resistance of Tramway Systems.—In his report, just presented to the convention of the International Tramways and Light Railways Association at Vienna, M. G. Pedrali, chief engineer of the Brussels tramways, deals with tests of the insulation resistance of tramway systems, an account of which is given in the *Street Railway Journal*. It is remarked that an effective and quick method of determining the existence of faults, without measurement, consists in observing the readings of the ammeter of the first dynamo during starting in the morning. If all cars are insulated from the trolley wires, and the needle of the ammeter is still deviated, it shows that the system contains a fault, which may be localised by opening the different line switches. On conduit and surface-contact systems the insulation should be regularly tested every day. "On lines both poles of which are insulated against earth," observes M. Pedrali, "it is necessary to take into account the electrolytic phenomena which tend to transport moisture from the positive to the negative pole; the greatest attention should be paid to this point." In regard to stray current, the losses per unit of pipe surface in the electricity passing between the rails and water or gas pipes may be approximately determined by the insertion of a perfectly insulated joint in the pipe, both parts of the pipe being then connected by means of a cable in which an ammeter of a resistance equal to that of the original joint is inserted. The author recommends the preparation of a diagram on which should be marked the points where the voltage difference between rails and pipes is largest, and the provision of test pipes at these points. Fig. 1 illustrates a rough way employed on some lines of testing the insulation of the trolley wire in order to find whether the insulators have a fault. A voltmeter, connected by one pole to the span wire and by the other to earth, is generally used to test the hanger, X, so as to ascertain whether the current passes over to the span wire, the strain insulator, Y, being subsequently tested by connecting the span wire between X and Y with the trolley wire and the pole to the rails, a voltmeter being inserted. This, however, gives only approximate results. The author states that the following "method of three readings" has often given good results. If A, B, C are the readings of the voltmeters as indicated in Fig. 1, R the resistance of the voltmeter, X the resistance of the hanger, and Y the resistance of the pull-off, then $X=(C-A-B)\,R/B$ and $Y=(C-A-B)\,R/A$. For ascertaining faults in conduits two groups of test lamps are provided on the switchboard,

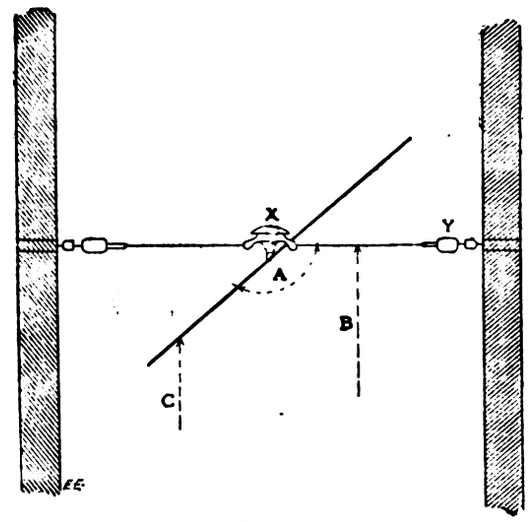

FIG. 1.

and are inserted between the two poles of the conduit, while the centre connection between the two lamp groups is connected to earth. If one of the two poles is earthed, the lamp group connected to the other pole lights up. For obviating contacts between the trolley wire and earth, caused by a foreign body, it is often sufficient to send through the line a strong current, adjustable by means of a rheostat. If it be necessary to localise the fault, the author recommends the following method of Prof. Eric Gérard: In parallel with the dynamo, a motor, M, of small

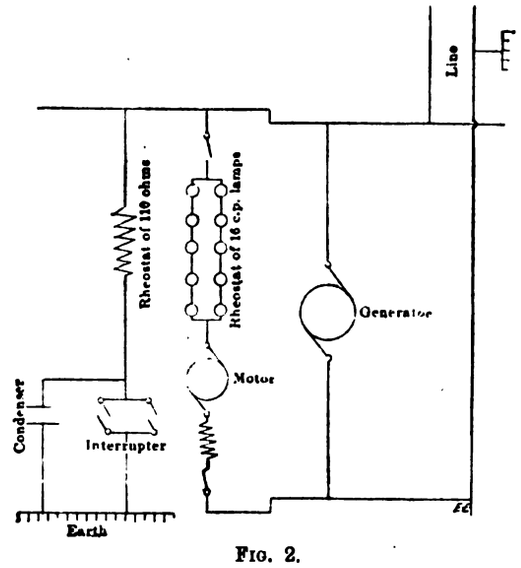

FIG. 2.

capacity is provided, which is geared to an interrupter; the other arrangements will be seen from Fig. 2. The apparatus is connected to the negative pole and the motor started. A regularly interrupted current of about five amperes now passes through the fault, the frequency of the interruptions being 70 to 80 per minute. A coil of 250 windings of ·6mm. wire, which is closed through a telephone, is then passed along the conduit. The telephone gives a regular steady noise until the fault is reached, when the noise ceases.

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EXETER'S NEW ELECTRICITY WORKS.

Like its neighbour, Taunton, Exeter was one of the very first towns in the kingdom to go in for a public supply of electricity, this having been started some 15 years ago—*i.e.*, in 1899—by the Exeter Electric Lighting Company, which consisted mainly of local residents, thus evidencing the enterprise of the town. In 1896 the Corporation took over the system, which had been extended from time to time, and in 1901 still further extensions were decided upon, these involving the erection of a new generating station in a more convenient position by the River Exe.

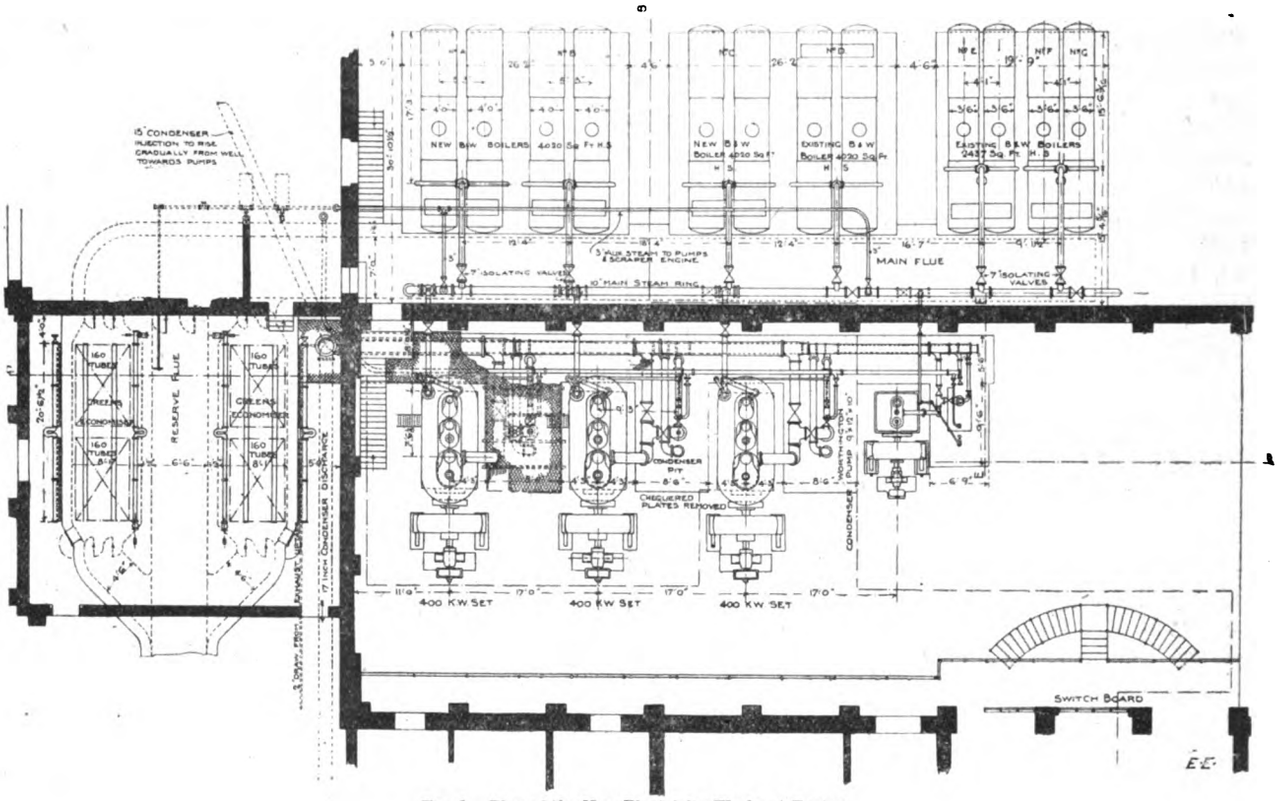

FIG. 1.—Plan of the New Electricity Works at Exeter.

The supply has hitherto been on the high-tension single-phase system, with Thomson-Houston series arc-lighting dynamos for the supply of the street lamps. The new plant is two-phase, the growing requirements for power, and the very probable early adoption of electric tramways, rendering a continuation of the old single-phase generating system impossible. Two-phase working was adopted in preference to the more orthodox three-phase, as it involved the least amount of alteration to the existing mains.

The plans and specifications for the generating station and its equipment were prepared by Mr. H. D. Munro, the city electrical engineer, who had charge of the work from its inception to the completion. It is important to note that the change from the single to the two phase system was effected without any interruption of the supply of current to consumers.

The British Westinghouse Electric and Manufacturing Company, of Trafford Park Works, Manchester, obtained the contract for the complete equipment of the new power-house, the laying of the new high-pressure mains being entrusted to Messrs. Siemens Bros. and Co. As sub-contractors to the British Westinghouse Company, Messrs. Willey and Co. were responsible for the structural iron-work, the coal conveyors (New Conveyor Company's type), coal bunkers, pipework, etc.; Messrs. Belliss and Morcom supplied the engines; Messrs. Babcock and Wilcox, the new boilers; the Worthington Pumping Engine Company, the condensers; Messrs. E. Green and Son, the economisers; and Messrs. Musker and Co, the overhead travelling crane.

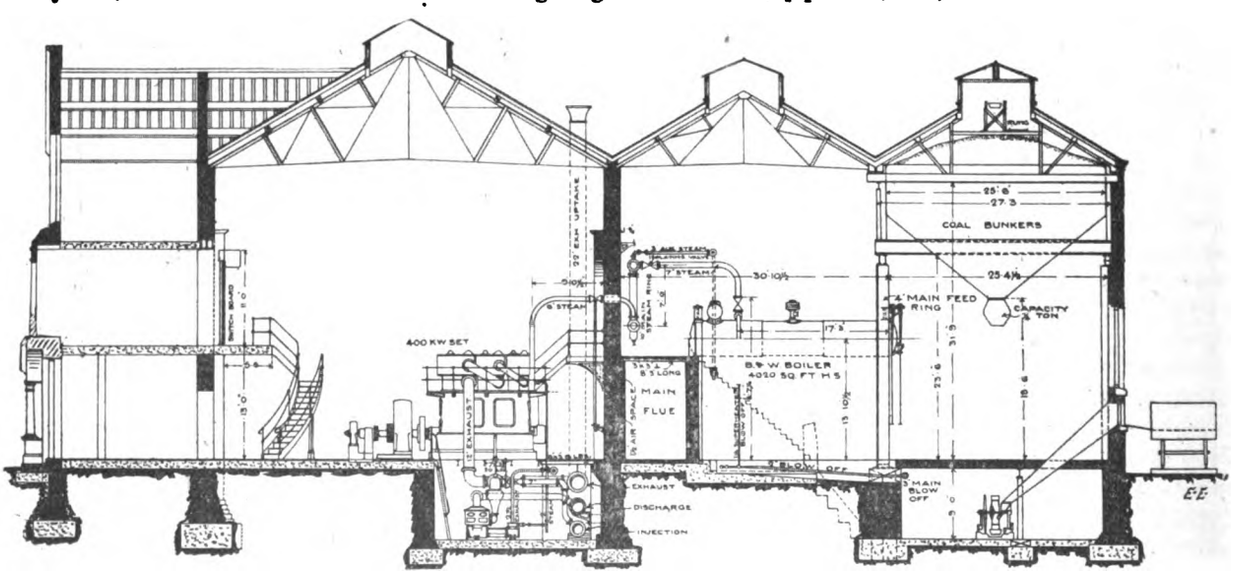

FIG. 2.—Sections of the Exeter Electricity Works.

Although the new station has been supplying current to the city mains for the past four or five months, the formal opening did not take place until the beginning of

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this month, when the opening ceremony was conducted by the Mayor (Mr. F. J. Widgery), assisted by Mr. Alderman W. Wreford, J.P., and Mr. Alderman W. H. Reed, J.P., the ex-chairman and present chairman respectively of the Electric Lighting Committee. Amongst others present at the ceremony were Mr. H. D. Munro, city electrical engineer; Mr. D. Cameron, the architect; Mr. Oliver Shiras and Mr. C. A. Henderson, of the British Westinghouse Company; Henry Willey, Esq., of Messrs. Willey and Co.; Mr. D. Brealy, the builder, and various other gentlemen more or less intimately connected with the work.

The buildings at present erected cover an area of about 150ft. square, and considerable room has been allowed for future extensions. They are divided into three bays, which form the boiler-house, the engine and generator room, and the offices respectively; the economisers, boiler-feed pumps, etc., being situated in annexes. The shaft is a handsome octagonal structure of brick, and is 155ft. high, with an internal diameter of 8ft. 6in. The boiler-house is a lofty building, 102ft. long and 55ft. wide, the engine-room being of the same length, but 10ft. less in width. The floor is of terazzomosaic paving to ensure the utmost cleanliness, and galleries give access to the switchboard, as well as to the boiler-house and the various offices.

The system of handling the fuel is very complete. The coal is put into shoots which deliver it to the automatic filler of the gravity bucket coal-conveyor, which is electrically driven by a Westinghouse two-phase induction motor. This conveys the fuel to a gallery under the roof, the fuel then being dropped into one or other of the series of bunkers beneath, these bunkers having a capacity of about 13,500 cubic feet, which is equivalent to about 500 tons. The conveyor can deal with 30 tons of coal per hour. From the bunkers the coal is discharged in measured quantities into the hoppers of the chain-grate mechanical stokers. The latter are also electrically driven, and besides carrying the coal into the fires, discharge the ashes and clinker into the basement below the boilers, whence the same conveyor removes them to the ash bunker. A railway siding, at present under construction, will complete the fuel and ash handling arrangements. The boiler-house plant consists at present of three new Babcock and Wilcox boilers, each with a heating surface of 4,020 square feet, and fitted with superheaters. Eventually four of the boilers in the old station, which are of the same type, will be brought over to the new station, and the total capacity will then be 2,700 h.p. A steam-pipe ring on the boiler-house wall carries the steam into the adjacent engine-room, this being so arranged that any boiler or engine can be isolated if necessary.

The main steam-piping is 10in. in internal diameter, with branches 7in. in diameter, the steam stop valve being of the Hopkinson parallel-slide pattern. All the steam-pipes, valves, separators, drains, etc., had to pass a maker's test of 400lb. hydraulic pressure per square inch, and when erected and completed were subjected to a 200lb. per square inch test.

Fig. 1 is a plan of the boiler and generator houses, and shows also the annexe containing the economisers Fig. 2 gives a sectional elevation of the station.

The new boilers are each capable of evaporating 13,000lb. of water per hour, and they steam at a pressure of 150lb. with Welsh coal, hand firing and natural draught. They are, however, as stated above, fitted with chain-grate mechanical stokers, which are not shown on the plans. After erection the boilers were tested under a hydraulic pressure of 250lb. per square inch, and the steam and water drums, sections, and mud-drums under a pressure of 300lb. per square inch. Two of the three feed pumps are steam driven, and one electrically driven. The former are of the Worthington direct-acting type, and are each capable of delivering 2,500 gallons per hour against a boiler pressure of 150lb. The electrically-driven pump is of the Worthington three-throw plunger pattern, and has a capacity of 3,900 gallons per hour; its motor, a two-phase two-speed Westinghouse induction machine, taking 60-cycle current at either 220 or 400 volts. The two Green's economisers each consist of 320 tubes, and work at a pressure of 150lb. per square inch with cold feed water. The scrapers are of the latest pattern, the driving engine taking steam at 140lb. pressure.

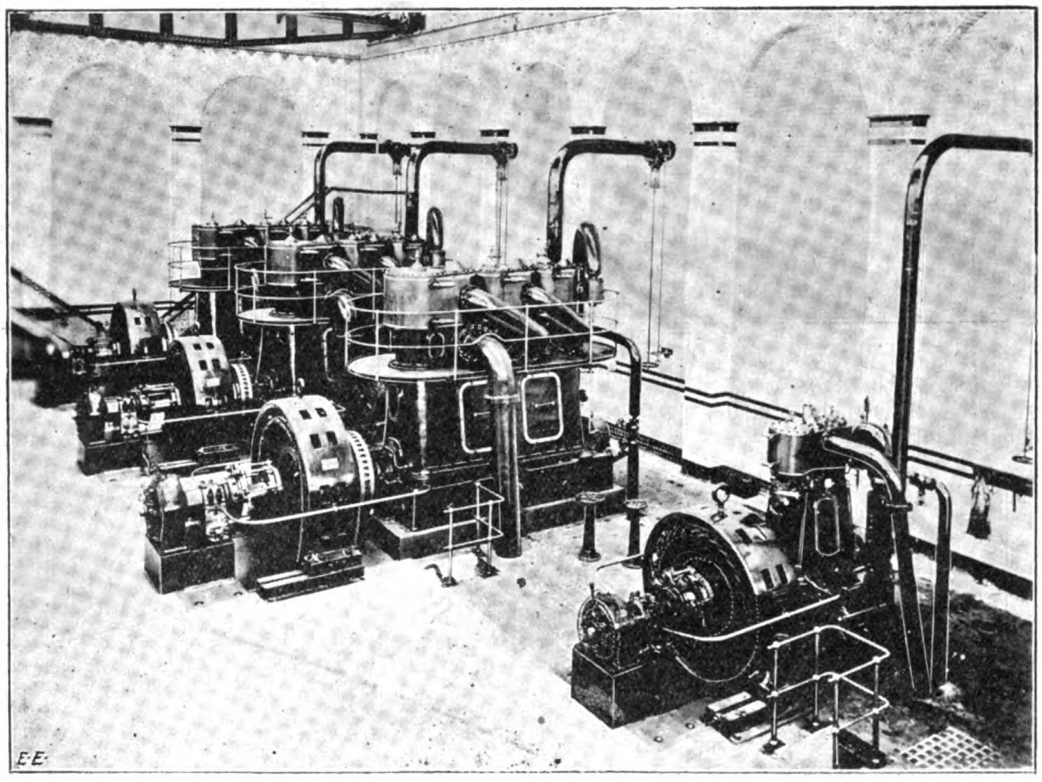

FIG. 3.—View of the Engine Room at Exeter, showing the Belliss Engines and British Westinghouse Two Phase Alternators.

The engine-room plant at present comprises four Westinghouse two-phase generators direct-coupled to Belliss and Morcom engines, three being of 400 kw. and one of 100 kw. capacity, a total of 1,300 kw. The large sets run at 360 revolutions per minute and the small one at 514 revolutions per minute, the pressure being 2,200 volts and the frequency 60. Steam is supplied at 145lb. pressure, and each engine is connected with a Worthington jet condenser. Each set is capable of dealing with one-hour overloads of 25 per cent., and the engine governors are such as to ensure that the variation of steady and momentary speed shall not exceed 5 and 10 per cent. respectively when full load is thrown on and off. The exciters are

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direct-coupled, and are of the Westinghouse multipolar type. The engine-room is spanned by a 10-ton hand-power travelling crane, the span being 44ft. and the lift 18ft. This was supplied by Messrs. C. and A. Musker. Fig. 3 is a photo showing the engines and generators.

The controlling arrangements include a combined high and low tension switchboard for connecting the four generators with the six supply circuits, each generator circuit including an integrating wattmeter. The panels of the high-tension board are of marble, and provision is made for the addition of extra ones at any future time. Each alternator and feeder panel is equipped with switches, circuit breakers, ammeters, etc., of the latest Westinghouse patterns, the alternator panels being also fitted with Westinghouse synchronising gear. Three station voltmeters with switches and transformers, calibrated up to 2,200 volts, are also fitted. Arrangements are made to enable any desired generator or circuit to be isolated from the main 'bus bars and switched on to "hospital bars" for independent working. Figs. 4 and 5 give front and back views of the switchboard.

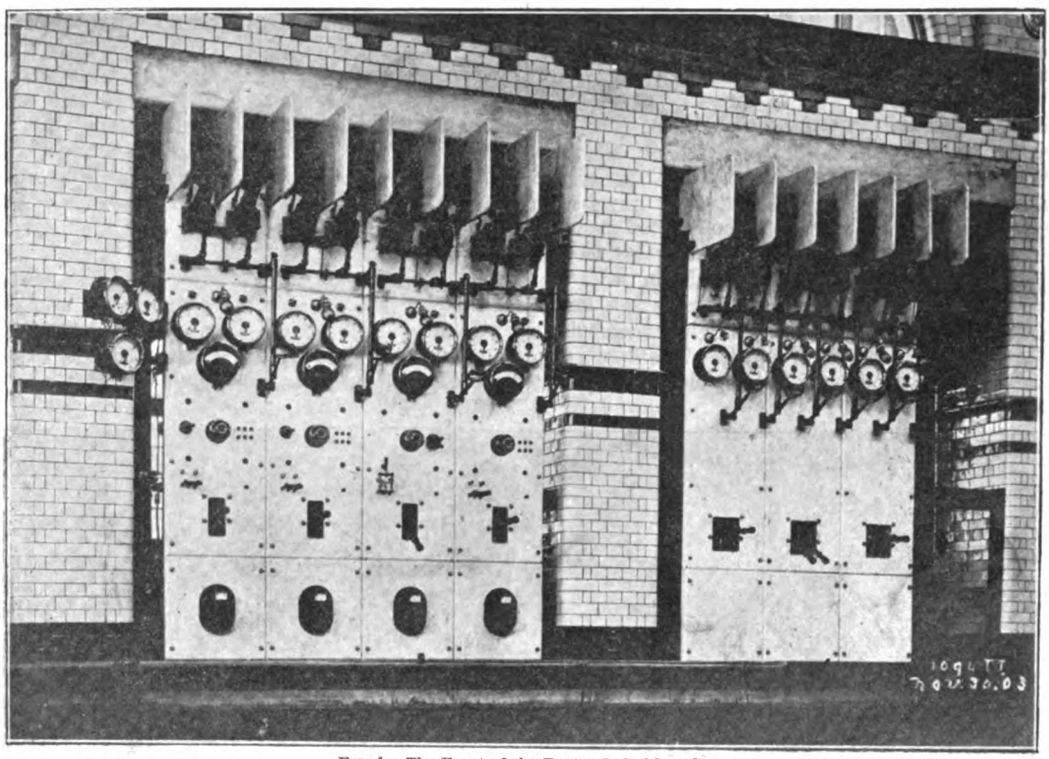

FIG. 4.—The Front of the Exeter Switchboard.

The whole of the work has been carried out on the most modern lines, the lay-out of the buildings and plant being such as to allow future extensions to be made from time to time. In this connection it may be mentioned that only one-fourth of the available ground area is at present occupied, so that the further increase of the lighting load, the development of the motor load, and the advent of the extensive adoption of electric tramways that is foreshadowed will not be difficult to cope with.

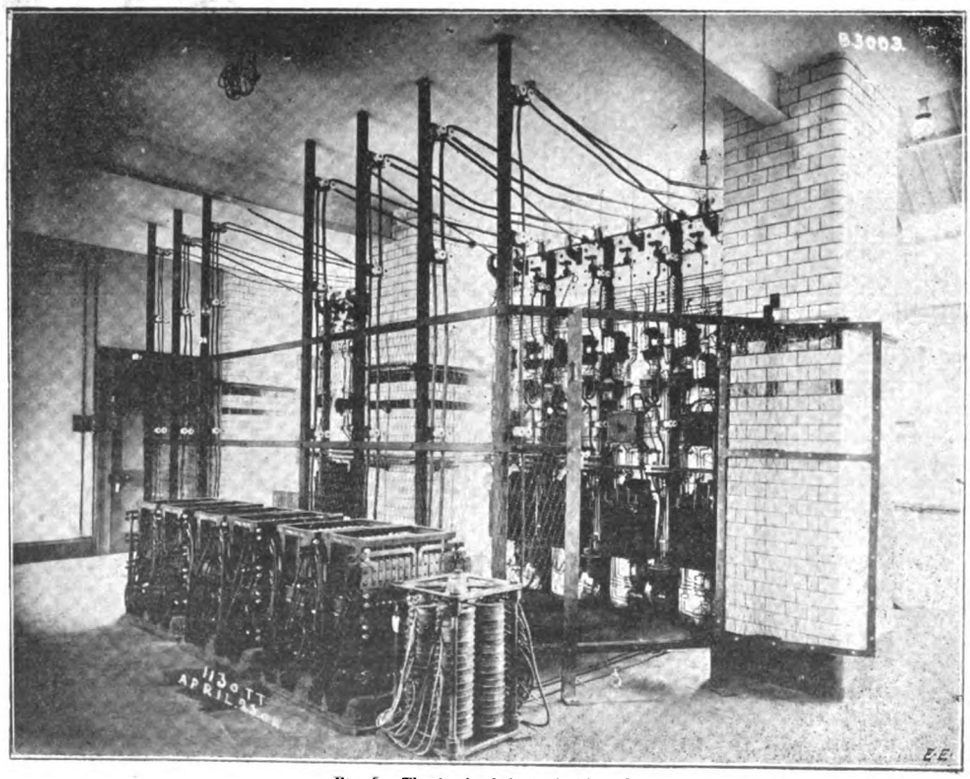

FIG. 5.—The Back of the Switchboard.

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STANDARD FORM OF TRAMWAY ACCOUNTS.

The following is the accepted standard form of tramway accounts prepared by a joint committee of the Institute of Municipal Treasurers and Accountants (Incorporated) and the Municipal Tramways Association of Great Britain.

Dr. **REVENUE ACCOUNT** for year from ..... to ..... Cr.

Expenditure.	Average per car mile.	£ s. d.	£ s. d.	*Income.*	Average per car mile.	£ s. d.
To TRAFFIC EXPENSES:	d.				d.	
1. Superintendence				By TRAFFIC REVENUE		
2. Wages of motormen and conductors				By SUNDRY REVENUE:		
3. Wages of other traffic employés				Advertising on cars		
4. Cleaning and oiling cars						
5. Cleaning, salting, and sanding track						
6. Fuel, light, and water for depôts						
7. Ticket check, including wages of inspectors and clerks						
8. Uniforms and badges						
9. Miscellaneous						
To GENERAL EXPENSES:						
10. Salaries of general officers and staff						
11. Store expenses						
12. Rents						
13. Rates and taxes						
14. Printing and stationery						
15. Fuel, light, and water for offices						
16. Law charges						
17. Accident insurances and compensations						
18. Fire and other insurances						
19. Miscellaneous						
To GENERAL REPAIRS AND MAINTENANCE:						
20. Permanent way						
21. Electrical equipment of line						
22. Buildings and fixtures						
23. Workshop tools and sundry plant						
24. Cars						
25. Other rolling-stock						
26. Miscellaneous equipment						
To POWER EXPENSES*:						
27. Cost of current at ——d. per B.T.U.						
Total amount of working expenses						
Balance carried to net revenue account						
* Where there is a separate tramway power station, an abstract of the total expenses should be shown in the form provided.						

Dr. **CAPITAL ACCOUNT**, year ended ..... Cr.

Expenditure.	To March 31 190...	From April 1, 190... to March 31 190...	Total.	*Income.*	To March 31 190...	From April 1, 190... to March 31 190...	Total.
To PERMANENT WAY				By LOANS RAISED (less loans redeemed)—			
To ELECTRICAL EQUIPMENT OF LINE				viz.:			
To LAND							
To BUILDINGS AND FIXTURES							
To POWER STATION AND SUB-STATIONS PLANT*				By LOANS REDEEMED			
To WORKSHOP TOOLS AND SUNDRY PLANT				By REVENUE CONTRIBUTION TO CAPITAL OUTLAY			
To CARS (including electrical equipment)							
To OTHER ROLLING-STOCK							
To MISCELLANEOUS EQUIPMENT							
To OFFICE FURNITURE							
To PARLIAMENTARY EXPENSES							
To PRELIMINARY EXPENSES							
* This item applies only to systems having a separate tramway power station.							

Dr. **RESERVE OR RENEWALS FUND ACCOUNT** for year from ..... to ..... Cr.

	£ s. d.	£ s. d.		£ s. d.
To appropriation for renewal of			By balance brought forward	
			By dividends on investments	
			By APPROPRIATION ACCOUNT:	
			Amount set aside for renewals	
To balance carried to balance-sheet				

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Dr. **NET REVENUE ACCOUNT** for year from ..... to ..... **Cr.**

	Average per car mile.	£ s. d.		Average per car mile.	£ s. d.
	d.			d.	
To INTEREST ON CAPITAL (including tax)			By balance from revenue account		
To INCOME TAX ON PROFITS			By BANK INTEREST (less interest charged)		
To BANK INTEREST (less interest received)					
To RENT OF LEASED LINES					
To balance carried to appropriation account					

Dr. **APPROPRIATION ACCOUNT** for year from ..... to ..... **Cr.**

	Average per car mile.	£ s. d.	£ s. d.		Average per car mile.	£ s. d.
	d.				d.	
To amounts appropriated for:				By net revenue for the year brought down		
Repayment of mortgage loans						
Contributions to sinking fund						
Reserve or renewal funds						
.....						
.....						
.....						
To amounts otherwise appropriated—viz.:						
Transferred to.....fund in aid of rates						
.....						
.....						
.....						

Dr. **SINKING FUND ACCOUNT** for year from ..... to ..... **Cr.**

	£ s. d.		£ s. d.
To balance carried to balance-sheet		By balance brought forward	
		By dividends on investments	
		By APPROPRIATION ACCOUNT:	
		Contributions during the year.....	

BALANCE-SHEET, as at .....

Liabilities.	£ s. d.	£ s. d.	*Property, Assets, and Outlay.*	Expenditure. To..... 190 .	Expenditure. During year.	Total.
				£ s. d.	£ s. d.	£ s. d.
LOANS:			COST OF EXISTING WORKS, ETC.:			
Stock			Permanent way			
Mortgages			Electrical equipment of line.....			
REDEMPTION OF DEBT:			Land.....			
Amount of mortgage loans repaid			Buildings and fixtures			
SINKING FUND			Power station and sub-stations plant*			
RESERVE OR RENEWALS FUND			Workshop tools and sundry plant			
SUNDRY CREDITORS			Cars (including electrical equipment)...			
			Other rolling-stock.....			
			Miscellaneous equipment			
			Office furniture			
			Parliamentary expenses.....			
			Preliminary expenses.....			
			INVESTMENTS:			
			.....			
			.....			
			.....			
			STORES:			
			.....			
			.....			
			.....			
			SUNDRY DEBTORS			
			UNEXPIRED LICENSES			
			CASH			

* This item applies only to systems having a separate tramway power station.

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Abstract of Power Expenses.

—	Average per kw.-hour.	Average per car mile.	£ s. d.
27. Salaries and wages			
28. Fuel			
29. Water			
30. Oil and waste			
31. Miscellaneous supplies			
32. Repairs to steam plant			
33. ,, ,, electrical plant			
34. ,, ,, ducts, feeder cables etc.			
35. ,, power and sub-station buildings			
Proportion of rents, rates, and taxes			
,, ,, insurance premiums			
,, ,, general management			
Amount laid aside to meet depreciation and renewal			
Interest on capital, £..... at £..... per cent.			
Sinking fund			

Statistical Information.

Total borrowing powers ..... £
Borrowing powers exercised ..... £
Unexhausted borrowing powers ..... £
Gross capital expenditure ..... £
Mileage of track :

	Single.			Double.			Total.		
	Miles.	Fur.	Yds.	Miles.	Fur.	Yds.	Miles.	Fur.	Yds
Owned									
Leased									
Totals									

Population served by tramways .....
Traffic revenue ..... £
Total revenue ..... £
Working expenses ..... £
Interest on capital ..... £
Sinking fund ..... £
Net balance ..... £
Disposal of net balance,

Car miles .....
Passengers carried .....
Total number of units used .....
Number of units used per car mile .....
Average number of cars in use for hour day .....
Percentage of working expenses to receipts .....
Average traffic revenue per car mile .....
Average traffic revenue per mile of single track .....
Average total revenue per car mile .....
Average car miles per day per car .....
Average speed per hour .....
Average car hours per day .....
Average working expenses per car mile, excluding power cost
Average working expenses per car mile, including total power cost .....

Scale of fares:

	½d.	1d.	1½d.	2d.	2½d.	3d.	3½d.	Average fare charged per mile.
Average distance (miles)								

Average fare paid per passenger .....
Average number of passengers per car mile .....
Average journeys per head of population per annum .....
Number of cars in stock .....
Total amount of sinking fund ..... £
Amount of sinking fund applied in reduction of debt ..... £
Amount of reserve or renewals fund ..... £

REVENUE ACCOUNT.

Classification of Working Expense Accounts.

Traffic Expenses.

Account No. 1.

Superintendence.—Charge to this account salary of traffic superintendent and assistants.

Account No. 2.

Wages of Motormen and Conductors.—Charge to this account wages of motormen and conductors engaged in operation of cars.

Account No. 3.

Wages of other Traffic Employés.—Charge to this account wages of depôt clerks, traffic regulators, trolley turners, points boys, etc.

Account No. 4.

Cleaning and Oiling Cars.—Charge to this account wages paid to car cleaners and oilers, and cost of all cleaning material, brooms, brushes, buckets, chamois skins, dusters, mops, polish, soap, sponges, waste, disinfectants, water, oil, grease, etc.

Account No. 5.

Cleaning, Salting, and Sanding Track.—Charge to this account wages of men employed in cleaning, salting, and sanding track, cost of tools for cleaning track, salt, and sand.

Account No. 6.

Fuel, Power, Light, and Water for Depôts.—Charge to this account cost of fuel for depôt offices, cost of lighting depôts, and water, other than water for cleaning cars.

Account No. 7.

Ticket Check.—Charge to this account cost of tickets, conductor's punches, wages of ticket inspectors, clerks in punch and ticket office, and deduct the receipts from advertisements on back of tickets.

Account No. 8.

Uniforms and Badges.—Charge to this account cost of uniforms and badges supplied to traffic staff.

Account No. 9.

Miscellaneous.—Charge to this account cost of Inland Revenue and police licenses for cars.

General Expenses.

Account No. 10.

Salaries of General Officers and Staff.—Charge to this account salaries of general manager, accountant, auditors, and all officers and clerks not engaged exclusively in any one department.

Account No. 11.

Store Expenses.—Charge to this account all salaries and expenses in connection with storeroom, including wages of vanmen conveying supplies from general store to depôts and collecting scrap.

Account No. 12.

Rents.—Charge to this account rental of head offices, sub-offices, and wayleaves.

Account No. 13.

Rates and Taxes.—Charge to this account all local rates and taxes, including municipal rates, police rates, poor and school rates, etc., on the annual value of the tramways undertaking.

Account No. 14.

Printing and Stationery.—Charge to this account all expenditure for printing and stationery supplies. The cost of tickets should be charged to Account No. 7.

Account No. 15.

Fuel, Light, and Water for Offices.—Charge to this account cost of coal and other fuel for head office and sub-offices, also cost of electric light, gas, and water for same.

Account No. 16.

Law Charges.—Charge to this account all legal expenses except those incurred in connection with damage claims.

Account No. 17.

Accident Insurances and Compensations.—Charge to this account the annual premium on third-party and employers' liability policies, or if claims are settled by the department the amount of claims paid and the legal expenses connected therewith.

Account No. 18.

Fire and other Insurances.—Charge to this account the annual fire, boiler, and other insurance premiums.

Account No. 19.

Miscellaneous.—Charge to this account any other sundry expenses not included in any of the foregoing accounts, including repairs to office furniture.

General Repairs and Maintenance.

Account No. 20.

Permanent Way.—Charge to this account all expenditure for repair and maintenance of track and roadway, of tracks in yards, depôts, and other buildings, including wages, material, tools, fuel, light, water, freight, cartage, and other expenses in connection with this work. The cost of preparing rails for repair of bonding, and of removing and relaying paving, etc., for repair of electrical equipment of line should be charged to Account No. 21. The expenses of the permanent-way yard, including wages of yardmen, would be distributed over the accounts benefited.

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ACCOUNT No. 21.

Electrical Equipment of Line.—Charge to this account all expenditure for repair of overhead, conduit, or surface-contact electric line, including wages, material, and tools employed or used in taking up, resetting, and repainting poles, taking down trolley feed, guard, and supplementary wires and substituting new, repairing rail bonding, removing and relaying paving for repairs of the electric line, repairs to ducts and cables, section boxes, etc. The cost of repairs of electric line in yards and depôts should be charged to this account.

ACCOUNT No. 22.

Buildings and Fixtures.—Charge to this account all expenditure for repair of buildings and fixtures used in connection with the operation of the tramways, including wages, material, tools, freight, cartage of materials, and all other expenses connected with this work. The term "buildings and fixtures" includes workshops, office buildings, waiting-rooms, car sheds, stables, stores, etc., and all fixtures, including gas-pipes, water-pipes, drains, heating apparatus, lighting fittings. The cost of repair of power station and sub-station buildings should be charged to Account No. 35. The cost of repair of tracks in yards, car sheds, and other buildings should be charged to Account No. 20. The cost of repairs of electric lines in yards, car sheds, and other buildings should be charged to Account No. 21.

ACCOUNT No. 23

Workshop Tools and Sundry Plant.—Charge to this account all expenditure for repair of workshop tools, machinery, and appliances, such as engines, boilers, shafting, motors, etc. Hand tools of tradesmen should be charged to the account benefited by their use.

ACCOUNT No. 24.

Cars (including Electrical Equipment of Cars).—Charge to this account all expenditure for repair of cars, and electrical equipment of same, including wages, material, tools, freight, cartage of material, and all other expenses connected with this work. The term "cars" includes car bodies, trucks, motors, and controllers, and all fixtures or appliances inside of or attached to these parts. The cost of incandescent lamps, bell cord, trolley rope, commutator brushes, tools for motormen, etc., should be charged to this account.

ACCOUNT No. 25.

Other Rolling Stock.—Charge to this account all expenditure for repair of sundry vehicles, including water cars or carts, sand and salt cars or carts, store carts, snow ploughs, sweepers, lorries, vans, broughams, etc., including wages, material, tools, freight, cartage of material, and all other expenses connected with this work. All vehicles used exclusively for work included under any of the foregoing accounts should be charged directly to the account benefited.

ACCOUNT No. 26.

Miscellaneous Equipment.—Charge to this account all expenditure for repair of harness and cost of replacing horses, not otherwise directly charged.

Power Expenses.

ACCOUNT No. 27.

Charge to this account cost of power at a price per unit, or

*ACCOUNT No. 27.

Salaries and Wages.—Charge to this account proportion of chief engineer's salary, and all wages in the power station and sub-stations, except wages of men engaged in repairing plant. This account should include wages to the following employés: superintendent of station, engineers, greasers, feed-pump attendants, stokers, coal and ash attendants, electrical engineers, switchboard attendants, motor attendants, basement attendants, cranesmen, cleaners, boiler fitters, clerks, and storemen, watchmen, sub-station attendants, sub-station improvers, sub-station cleaners.

*ACCOUNT No. 28.

Fuel.—Charge to this account all expenditure for coal or other fuel used at the power station, including freight, cartage, and removal of ashes.

*ACCOUNT No. 29.

Water.—Charge to this account cost of water for boilers and condensers.

*ACCOUNT No. 30.

Oil and Waste.—Charge to this account all expenditure for lubrication of power plant and sub-station plant, including oil, grease, waste, rags, etc.

*ACCOUNT No. 31.

Miscellaneous Supplies.—Charge to this account all sundry expenditure in the operation of the power station and sub-stations not detailed under the foregoing accounts. Material used in repairs should not be charged to this account. The following is a list of some of the items chargeable to this account: Globe metal polish, emery and glass paper, brushes and mops, oil cans and spouts, soaps and sodas, tallow, turpentine, graphite, sternoline grease, pumice stone, ground black-lead, bathbricks, chalk, squeegees, toilet rolls, twines.

*ACCOUNT No. 32.

Repairs to Steam Plant.—Charge to this account all expenditure for wages, material, tools, freight, cartage of material, and all other expenses in connection with repair of steam plant, including engines and engine parts, appliances, and fixtures, belts, belt tighteners and fixtures, receivers, lubricators and oiling devices, boilers, furnaces, economisers, pumps, feed-water heaters, tanks, condensers, coal and ash conveyors, mechanical stokers, and other boiler-room appliances, piping and steam fitting, including valves, separators, water connections, and water-meters.

*ACCOUNT No. 33.

Repairs to Electrical Plant.—Charge to this account all expenditure for wages, material, tools, freight, cartage of material, and other expenses in connection with repair of electrical plant, including generators, switchboards, cable and feeder terminals, storage batteries, transformers, rotaries, boosters, rheostats, circuit breakers, ammeters, and other electrical equipment. Commutator brushes for generators should be charged to Account No. 31.

*ACCOUNT No. 34.

Repairs to Ducts, Cables, etc.—Charge to this account all expenditure for wages, material, tools, freight, cartage of material, and other expenses in connection with repair of ducts for cables, manholes, cables, and other electrical plant, which expense, when the power is purchased, is included in the price of the current.

*ACCOUNT No. 35.

Charge to this account all expenditure for repair of power station and sub-stations buildings, including wages, material, tools, freight, cartage of materials, and all other expenses connected with this work.

Capital Account.

CLASSIFICATION OF CAPITAL ACCOUNTS.

Permanent Way.	Cars (including electrical equipment of cars).
Electrical Equipment of Line.	Other Rolling-Stock.
Land.	Miscellaneous Equipment.
Buildings and Fixtures.	Office Furniture.
Power Station and Sub-Station Plant.*	Parliamentary Expenses.
Workshop Tools and Sundry Plant.	Preliminary Expenses.

Expenditure.

Permanent Way.—Charge to this account all expenditure for track and roadway construction, including labour, materials, tools, freight, cartage cost of grating, excavating, track laying, ties, yokes, slot rails, sewer manhole frames and covers, rails, rail fastenings, welded joints, special work (including crossings, cross-overs, curves, frogs, guard rails, switches), concrete, paving, oils, pitch, gravel, chips, asphalt, bitumen, drain boxes, sewer boxes, F.C. traps, gratings, C.I. pipes, F.C. pipes, iron paving blocks, bricks, bolts and nuts, coal, cement, dog spikes, road metal, sand, spelter, F.C. siphons, lifting wood, fences, bridges, culverts, trestles, subways, tunnels, etc., engineering and superintendence, wages of clerks, timekeepers, watchmen, light and water, street improvements, and other expenses not detailed above. The cost of tracks in car depôts and other buildings should be charged to this account. The cost of preparing rails for bonding should be charged to electrical equipment of line account.

Electrical Equipment of Line.—Charge to this account all expenditure for electrical equipment of line, including labour, materials, tools, freight, cartage, cost of preparing rails for bonding, rail bonds, *ducts, *manholes, poles, rosettes, *cables, guard wire, span wire, strain wire, supplementary wire, trolley wire, *ground feeders, *underground feeders, pole fixtures, overhead appliances, conduit appliances, surface-contact appliances, engineering and superintendence, wages of clerks and timekeepers and other expenses not detailed above.

Land.—Charge to this account cost of ground purchased for workshops, car-sheds, offices, and other buildings used in operation of line. Ground purchased to form tramway track should be charged to permanent-way account.

Buildings and Fixtures.—Charge to this account all expenditure for buildings and fixtures including labour, materials, tools, freight, cartage, and all other expenses incidental to the work. "Buildings and fixtures" includes car-sheds, *power station, *sub-stations, workshops, stores, stables, offices, waiting-rooms, etc.

**Power Station and Sub-Station Plant.*—Charge to this account all expenditure for steam and electrical equipment of power station and sub-stations, including foundations for equipment. The cost of buildings used for power station and sub-stations should be charged to buildings and fixtures account.

Workshop Tools and Sundry Plant.—Charge to this account all expenditure for shop tools and workshop machinery, car-shed tools, granary machinery, permanent-way plant, sand-drying plant, and other appliances, including foundations for same.

Cars (including Electrical Equipment of Cars).—Charge to this account all expenditure in the construction of cars from the operation of which revenue is derived. The term "car" includes the car body, truck, motors, and controllers, and all fixtures or appliances inside of or attached to these parts.

Other Rolling Stock.—Charge to this account cost of sundry vehicles, including water cars or carts, sand and salt cars or carts, store cars, snow ploughs, sweepers, lorries, vans, broughams, etc.

Miscellaneous Equipment.—Charge to this account cost of horses, harness, uniforms, cash boxes, ticket boxes, bell punches, etc.

Office Furniture.—Charge to this account cost of furniture for head office, sub-offices, etc.

Parliamentary Expenses.—Charge to this account costs of Acts of Parliament promoted by the corporation for tramway purposes.

Preliminary Expenses.—Charge to this account all preliminary organising expenses not chargeable under any of the foregoing accounts.

Income.

Credit all loans raised or repaid, also amount provided for redemption of loans, as well as any contribution by revenue to capital expenditure.

* This item only applies to systems having a separate tramway power station.

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NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

The use of electric motors for all purposes is becoming more and more common each day. Whether the motors form part of an isolated private installation, or whether they are supplied with current from the mains of some public company, as a general rule the build and grade of the motors so installed are better than was the case some years ago. This is probably because, in the first case, the user has learnt that it is more economical in the long run to pay a decent price for the motor and so get a reliable machine built in accordance with the best modern practice, and partly because the science of electrical engineering has advanced, and not only have certain types become standardised, but the individual machines are better built, and are designed to withstand the usage they will meet with in practice, according to the particular class of work they are built for. This advance in the building of dynamos and motors is well illustrated in the building-up of the commutator. A few years ago it was quite customary to meet with plenty of machines in which, after a short period of work, the commutator segments would be found loose; now this is a fault rarely met with, as all the best makers subject the commutator to hydraulic pressure when building them up. This might be considered only a detail, but it is a most important detail, and affects the running of the machine to a very great extent, while it is only by attention to these details that a reliable machine can be turned out.

While a better class of motor is being almost universally employed, the writer regrets to note that the class of starting switch does not improve. A distinction must be clearly understood here. Better and more efficient starting switches are built to-day than was the case a few years ago, but the unfortunate part is that they are not met with in practice to any great extent; the various insurance companies who undertake the business of insuring electrical machinery against breakdown find that it is the exception to meet with installations in which the best classes of starters are used. These companies have unique opportunities for discovering what is the general trend of modern practice, for not only do they number the installations under their inspection by thousands, but they also come in contact with all classes of work carried out under expert advice and without such advice.

The fault of not putting in better starting and controlling apparatus does not lie with the motor manufacturers. Naturally they, having every confidence in their machines provided they receive anything like fair attention, would only be too pleased to put down the very best, not necessarily the most expensive, controlling apparatus possible, in order that the machines may have every opportunity of working properly. Neither does the fault lie with the makers of the starting switches; they naturally would prefer, for their own reputation, even if not for the enhanced profit, the best make of starting switch. The fault neither appears to lie with the consulting engineer, for it is only in those installations where a consulting engineer has drawn up the specification, or where the firms installing the motors have some practical knowledge of electrical motors, are these best types of starters found. The fault not lying with any of these, it would seem apparent that it rests with the contractor who instals the plant. This is right to a certain extent, for naturally if all the firms tendering only quoted for the best, then these would be installed. But the real blame lies with the purchasing firm, who too often think that all that is necessary in a motor installation is to buy some good make of motor, and then to let the work out for fixing these and running the necessary leads to some firm of contractors. Several are asked to quote, and the lowest tender is generally accepted on the simple ground it is the lowest, and without any attention being paid to the fact that each firm is tendering for valuable accessories, on which depend the successful running of the plant, and no comparison is made between the various classes of material quoted for, as though this were only a minor detail in place of being a matter of the most vital importance.

We have all heard of the Irishman who regretted that, not being a bird, he could not be in two places at the same time. Unfortunately, the manufacturer who is installing electric plant tries to successfully emulate the wish of this gentleman by looking at the question from two distinctly different standpoints at one and the same time. From one standpoint he argues that electricity is a most wonderful thing that he can't understand. He confesses he knows that a motor will develop horse-power, but why he confesses he does not know; neither does he pretend to any knowledge of the laws which govern the behaviour of a motor, nor the best conditions under which it should be run. From the other standpoint he argues it is only the putting down of a few wires and switches, which anyone can do, and that it will be better to save the expense of engaging a consulting engineer, who has made it the one object of his life to search out and discover the best arrangement of plant for any given purpose, the manufacturer forgetting all the time that upon these bits of wires and switches, etc., depend the success or failure of a plant which has cost hundreds of pounds, and on the successful working of which depends the running of his factory. The manufacturer, we have seen, has learnt to put down a good class of motor; the necessity for care in this particular has become impressed upon him, but his choice of the make of motor is often not logical. He is advised by a friend only to have those motors made by a certain firm, because this make of machine has given him every satisfaction. But he does not stop to consider why this particular make has in this instance given satisfaction. It may be that the motors are equipped with the best controlling device in the market, but the motor gets all the credit, not the starting arrangements. It may be that the motors are put down largely in excess of the power required, and in this case the opinion of a consulting engineer would have saved the amount of his fee several times over. Or, again, another manufacturer who has had a bad experience with motor driving may ultimately find that the motors which he condemned were all the time satisfactory, but that the controlling devices were not suitable, or that the motors were under their work. In either case, had a consulting engineer been engaged, the amount of his fee would have been negligible in comparison with the saving that he would have effected.

The fault, then, should be laid upon the manufacturer in many instances, and not upon the contractor. Take the case of a 30-h.p motor. It may be, having regard to the peculiar conditions of work, that the only suitable starting switch is one of the automatic self-starting type. What contractor, however, would dare to include in his tender for one of the Sturtevant switches of this class listed at £62, when an ordinary Cutler-Hammer switch can be listed at £6. 15s., knowing that one of his competitors will quote for this cheaper type, and also knowing that the tenders will be dealt with by a person having no special knowledge of the trade, and to whom it will be impossible to explain that the difference in price is a difference in value?

It is not necessary to instal in every case these high-class, expensive switches just referred to; in most cases a simpler and cheaper switch will answer all requirements, but it is necessary to see that in every case the switch is suitable for its work. There is one particular trade where a stoppage of the machinery would be the next thing to bankruptcy, and this trade is that of the printing of our great daily papers; these must be got out to time at any cost. The majority of these papers are now printed on electrically-driven presses, and a breakdown to one of these is of the rarest occurrence, although the auxiliary machinery in a printing establishment is by no means immune. The reason is not far to seek. The printing press is not supplied with a motor greatly over its work. Probably there is less margin in it than there is in the motor driving the bill machine, for instance, and the latter frequently breaks down. But—and here is the point—whatever the electric system adopted for driving the printing press, whether a Bullock-Teazer set or a Holmes-Clatworthy set, or any other similar device, is adopted, the whole is controlled by a high-class up-to-date controller, for which a high price is paid. This controller must be included, or else the firm supplying the electrical set will not complete the equipment; while in the case of the motor driving the bill

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machine, any sort of a starting switch which will meet the requirements of the supply company is considered good enough.

It is worth while considering first the requirements of a good starting switch, not only as regards the requirements of the supply company, but, what is of far more importance, as regards the due protection of the machines. For a breakdown of the plant of any manufacturer stops his production, and is, therefore, almost of as much importance as the breakdown of the motor driving the printing press of a daily paper. Afterwards it will be useful to study in detail the construction of some of the higher class starters used for special purposes.

The main requirements of a good starting switch are :

1. The switch must be as simple as possible in its construction, and all parts liable to wear out should be capable of easy replacement.
2. The resistance wires used in the construction of the switch must be wound in such a manner that they cannot sag so as to touch each other, or the framework.
3. The resistance wire must be of ample area, so that no part of the resistance will heat more than 90deg. F. above the surrounding atmosphere, even if left in circuit for comparatively long periods.
4. The construction of the switch must be such that there is path afforded for the induced current of the fields when the motor is stopped.
5. The switch must be so arranged that the resistance can only be cut out slowly.
6. The switch must be so designed that in no case shall the movement of the lever from one step to the next increase the value of the current flowing through the armature by an amount sufficient to noticeably affect the E.M.F. of the supply circuit.
7. All current-bearing parts must be well insulated from the framework, and the switch must be so designed that any dampness in the atmosphere will not cause leaks to be developed.
8. All contact areas should be of ample area, and in switches designed for large currents only a small shunt current should flow between the lever and the various contact steps.
9. The switch should be fitted in every case with a suitable automatic no-volt release. An overload preventer may also be included, but this is not of the same importance.
10. All working parts should be easily accessible, and should not be placed behind the switch-slab, so as to be inaccessible without taking down the whole apparatus.
11. The mechanical design of the switch should be such that the switch will withstand the rough usage it will receive from the hands of the ordinary untrained operator.
12. The switch should be fully up to the maximum load to be dealt with by the motor.

Any starting switch built in full accordance with these requirements should suit the majority of cases. Unfortunately, few except the more expensive switches will be found to comply with the whole of the points mentioned.

The first requirement is one which should always be complied with, but many manufacturers, in order to create a fresh design, unnecessarily complicate the parts, while some other switches of simple design are spoilt by the parts subject to wear and tear being made permanent instead of replaceable. This applies particularly to the step contacts, which are liable to be burnt by the ordinary working of the switch. It is an easy matter to make these loose, and no switch should be accepted in which this requirement is not met with.

The second point is one of the greatest importance. Nothing causes so much annoyance as the stoppage of a motor owing to a defective starting switch, and it must always be remembered that in many cases the switch supplied will be operated by a man entirely ignorant of its construction or of the function of the different parts. If, then, the resistance short-circuits so that some of it is cut out, the operator will probably not notice the difference in behaviour unless the coils are actually burnt out, and he will continue to use the instrument to the detriment of the motor, although the amount of resistance of the various stages of the starting operation is not correct. If the coils do sag in use, it may be through faulty construction in the first place, but more probably through improper use, owing to the operator leaving some part of the resistance too long in circuit. Knowing that this is a likely contingency, the manufacturer should build the switch so that it is impossible for any damage to be done by so operating the switch. The simplest and safest manner of preventing this is to wind the coils on porcelain mandrils. This construction gives a sound engineering finish to the apparatus, and the switch will then stand safely large variation in temperature, and also a certain amount of rough handling. The practice which is sometimes adopted of winding the coils upon asbestos mandrils is not to be recommended. In the first place, this construction is not so rigid, and in practice the asbestos mandril is liable to give, and the sag then becomes permanent; and in the second place, this form of mandril is too often replaced by a simple fibre core, which collects hydroscopic moisture and swells, and then there is a very great fear of the coils short-circuiting.

In the Ward-Leonard type of starter the coils are enclosed in an iron box filled with sand. This is a good form, and not only does the sand act as a support to the coils to prevent short-circuit, but it also acts as an absorber of heat, and the coils will stand successfully a higher current during the operation of starting. When this device is adopted, care must be taken to see that the box is made tight-fitting, as if not, with continued use the sand may escape through any crevices. In a well-built switch, however, this fault is not likely to occur.

The third requirement is perhaps very stringent, and a higher temperature rise might be permitted, but when it is considered that the temperature of the atmosphere is often 70deg. or more, and that the whole success of the starting switch depends upon the resistance coils, it is important that due attention should be given to this point. It may be also contended that it is not intended that the current shall pass continuously through the resistance wires, but that the coils are only used as conductors for limited periods. This certainly affects the question, but, on the other hand, the apparatus is placed in the hands of unskilful persons, and in practice it is not unusual to find with certain types of starters that some part of the resistance wires is left for considerable time in circuit; again, in other cases the motor has to be constantly stopped and started, so that a good margin is not inadvisable.

The fourth requirement is one of the most important of any, while it is a well-known fact to all electrical engineers that the breaking of the shunt current in a direct-current motor induces a high induction E.M.F. Many switchmakers appear to forget that the current due to this induced E.M.F. must be provided for. A simple method of showing the existence of this high induced E.M.F. is to arrange a switch in the circuit in such a manner that just at the make and break the ends of the shunt windings are connected through incandescent lamps. In a particular case the writer saw a motor connected to a 200-volt supply fitted with such a switch; at the moment of make and break the shunt wires were connected across two 200-volt lamps in series. At the make the lamps were faintly incandescent, but at the break they momentarily glowed very brightly, so showing that owing to the self-induced E.M.F. of the shunt coils the potential difference was far in excess of 400 volts, or more than double the normal pressure. While the insulation of any motor should be arranged to safely withstand a much higher potential than that at which the machine is intended to work, yet makers cannot anticipate that it will be periodically subjected to tensions more than double of the normal. At the same time, it must be remembered that the motor is started and stopped under all conditions, at times when the windings are damp or dirty, and that at these times it will take very little to break the insulation down—a little surface moisture, or a particle of copper dust bridging across to earth, is quite sufficient.

With liquid starting switches there is yet no good device for absorbing the self-induced current, but with the more

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ordinary starting switch with metallic resistance there is no difficulty when the current is not broken at the starting switch itself. All that is necessary is to connect the shunt lead to the end of the armature external resistance. If this be done as shown in Fig. 1, the movement of the starting lever to the first contact will make the circuit through the shunt fully. As the lever is moved on to the other contacts an external resistance is thrown into the shunt circuit, but the amount of drop in the pressure is not great, as the resistance is designed for the large armature current and not for the small shunt current. If the circuit be opened by another switch, the self-induced

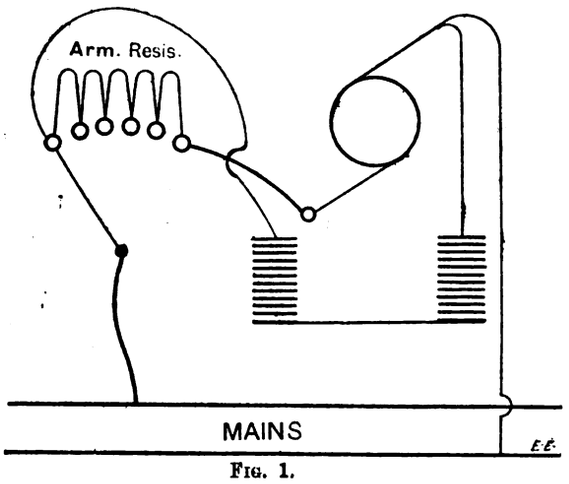

FIG. 1.

current can flow through the armature resistance and the armature itself, and so complete a closed circuit. On the other hand, if the switch is connected as shown in Fig. 2, a similar result will obtain, only in this case upon moving the switch to its first contact the circuit through the shunt is made through the armature resistance, and the shunt current is gradually increased as the armature resistance is cut out. A glance at the diagram will show that in breaking the circuit the self-induced current will at first flow through the armature and form a closed circuit, and afterwards through the armature resistance in addition.

The difference between the two methods of connection is this: With the second method of connection the induced

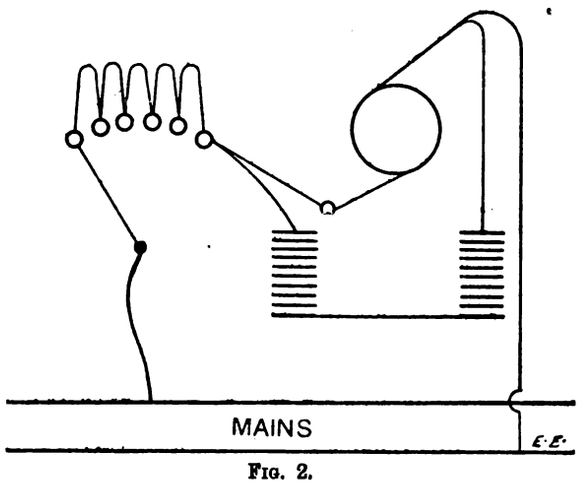

FIG. 2.

current flows through the armature only when the self-induced E.M.F. is at its highest value, and the resistance is inserted as the E.M.F. is lowering in value; this may give rise to a high value for the momentary current. With the first method of connection, however, the current flows through the greatest resistance when the E.M.F. is at its highest. The difference is not of great moment when the high resistance of the shunt windings is compared with the comparatively low resistance of the starting switch coils. If the starting switch is fitted with an automatic release, upon breaking the circuit by means of a separate switch the starting lever will come back to the off position. Now the current is broken immediately the auxiliary switch is opened, and the lever takes an appreciable time to come to the off position, and yet at times a slight spark will be noted as the lever leaves the last contact if the switch be quick acting. This spark can only be due to induction effects, and shows again the necessity for some device for absorbing the self-induced current. A consideration of the diagrams also shows the importance of inserting auxiliary switches, for with either of these methods of connecting up the switch it is impossible to arrange an absorbing path for the self-induced current of the armature if the motor be stopped by pulling the switch lever back by hand, as the shunt circuit is not then broken until the lever leaves the last contact. In this regard there are also the bad effects of the self-induced series current of a compound-wound motor to be considered, and as this is much greater than the shunt as regards value of current, disastrous sparking will occur.

(To be continued.)

THE POINTS-BOY PROBLEM, AS SOLVED BY THE ZYLBERLAST POINT SYSTEM.

A system that can dispense with the services of those juvenile attendants who, in the intervals between long and irregular mealtimes, switch tramcars (usually) in the right direction, will deserve well of the inter-urban travelling public. Further, there is an opening for such a contrivance in places where a single line of track, with siding loops, is in vogue, as the Board of Trade enjoins either the use of an overhead switch worked by hand or a double line of wire under such conditions. The latter is more generally used, and the extra wire is, of course, of certain utility in saving power. At the same time, the need for a more mechanical arrangement in connection with both the above operations has been felt for some time, and at one or two North Country towns experiments are being made in this direction. This article deals with a system (with the somewhat ominous title of "Zylberlast") that on Saturday last was explained to a party of tramway engineers and pressmen.

A portion of the Trafford Park tramway system had been fitted with the device, likewise a tramcar, and to the casual eye the alterations to both were not noticeable. When, however, the gang of experts arrived the differences from the normal state of things were seen to be as follows: (1) On tramcar, a point-shifting plunger at each end, actuated by the driver's left heel. (2) Also, a roller at each end to replace the point in its original position. (3) On track, an enlarged groove in the rail just before the nose of point. (4) In this groove, a guide tongue attached to the nose of the point (below the wheel flange), for the point-shifting plunger to push over when required. (5) A cast-iron shoe-shaped box lid protruding slightly above the road level alongside the point. This lid is still further raised by the point being shifted, and when then struck by the roller on the back of the car, is depressed, and thus pushes the point back into its original position. These details deal with the point operations only. For keeping the overhead equipment in touch with the point, the following outrages upon the scenery awaited the hypercritical eye: (6) In roadway, marks of a recently reinstated trench dug to inter a length of gas-barrel containing a connecting wire. (7) Up the side of adjoining house, a length of gas-barrel for a continuation connecting wire. (8) On the house roof, a spiral spring and bell crank for connecting the wires at right angles. (9) Slung to span wire, more connecting wire, similar to the usual arrangement. (10) Special frog. This is pulled over to suit the direction of the track points by the connecting wire. (11) On the frog, a catch to hold the frog switch in place (when the track point is banged back by the car roller) until the trolley wheel, trailing after the car, has passed the frog. (12) Just past the frog, a curved brass arm hanging in a position to be hit by the trolley wheel. This releases the catch, so that the spring on the house eaves pulls the frog switch back to its original position.

The foregoing dozen items describes the whole arrangement, save and except a box in the trap into which the action of the plunger and point sweeps the dirt that is always with us. This box has not been included in the

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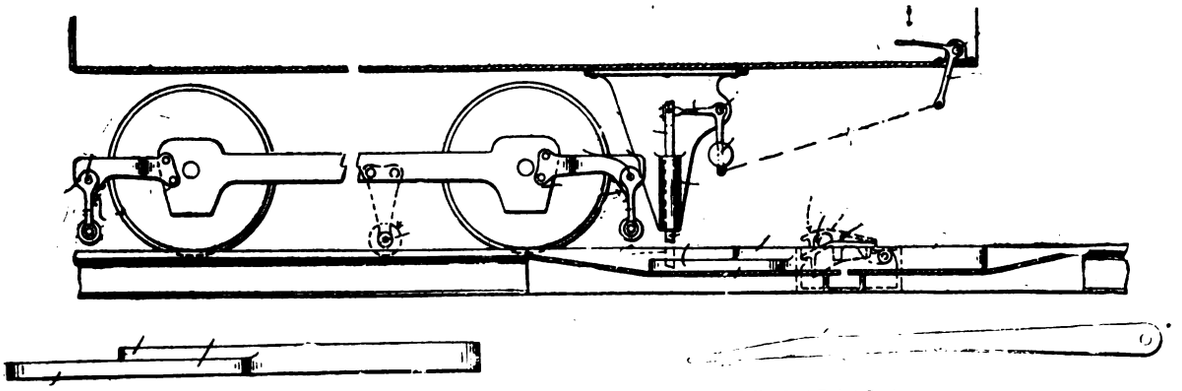
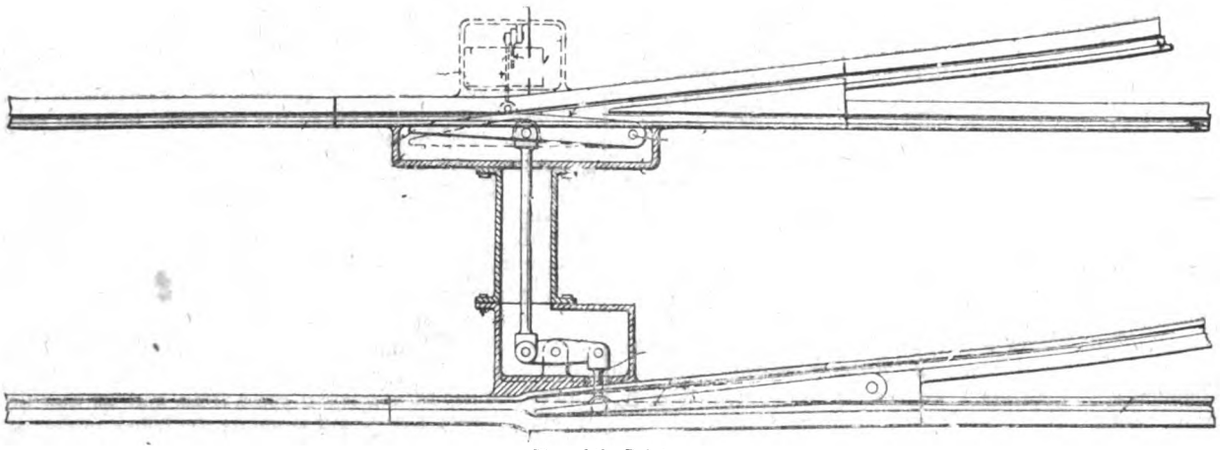
tabulation to prevent the unlucky numeral being saddled upon the undertaking at this period of its existence. The

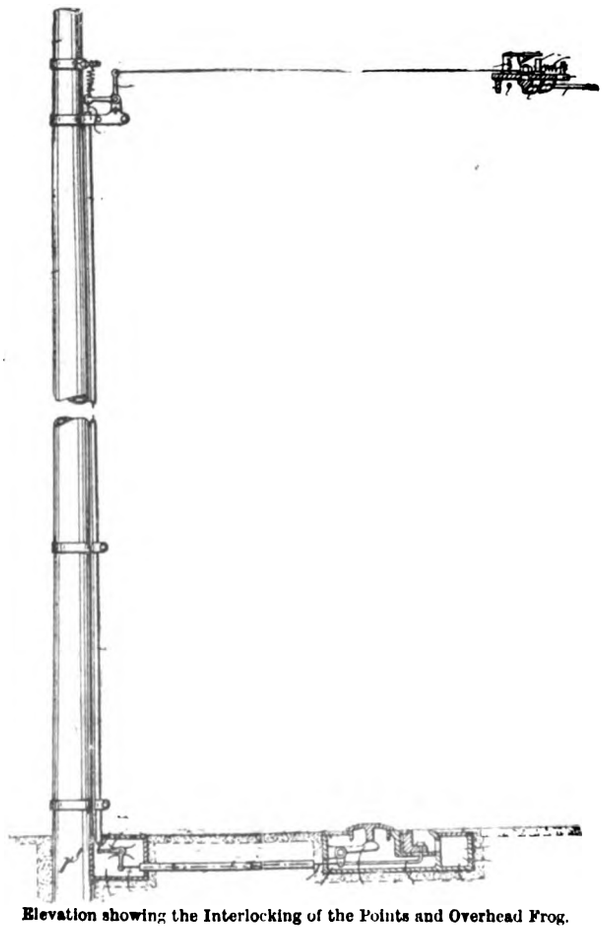


Elevation of the Underside of a Tramcar equipped on the Zylberlast Point System.



Plan of the Points.

success of the experiment was duly demonstrated by the especially fitted car being run over the points, when the



Elevation showing the Interlocking of the Points and Overhead Frog.

depression of the driver's heel and the impetus of the car did all that was necessary to guidance as required. At the present rate of electric traction invention, by the way, there will soon be an opening for persons with a surplus of limbs beyond the number given to men. On the above car, for instance, the following were operated upon by the various feet of the driver: the usual brake catch, lifeguard tripper, gong striker, and the special point plunger in question.

There are still improvements needed to overcome minor defects that are visible to the outsider, and it is understood that perfecting alterations are being made as follows: (*a*) For the shoe on box cover, that protrudes above the roadway surface, a flush slot is to be substituted, through which a trigger will emerge when the point is banged over; this trigger will be pushed back inside by the roller on the car, thus replacing the point; a spiral spring (in an oil-bath) will hold the trigger safely inside under normal conditions. (*b*) The overhead exposed springs will be replaced by counterweights. (*c*) The connecting wires in the tubes will be replaced by rods, thus avoiding chance of breakage.

When these alterations are completed, the system should be as near perfection as is possible on this sinful sphere, the only disadvantage appearing to be that the articles will not be distributed gratis. As to cost, enquirers should write to the Zylberlast Patent Point Syndicate, 20, Cross-street, Manchester: and it is understood that appointments to view the system at work can be made at short notice. A pamphlet with description, full detailed drawings, and a list of advantages running into double figures, is also to be obtained in further explanation of the system to those unable to view a demonstration.

AN EXPERIMENT TO ILLUSTRATE THE PRINCIPLE OF HORN ARRESTERS.

BY A. E. MOORE, A.M.I.E.E.

Diverging horns, attached to high-tension fuses, switches, etc., are used on some of the electric supply systems for the purpose of arresting the arc produced on opening a circuit. The arc, which is started at the lower end of the horns where they are nearest together, travels quickly upward, increasing in length until the voltage between the horns is no longer able to maintain it.

At a meeting of the Institution of Electrical Engineers,

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Mr. Cowan stated that "these horn-breaks are really single-coil magnetic blow-outs; and that if the horns be inverted the arc will travel downward." Now the rising of the arc is more generally understood to be due to the influence of convection, and in some text-books convection is the only cause stated. Theoretically, as Mr. Cowan stated, both the influences of convection and electromagnetism tend to arrest the arc. In view of these statements, I recently made some experiments to determine whether the influence of convection or of electromagnetism plays the more prominent part. The result shows that convection plays only a small part. As the electromagnetic effect seems to be little known, a description of the experiments and results may be of some interest.

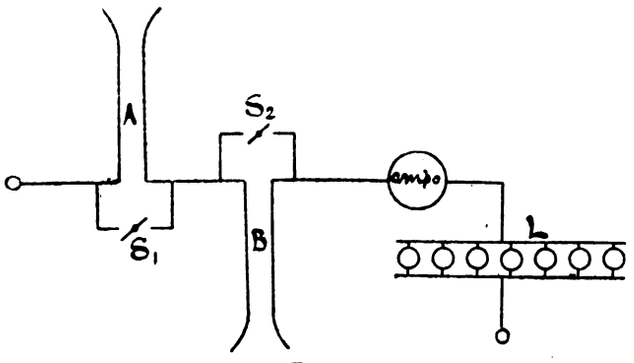

FIG. 1.

A circuit was arranged as illustrated diagrammatically in Fig. 1. A and B represent horn-breaks, and in order to intensify and prolong the effect, the horns in each break were arranged to be parallel and $\frac{3}{8}$in. apart for a length of about 10in. before diverging. They were made of No. 12 S.W.G. copper wire. S_1 and S_2 represent switches for short-circuiting the break which is not in use. L represents a bank of incandescent lamps used as a load. The circuit voltage was 110 volts, and the load when the gaps were closed 25 amperes. An arc lamp carbon was used to start the arc. S_1 was left open and S_2 closed. The circuit was then completed by bridging the gap, A, with the arc lamp carbon. On removing the carbon, the arc produced travelled up the horns and broke on the diverging part. S_2 was then opened and S_1 closed, and the experiment repeated on gap B. The result was most interesting to watch, for the arc travelled downwards and broke on the diverging part. As in the case of the gap A, the arc travelled, as it were, *away from the circuit.* The experiments were repeated a number of times with similar results. It was found, however, that the arc was rather more persistent in B than in A. This, no doubt, was due to the influence of convection.

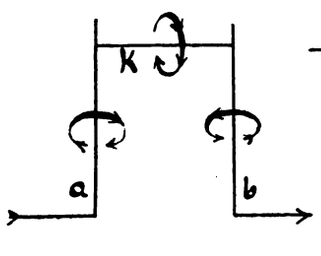

FIG. 2.

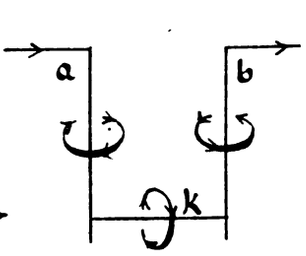

FIG. 3.

It will be well now to briefly consider the theory of this action. In Fig. 2 let *a* and *b* be the two sides of the horns, and *k* the arc. Imagine the current to be flowing from *a* to *b*, then the magnetic lines of force encircling *a*, *b*, and *k* will be as illustrated by the arrows; thus producing a mutually repelling force on the three conductors, of which the arc, *k*, is a movable one, and it therefore rises. Now, it will be seen that this repelling force only exists in virtue of the relative positions of *a*, *b*, and *k*. If *k* existed as a straight line across the exact base of *a* and *b*, no magnetic force (except it were from some external source) would be exerted upon it. Again, if we assume the horns to be removed, and the arc to exist across the ends of the conductors, no magnetic force will be exerted on it so long as it is quite straight; but if, due to any cause—convection, for instance—the arc becomes curved in any direction, then a magnetic force will be exerted on the arc, tending to burst it. This is the same effect as in Fig. 2, except that in place of the metallic horns the sides, *a* and *b*, are formed by the arc itself. It is now quite obvious that if Fig. 2 be inverted as in Fig. 3, the force on *k* will be downwards; or in any position of the horns the effect will be to force *k* to the outer and wider ends of the horns. Moreover, it is immaterial whether the current be continuous or alternating, for if the current be reversed in *a* and *b*, it is also reversed in *k*, always producing a force on *k* in the same direction—viz., towards the outer ends of the horns—no matter what their position is. This effect brings out an important point affecting the design of this form of arc-breaking device.

From the preceding lines it is obvious that if the arc is started at the points *x* and *y* (Fig. 4), it may be deflected slightly upward or downward; but if it does happen to bear ever so little downward, it will then be *forced downward.* To

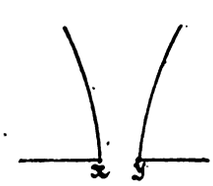

FIG. 4.

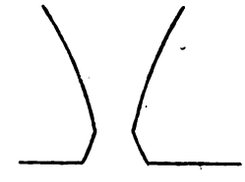

FIG. 5.

make sure that the arc shall not be deflected downwards, the fuse or switch contact must be placed a short distance up the horns; and in the case of a lightning arrester the horns should be shaped after those in Fig. 5, and not Fig. 4, so that the discharge breaking across the shortest path will be a short distance up the horns.

It was found in the experiments that when the arc was started at the very base of the horns (A, Fig. 1), that it often lingered for some seconds; sometimes fusing the horns off, sometimes breaking below, and sometimes—but by no means very frequently—it went upward. No uncertainty, however, was experienced when the arc was started above the base, the arc always travelling upward.

AYR ELECTRICITY ACCOUNTS.

The following is an abstract of the revenue account of the Ayr Corporation electricity department for the year ended May 15, 1904.

Dr. *Expenditure.*	£	s.	d.
Generation of electricity	4,069	7	2
Distribution of electricity	257	3	4
Attendance and repairs to public lamps	170	11	3
Management expenses, salaries, etc.	573	12	11
Law expenses	9	13	6
Rents, rates, taxes, etc.	357	16	8
Repairs to front property	1	15	8
Expenses of renewing mortgages	44	2	7
Special charges, insurances, etc.	215	7	7
Annual payment of expenses of opposition to Electric Power Bills	108	8	9
Balance carried to net revenue account	5,449	19	2
	£11,257	18	7

Cr. *Revenue.*	£	s.	d.
Tramway traction	1,753	17	7
Public lighting	3,590	10	8
Sale of current per meter	5,627	5	1
Miscellaneous receipts	286	5	3
	£11,257	18	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,192,629
Quantity sold	Tramways	324,157	1,047,781
	Public lamps	430,864	
	Private consumers	292,760	
Quantity used on works			63,744
Total quantity accounted for			1,111,525
Quantity not accounted for			81,164
Total maximum supply demanded (kilowatts)			529

Number of public lamps: 122 arcs and 163 incandescents.

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ELECTIVE AUDITORS.

What exactly are the duties of elective auditors we do not profess to know, and we do not pretend to care, but we do know duties which are outside their sphere of operations, and with which they ought not to be allowed to interfere. If, however, they do interfere with concerns which do not come within the purview of their work, they need a stern reminder—"hands off." South Lancashire is the home of the interfering elective auditor. Here he runs riot and desires to rule the roost. The latest phase of his activity is at Salford, in a letter by Mr. Hunt—whom we assume to be an elective auditor—to the *Salford Chronicle*. He commences with a tirade against secrecy—secrecy in selecting contracts, secrecy in prices—and then goes on to tell what everybody who pretends to know anything about municipal affairs is perfectly familiar with, that there is no such thing as secrecy. Anyone who is a ratepayer can for a small fee get to know all about contracts and prices. Mr. Hunt's whole letter is to the tune that the ratepayers elect representatives, but they ought not to trust these representatives to do anything that is not blatantly proclaimed throughout the length and breadth of the constituency. As every member of the Council knows that any elector can get the information he wants, we fail to see why he should go out of his way to proclaim it on the housetop. Mr. Hunt, as we say, knows this, for he says: "In fact, nothing which the Council has accomplished can be kept secret if knowledge is desired." Then why all this pother? It will thus be seen that Mr. Hunt himself conclusively shows his references to secrecy to be unwarranted, unless he wants committee or Council to send a copy of the agenda and minutes to every ratepayer. But secrecy is not the real trouble. The cloven hoof is seen in the following: "This is a subject well worth the attention of the miners and their friends." In other words, Mr. Hunt is playing to the gallery of trade unionism. What has it to do with an elective auditor's duties that the "strike clause in a specification is modified?" What has he to do with the clauses of a specification at all? He is not responsible for the goods purchased or the work specified in these clauses, and we should have thought that the fewer the restrictions upon a contractor the better for the purchaser. Why should not a firm object to the strike clause? They may do it on principle—not because they are better or worse masters than others, but simply because they resent interference in their own business. Our trouble is to find where an elective auditor is concerned with any clause. It seems to us that the auditor's duties begin and end with a strict examination of accounts. *Why* the committee or council decided to buy a machine from one contractor rather than another has nothing to do with the auditor. He has not had to consider the matter or compare the machines—their make or efficiency. If, however, those duties are his, neither committees nor councils are required, only elective auditors. Perhaps Mr. Hunt may not understand what is a truism to most business men who know aught of machinery—that often a thousand pounds initially saved is a loss of several thousands before the end comes. The basing of an argument for or against a council or an engineer because of a possible initial saving of a thousand pounds—one contract being that much below another—unless the things tendered for are identically alike, savours of idiotic ignorance. This is what Mr. Hunt does, and why he does it is easily seen from "In this there was no trip to Paris; in fact, it was not even necessary to leave Manchester, and they were consequently passed over." This looks like trying to curry favour with your neighbours. The chances are a million to

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one but that Mr. Hunt is a "whole-hogger" in free trade, but the suggestion contained in his letter is rampant protection.

THE TRUTH.

Our contemporary the *Journal of Gas Lighting* has accepted our challenge, scored a point, and landed itself irretrievably into our hands. The point scored—and we cry peccavi—is over the grammatical construction of a sentence. Truly the sentence is involved—a comma misplaced, and a wrong ending given. Had the *Journal* been generous it would have let its

reason serve
To make the truth appear, where it seems hid
And hide the false.

The motto of *this* paper is the truth, the whole truth, and nothing but the truth; the motto of our contemporary should be special pleader. So special is it, that it hesitates not to delve in the dirtiest of literary ditches in order to serve up muck which it thinks may be used to bespatter the electrical industry. After its exhibition of this week, its influence—if it ever had any—as a special pleader is gone. Grub-street would not admit such tactics. It cannot descend lower, as we shall now prove. So eager is the writer in the *Journal of Gas Lighting* to make his point, that he proves his ignorance.

"You are too swift, Sir, to say so."

Why, before crowing over what you are pleased to term "the worse for the ratepayers," did you not look at the original figures? Fie upon you; your criticisms are trumped up second-hand. It suited your purpose to pretend to mistake, and so lead your readers to believe that Erith had an adverse balance of £1,801. You either knew better or you were ignorant of the truth. Either horn of the dilemma is good enough to spit you upon. Our contributor meant, in his involved sentence, that the deficit was £781, and *that* (£781) was the amount of the deficit after paying £1,801 capital charges. There are not two deficits, as our contemporary would make out—one £781, one £1,801—and no sensible reader would have interpreted the involved sentence to mean so, but would have sought to detect the error. Had our contemporary desired it, the rectification of the matter could have been made from p. 502 of our last issue, where the credit balance on the year's working is given as £1,020. 8s. 5d. The capital charges required £1,801. 16s. 8d., thus leaving an adverse balance deficit of £781. 8s. 3d. Our contemporary did not want the truth; it served his purpose better to assume a lie, and so make matters look as bad for Erith and the electrical industry as possible. Whether the *Journal of Gas Lighting* on p. 26 of its issue of Oct. 4 is writing ignorantly or maliciously we have no means of telling; but it can take it either way, and either is bad enough. Now a word to our contemporary. Before trying a fall with the *Electrical Engineer*, be sure of your facts, and do not prostitute the English language by crying "truth, truth," when the sole object is to hide the truth.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BIRMINGHAM ELECTRIC CLUB.

SIR,—It has been a matter of continual surprise for some time past that in Birmingham and the surrounding district those who are engaged in electrical work know so little of each other. In the different branches of the work this is very marked, and it is so in a great measure with those engaged in the same branch. Consequently it has been thought that a club would be instrumental in rectifying this, and from enquiries made it is found that the suggestion of a club is heartily received by individuals in railway telegraphs, postal telegraphs, National Telephone Company, electric light, technical schools, manufacturers, construction, traction, and professional. Two circulars have been issued (copies herewith), and the first meeting is to take place on Saturday next at the Colonnade Hotel, one of the chief hotels in the city. The first meeting will, of necessity, be mainly devoted to the business of outlining the club, appointing a committee, etc.

From enquiries I learn there is at present no such club in existence. The Westinghouse Company in America have, as you are probably aware, an "Electric Club" in their works, supported by the firm, and they have a periodical, entitled "The Electric Club Magazine." Also, at their branch works, in Manchester, England, they have a similar club, but in each case it partakes more of a technical school than a club.

The club we are about to form here will be called an "Electric Club." My fellow-workers join me in asking that you will kindly mention in your next issue the effort we are making to form this "Electric Club," and if you are favourable to so doing, you may, if you think well, produce a copy of the first circular, herewith enclosed. We think that if you will do this, it will greatly assist us.—Yours, etc.,

W. DALBY.

Birmingham, Oct. 4, 1904.

The circular, which is written from Mr. W. Dalby's address at 187, Ombersley-road, Sparkbrook, reads as follows:

"Proposed Electric Club.—Dear Sir,—A meeting will be held *re* the above on Saturday night next, Oct. 8, at the Colonnade Hotel, time 7 p.m., when we trust to have the pleasure of your presence to assist in the formation of such a desirable institution.—We beg to remain, faithfully yours, W. Dalby, M. G. Waggott, W. H. Whitehouse, M.I.E.E."

[N.B.—If this proposed club is well managed by a committee representing all branches of electrical work, it should do a great deal of good. We would suggest that the local section of the Institution of Electrical Engineers should take the matter up, and that club dinners before each meeting of the section should be held.—ED. *E. E.*]

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

X.—ON DRUDGERY.

MY DEAR YOUNG 'UN,—If it is of any interest to you to know it, you have given me the hump. Your letter is a fearful whine from one end to the other. You can't see how you are going to learn anything under your present foreman. Your mates tell you a thing is so because it *is* so, and don't know any other reason. You have been stuck on a drilling machine for six months, and, for all you can see, are likely to stick for another six. In other words, you have been injudicious enough to turn up your nose at your work, and mad enough to write to me stating the same.

Now, in the first place, how long have you been in the shops—ten minutes or a quarter of an hour? Not so long ago you were all on fire to start work. Now you are as damp and chilly as a mudbank in winter. If six months' work is going to do this for you, what will you be like in six years? You can't expect to go through life at the express speed you developed in College. If you got practical facts flung at you in the same profusion that you received theory, you would be greyheaded at thirty, and a babbling idiot at sixty; your brain wouldn't stand it. Our atmosphere has about four parts of nitrogen to one of oxygen. Nitrogen is of no active service to us at all—it is just put in to dilute the oxygen fuel and keep us from burning ourselves out too quickly. In the same way, the drudgery of the shops is essential to us in order that we may have time to soak in the meaning of the big facts that occasionally come up against us. If you study such men of affairs as you have the opportunity of meeting, you will see that directly a man tries to do too much he becomes

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irritable. He is eliminating the nitrogen, and his system won't stand the combustion. A shop foreman who was a friend of mine always used to shake his head at any man who was trying to get on in the profession too quickly. "Ah!" he would observe, "it's Christmas pudding—only Christmas pudding that does it!" He was quite right; to get experience you must put years of work in, and you can't, by worrying and fussing, cut down the number of Christmasses required. Thirty knots is good going for a torpedo-boat destroyer. Try to push the speed up to thirty-five and the boat will be all coal bunker and no engine.

Another point, are you sure you have enough to do? My experience is that so long as my nose was kept hard up against the grindstone I hadn't time to grumble. It was only when the slack time came that I had opportunity to rub that nose and make sniffy remarks about my work. This doesn't clash with my former proposition in this letter, which was directed against wild grabbing for "experience." I am now talking about continuous hard work at one job. The more occupation you can get—particularly if it is of a healthy, weight-lifting nature—the better for your spirits. Come into the shop in the morning with the intention of beating your previous output, and you will find yourself becoming so cheerful that you will want to scrap with the first fitter that reminds you that you're not on piecework.

Another thing; think about your work. The amount of attention which is necessary to carry the job through without disaster is the minimum which you should give. That is your employer's part of your brains. Now turn on the limelight for your own benefit. For instance, you have a hundred gunmetal sleeves to bore and face-up. Nothing more simple; nothing more monotonous. Yet any number of interesting points come out of the job. What is the quickest lathe speed you can use? How deep a cut can you take? Which would probably go first—the tool, the work, or the strap? (Don't be rash, however.) This brings you on to strength of materials of the machine tool if you want to get there. But there are plenty of things nearer home than that. The best rig-up, the proper rake on the tool, the best lubricant to use, the use of the turret head—plenty to think about; matter you will never find in books, but which you will use every day later on. You are gathering impressions every time you look at your job. You are doing work instead of talking about it—making friends with the iron and brass that you will some day use for your own advantage.

Finally, I would make a radical suggestion. I know that shop life is very dismal at times—that it will, in fact, play upon your health through your spirits if you let it. But as an antidote to it I would recommend you to have an evening hobby connected with engineering, but offering you sufficient change of work. I never yet knew a young man of parts who did not think that, if he had time, he could develop a career along a certain line of knowledge. Very well, devote some part of your evenings to the development of your speciality. Do not work exclusively at it, for you must make records of your general experience. But you will now do no harm by commencing to build up your special attainments on sound engineering lines, which means by slow growth. Then when you come home to tea rampant because your foreman has called you a lost, ensanguined son of a paralytic idiot, or words to that effect, for something which you know to be his own silly mistake, you will simply go for your own special work. In two hours you will not only have laughed at him and forgiven him, but you will be smoking your Navy Mixture with the calm anticipation of the time when he will crawl round your feet for a job.—Yours,

THE OLD 'UN.

FORTHCOMING EVENTS.

MONDAY, OCT. 10.

Institution of Mechanical Engineers (Graduates' Association).—At 8 p.m., paper by Mr. V. I. N. Williams, graduate, on "Exhaust System of Dust Collecting."

FRIDAY, OCT. 14.

Electro-Harmonic Society.—At 8 p.m., smoking concert. (For programme see other column.)

METHODS OF DEALING WITH MIXED SYSTEMS OF TRACTION.*

BY MR. A. L. C. FELL, M I E E., M I MECH.E, ETC., CHIEF OFFICER, LONDON COUNTY COUNCIL TRAMWAYS.

In this short paper the author only proposes to deal with the question of "mixed traction" in a very broad manner. In the majority of instances in this country, electric tramways have been installed as a development of some other system of traction, so that for a short time, at any rate, nearly every manager of an electric tramway has had to consider the question of "mixed traction." The subject may be roughly divided under the following headings: (1) temporary mixed traction during reconstruction; (2) mixed traction under normal conditions; (3) mixed traction in connection with running powers. The problem to be faced during reconstruction is a very complicated one. It is to maintain, as far as possible, a useful and fairly efficient service without incurring serious loss. The larger the city the greater the difficulty, as competing omnibus companies, tubes, underground, overhead, and surface railways are only too anxious to absorb the traffic and provide increased accommodation. In smaller cities and towns, where the tramway has practically a monopoly, the question of opposition need not be feared, but any dislocation or stoppage of the tramways is a matter of vital importance to the travelling public.

Each tramway authority has to consider the following questions before the work of reconstruction is commenced: (1) Will it be necessary to close the road for vehicular traffic? (2) What is the best method of arranging the work, so that the tramways can be kept running? (3) Can the work be carried out properly and expeditiously if a short length of single line is reconstructed, and temporary crossovers are used? (4) Will it be advisable to lay a temporary track on one side of the road and reconstruct a fairly long length of single line? (5) Will it not be better to stop the tramways? The answers to these questions depend entirely on local conditions.

In London in the majority of cases the roads have been kept open for vehicular traffic, and the tramways have with two exceptions been kept open, but the loss in receipts last year due to the disorganisation of the traffic during reconstruction amounted to upwards of £24,000. Where the tramways have been kept running, a temporary track has been laid at one side of the road. In two instances the tramways were stopped during reconstruction. In the first instance the route was an unimportant one, and electrical running was not commenced until the whole route was complete. In the second instance, one track was reconstructed at a time: when about one-third of the route was completed work was commenced on the other track; in this way half the roadway was kept open for vehicular traffic. Whenever possible, mixed traction and the necessity for changing cars has been avoided.

If the original system is a horse or a steam tramway, and it is desired to reconstruct for an overhead electric tramway system, it is advisable to complete the whole of a route before the electric cars are put into operation, and so avoid "mixed traction" if possible; but if it is a question similar to that which recently had to be dealt with in London, it is not possible. The special instance was as follows: A horse tramway originally ran from the Westminster and Blackfriars Bridges to Brixton. About 10 years ago a portion of this route was reconstructed and extended, and a cable system of traction was installed, as the gradients were considered too steep on the extension to be profitably worked by horse traction. For the convenience of the passengers the horse cars on the other portion of the route were fitted with cable grippers, so that they could be run over the whole route; the change over at the junction of the two systems being made very rapidly. In 1903 the portion of the route operated by horses was reconstructed, and a conduit electric traction system was installed. Owing to obstructions in the roadway, it was not possible to carry the conduit sufficiently far to enable the cars on the cable and electric systems

* Paper read before the Liverpool Congress of the Municipal Tramways Association of Great Britain.

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to be brought close to one another, and it was necessary to draw the cable cars over the intervening space by means of horses. The original intention was to temporarily operate the electric cars over the cable system, and they were fitted with cable grippers and plough-lifting devices, but it was found that the cable was not strong enough to draw the heavy electric cars, and it became necessary to transfer the passengers from the electric to the cable cars, and *vice versâ*. As this very mixed system was very inconvenient and expensive, it was arranged to reconstruct and electrify the cable portion on the conduit system. The cable had to be stopped during reconstruction, and the question of operating the cars by horse traction was discussed, but as four horses would have been necessary to draw each car, it was decided, after very careful consideration, to stop the tramways altogether during reconstruction, but to allow the ordinary vehicular traffic to use one-half of the road, as the thoroughfare was a very important one. The work was carried out in this manner, and not only was a very heavy loss on the disorganised working prevented, but it was possible to open the first portion of the road in 6½ weeks, and a second portion in 1½ weeks, and the remainder in three weeks, or a total of 3½ miles of double track in 11 weeks from the date on which the cable tramways stopped running. The result, from the traffic point of view, is that the receipts from this portion of the route have been doubled, and the receipts on the portion of the road previously reconstructed for electric traction have been increased by over 25 per cent., clearly demonstrating that a through route not operated by mixed systems of traction is what the travelling public require. The cost of operating the above route by horse and cable systems was 9·99d. per car mile. The cost of operating by electricity, horse, and cable was 7·92d. per car mile. The cost of operating by electricity only is 7d. per car mile, including all charges for power supply. We hope that when we obtain the necessary power from our permanent generating station at Greenwich that the cost of operation will be reduced to less than 6d. per car mile.

Some municipal authorities may think it advisable to permanently operate several different systems of traction, and under special circumstances this may be the best policy to adopt, although as a general rule a uniform system is most easily and efficiently worked. Taking London as an example, where mixed traction has been somewhat freely used and will still be used, although only to a limited extent, horse, cable, and electric traction have all been in operation at one time, and in one instance already mentioned the whole of these systems were for a short time in operation on one route. The London County Council has abolished the only cable line which it possessed, and the majority of the horse lines in the south of London have been reconstructed and are now worked on the conduit system. The remaining lines will very shortly be dealt with, and reconstructed either on the conduit or the overhead trolley system. If necessary, the Council will not hesitate to mix these two systems. The complications introduced present no insurmountable difficulties to the management, as the method of changing from one system to the other is very simple and expeditious, the whole operation being carried out in about 15 seconds. The conduit plough has simply to be wound up by a winch and the trolley arm is released, and the trolley placed on the overhead line, the only drawback being that cars have to be fitted with both trolley standards and plough carriers; in other respects the equipment of the cars is identical. In London, in all probability, the conduit system will be installed in all crowded thoroughfares and on every route which can be profitably operated. I only hope that as time goes on we shall be able to materially decrease the cost of construction on the conduit system, and also reduce the cost of operation, so that practically the whole of the London County Council's tramways may be on the conduit system. For London, I am convinced that the conduit system is the ideal system, and the only one that is likely to prove an unmixed blessing.

The London County Council are now constructing a shallow tunnel on the north side of the river between Southampton-street and the Victoria-embankment. This tunnel will form the main connection between the Council's northern and southern tramways as soon as parliamentary powers are obtained for lines over Westminster and Blackfriars Bridges and along the Victoria-embankment. It will only be possible to work single-decked cars through this tunnel, as it is only 13ft. high. It will be necessary, so that full advantage may be taken of the tunnel, to run through cars from one end of the system to the other. To do this the majority of the cars will have to be of the single-deck type with vestibules, which can be either open or closed, in which passengers desiring to smoke can be accommodated. The double-deck cars will be used for short-distance journeys, and on other than through routes.

Local difficulties with regard to "mixed traction" may be easily dealt with. Special routes can generally be arranged on which each system may be operated, but "mixed traction" is a more serious question when through running over tramways belonging to outside authorities is contemplated, as not only have different systems to be dealt with, but the subject of standardisation has to be faced. Unhappily, up to the present time there has been no uniformity; the so-called standard gauges are not identical. The sections of rails vary greatly, and in several instances the dimensions of the cars vary to such an extent that, although the rails may be laid to a standard gauge, a sufficient clearance cannot be obtained between the cars. A great deal is at present being done with a view to standardising where possible, but it will be a very long time before these standards can be introduced—in fact, I very much doubt if the standards will ever be uniformly adopted in this country. In numerous instances the authorities have decided to continue the development of the local tramway system, so that the various parts of the undertaking will be interchangeable. This can quite readily be understood when it is considered that when the majority of the undertakings were started no definite standards were recognised, and each pioneer authority had to make its own standards.

If any members of this association wish to realise to what extent traction can be mixed I would recommend them to visit Paris. A short time ago I saw no less than 12 systems of traction in operation in Paris in one day. The systems were as follows: (1) conduit; (2) overhead trolley; (3) accumulator; (4) steam cars drawn by locomotive; (5) superheated steam cars; (6) gas cars; (7) oil cars; (8) horse cars; (9) Diatto surface-contact system; (10) Dolter surface-contact system; (11) tube railway, third rail; (12) electric locomotive drawing ordinary steam railway trains into passenger station.

Taking the first 10 on above list as an example of what may be done on any tramway undertaking, the following arrangements might be made: The conduit cars could be run over the trolley, surface-contact, and accumulator systems, but to do this the cars would have to be fitted with ploughs, trolley standards, and accumulators. In certain cities in Germany the cars are equipped with both trolleys and accumulators, as overhead traction is not permitted in the most important thoroughfares; but I understand that the cost of operation is abnormal, and the working is very unsatisfactory. In my opinion it would be less expensive to instal the conduit system in the restricted area. In Paris the overhead and conduit systems are extensively used in conjunction with one another, and the results are most satisfactory. I understand that a similar mixed system in Bournemouth also works satisfactorily. There would be no difficulty in fitting up cars for trolley and surface-contact systems, but I am afraid that it would be a more complicated matter to equip cars for the conduit and surface-contact systems, as the plough and the necessary lifting gear takes up all the available space between the motors, and the surface-contact skates would have to be divided and very short. Horse, steam, gas, oil, and other self-contained systems might be operated on any of the other systems, but the electrically-equipped cars would be useless on the lines operated by these systems unless the routes were electrically equipped throughout.

Attached hereto will be found a tabulated statement to the list of queries which I circulated amongst the members of the association with a view to ascertaining what is being done with regard to "mixed traction" under various conditions. It will be noted that nearly every local authority

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has tried to avoid "mixed traction." It appears that very few authorities stopped running the tramways during reconstruction.

In the majority of cases, short lengths of single line have been reconstructed, and temporary cross-overs have been used to keep the tramways open. Very few instances are given where through "mixed traction" is in operation on the same route. The answers to some of the questions seem to denote that they have not been quite clear. This is especially noticeable with regard to Question 10. Under this heading, it was simply the items of "gauge" and "clearance" about which information was desired, and not about running powers.

QUESTIONS AND ANSWERS.

1. Have your tramways been reconstructed for electric traction?
   - 34 Corporations: Yes.
   - 12 Corporations: No.
   - 5 Corporations: Part of the lines.
   - 3 Corporations: Electric traction was the first system.
   - 1 Corporation: Lines now under construction.
2. Was the work done by contractors?
   - 18 Corporations: Yes.
   - 14 Corporations: No.
   - 14 Corporations: Partly by corporation and partly by contractors.
3. During reconstruction—
   (*a*) Did you stop the ordinary vehicular traffic?
   - 12 Corporations: Yes.
   - 34 Corporations: No.

   (*b*) Did you stop running the tramways?
   - 15 Corporations: Yes.
   - 24 Corporations: No.
   - 3 Corporations: Only in a few instances.

   (*c*) Did you close the roads altogether?
   - 6 Corporations: Yes.
   - 34 Corporations: No.
   - 1 Corporation: In a few cases.
   - 1 Corporation: Only track portion.
   - 1 Corporation: Not all; some side roads.
4. If you continued running the tramways, did you reconstruct one track at a time:
   (*a*) With temporary cross-overs?
   - 23 Corporations: Yes.
   - 5 Corporations: No.
   - 7 Corporations: Yes.
   - 4 Corporations: No.

   (*b*) With a temporary track laid at one side of the road?
   - 8 Corporations: Yes.
   - 1 Corporation: Yes, in one case.
   - 10 Corporations: No.
   - 1 Corporation: Yes, for single track.
5. Have you more than one system of traction in operation regularly? If so, please give particulars.
   - 6 Corporations: Yes.
   - 44 Corporations: No.
6. Do you run through cars over more than one system?
   - 8 Corporations: Yes.
   - 35 Corporations: No.
7. If so, how do you operate the cars?
   - 1 Corporation: By lifting plough from conduit and connecting trolley arm.
   - 1 Corporation: The horse cars were fitted with cable grippers.
8. On a route where more than one system of traction is in operation, do passengers change cars at the end of each system?
   - 4 Corporations: Yes.
   - 6 Corporations: No.
   - 1 Corporation: Except in one case.
9. If so, do you issue through transfer tickets?
   - 2 Corporations: Yes.
   - 1 Corporation: Yes, in one case.
   - 9 Corporations: No.
10. If outside authorities or companies have running powers over your lines, have you experienced any difficulty?
    (*a*) With regard to the gauge of the track?
    - 19 Corporations: No difficulty experienced.

    (*b*) With regard to the clearance between the cars?
    - 19 Corporations: No difficulty experienced.
    - 1 Corporation: Difficulty anticipated in one instance.

'E DON'T KNOW WHERE 'E ARE!

BY SIMPLEX.

Alderman Boyd, of the Southwark Borough Council, has dissolved into airy nothingness the whole fabric of electrical engineering. "Properly speaking," he is reported as saying, "there is no such thing as an electrical engineer. Any person of ordinary intelligence could read up in a month all that an electrical engineer knew. There is nothing in it."

Wot cher! Hev yer seen an engineer a knockin' rahnd abaht this wye?
Nice cove—got a dyzed egspresshun on, like a dorg wot's gorn astrye!
Used ter be M.I.E.E. an' sitch et cetterrar—
But Mister Boyd says that that's all tommy-rot, so 'e don't know w'ere 'e are!

'Ard lines! Never sees a piper now, except perraps the *Dily Mile*.
Used ter! Took the *Electrician* in an' read it reg'lar without fyle!
Nah 'e knows 'e's bin done in, and buys the *Evenin' Star*;
For Mister Boyd says that Science is a suck, so 'e don't know w'ere 'e are!

Wot ho! Got the blooming 'ump, 'e 'as; an' mourns a stoopid misspent life!
Worked so 'orrid 'ard to train hisself, 'e 'ad'nt time ter kiss his wife!
Nah 'e knows 'is chump is soft—for it on'y tikes an 'arr
Ter learn the whole of electricity—so 'e don't know *wot* 'e are!

Oh, lor! Mister Boyd, I reely think yer've bin an' gone an' done it nah!
One word—an' all the crard of engineers must find their 'ats an' mike their baah!!
Don'tcher think yer impidence a bit pecooliar?
An' w'en yer'e next in the Borough Council room, jest remember *w'ere* yer are!

CLEANLINESS VERSUS INSULATION.

(Founded on a Recent Incident.)

This is a tale of blood,
Of blood and soap combined,
That in a watery flood
The shop wires undermined.

A butcher's shop the scene:
The butcher clove his meat;
The shop well washed had been,
The butcher had wet feet.

Till, with a sudden yell,
His steel he flung aside;
He merely gasped "Oh! Heavens,"
And fled all terrified

Unto the local Works,
And told the smiling Chief
In spasms, fits, and jerks,
"Your 'lectric's on my beef."

The Chief he sent in state,
With Eversheds and pliers,
For to investigate
And mend the faulty wires.

On mutton, beef, and ham
Was juice at many a volt;
Who touched them said "Oh! Heavens,'
And skittered like a colt.

And now, with wary touch,
The mains man roves the stock
Here slightly, there it's much,
Here comfort, there a shock!

By paths of painful pang
He traced the errant juice
O'er fields of flesh and *sang*
It made conductive use.

Until he found the spot
Where blood and soapy brew,
With brooms and water hot,
Those leads had rotted through.

Moral: Butchers' shops require special wiring precautions.

—B. C. H. J.

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THE SPEED REGULATION OF THREE-PHASE MOTORS BY POLE CHANGING.*

The regulation of three-phase railway motors by changing the number of poles seems to be increasing in importance (*vide* the new locomotives for the Valtelina Railway, etc.), so that the following discussion of the subject will be of interest. It will be assumed that the motors are drum-wound, and that the speed reduction required is as 2 : 1. In order to determine the relative qualities of the various possible arrangements, the following points must be considered: (*a*) the field curve, which is better the nearer it approaches to a sine curve; (*b*) the flux, Φ, because of its effect on the iron losses in the stator yoke; (*c*) the maximum

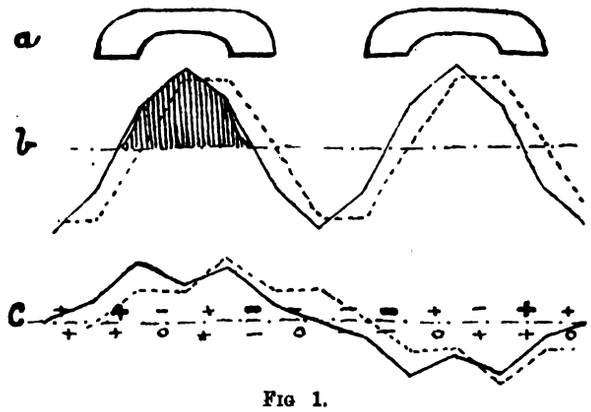

FIG 1.

air-gap flux density, $B_{max.}$, because of its effect on the magnetising current, J_μ, and on the iron loss in the teeth; (*d*) the magnetising current, J_μ, itself, because, besides depending on the maximum flux, it also depends on the greater or less amount of interaction between the separate phases; (*e*) the leakage, because on it depends the overload capacity of the motor.

In order to avoid considering every possible number of slots separately, a uniform smooth-cored winding will be assumed in all cases. This assumption is very nearly correct with even as few as three slots per coil side, and is in any case much more correct for the ordinary motor than the assumption of a single slot for coil side. The voltage will, for simplicity, be assumed to have a sine form, as with this shape, neglecting hysteresis losses and saturation, the

FIG. 1D.

magnetising current is also of sine form, and has the relative values of 1, −·5, and −·5 in the three phases at a given instant, and of ·866, 0, and −·866 at an instant one-sixth of a period later. The curves of magnetising current (and of ampere-turns) for these two instants are shown full and dotted, respectively, in the following curves. Neglecting saturation, these curves of magnetising current will also represent the air-gap induction, and their highest ordinate will be the required maximum density ($B_{max.}$ for the full line, and $B'_{max.}$ for the dotted line). The area of the curves also represents the total flux, Φ and Φ', at the two instants. For greater simplicity two groups of winding arrangements will be distinguished: (*a*) those having one coil per pair of poles per phase, and (*b*) those with one coil per pole per phase (considering the larger number of poles in each case). After changing over to the smaller number of poles this will give one or two coils per pole per phase respectively. A further distinction may also be made with regard to the way in which the coils are connected together: (A) with the same coils in one phase for both numbers of poles, or (B) with different coils in one phase for the two number of poles.

Group Aa.—To this group belongs Dahlander's method (*Elektrotechnische Zeitschrift*, 1897, p. 257), consisting of a standard coil or bar three-phase winding, but with narrow coils (coil side = one-third of the (smaller) pole-pitch). (See Fig. 1A.) For forming the smaller number of poles every alternate coil in each phase is reversed. The field curves for the two numbers of poles are shown in Figs. 1B and 1C respectively. The shaded portion in Fig. 1B represents the voltage induced in the winding, differing from the field curve only in having parabolic sides to allow for the fact that the whole flux is not looped with the whole of the turns. Calling the induced voltage 1, the turns per phase per magnetic circuit (with the larger number of poles) 1,

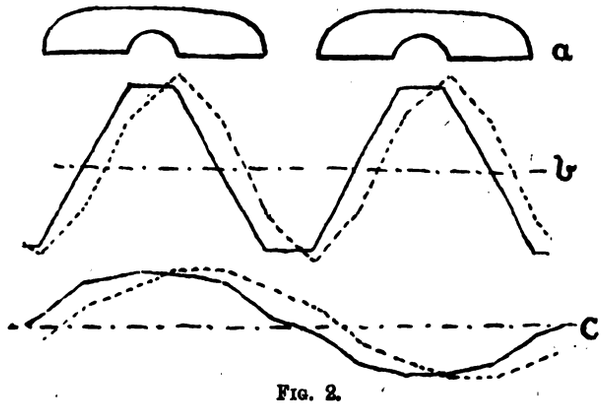

FIG. 2.

and the pole-face area (with the larger number of poles) 1, the relative results shown by the curves Fig. 1B and Fig. 1C are:

No. of poles.	$B_{max.}$	Φ.	$B_{max.}$	Φ.	J_μ.
2 *p*	1·8	1·05	1·56	1·04	·9
p	1·23	1·36	1·42	1·42	·41

The leakage and overload capacity have still to be dealt with. In this case, and in most of the other cases to be considered, the changing of the poles has little, if any, effect on the leakage, consequently the short-circuit current will

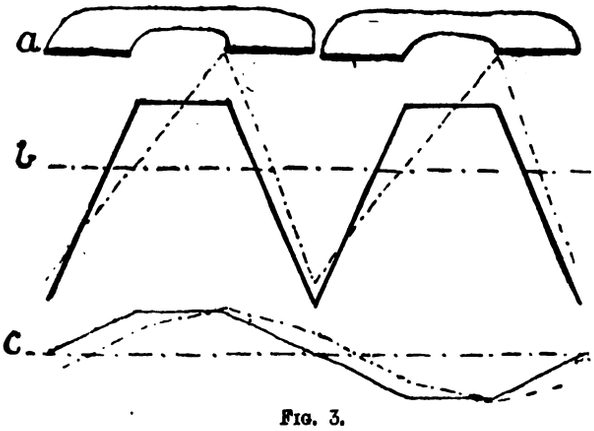

FIG. 3.

remain the same for both numbers of poles so long as the voltage is unchanged. The circle diagrams for the two cases will, therefore, be as in Fig. 1D, the maximum ordinate which is proportional to the maximum power obtainable being almost the same as both the speeds. In other words, the motor can develop about double the torque at the lower speed, and is, therefore, comparable with a direct-current series motor. It is, of course, possible to increase the torque at the higher speed by coupling the coils in parallel instead of in series, but this involves increasing the iron sections.

The saddle-shaped top of the field curve (Fig. 1C) can be improved by employing broader coils (coil side = $\frac{2}{3}$ of the (smaller) pole-pitch), as shown in Fig. 2A. Such a winding would have to be carried out similarly to a direct-current winding or bar winding, coils of different phases being partially superposed in the same slots. The resulting

* Abridged translation of an article by J. K. Sumer in the *Zeitschrift für Elektrotechnik*, June 26, 1904.

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curve shapes are shown in Figs. 2B and 2C, and the other particulars in the following table:

No. of poles.	Bmax.	Φ.	B'max.	Φ'.	Jμ.
2p	1·8	1·2	2·08	1·21	1·2
p	1·125	1·46	1·17	1·49	·45

The saddle-shaped top of the field curve can also be avoided by spreading the coils out more, so that the coil-pitch is, say, $\frac{4}{5}$ of the (smaller) pole-pitch. With narrow coil sides ($\frac{1}{3}$ of the pole-pitch) this would result in only half the space being utilised, but with broad coil sides ($\frac{2}{3}$ of the pole-pitch) the results shown in Fig. 3 would be obtained.

As the coil-pitch is increased beyond the smaller pole-pitch and approaches the larger pole-pitch, the results obtained naturally become less satisfactory for the low speed, but better for the high-speed connections. This is made evident by the unsymmetrical nature of the field curve and by the unsatisfactory results shown in the following table for this case:

No. of poles.	Bmax.*	Φ.	B'max.*	Φ'.	Jμ.*
2p	3	1·33	2·6	1·3	1·5
p	·9	1·2	1·04	1·21	·3

* The total area of the positive and negative flux waves have naturally to be alike, and the zero line has been drawn to suit this. The Bmax. column contains the actual top value from the curve, as that decides the teeth losses, but the magnetising current, Jμ, has been calculated for the average between the pointed flux curve and the flat-topped flux curve.

Group Ab.—This group contains windings with one coil per pole per phase, and with the same coils forming one phase with either number of poles. The author discusses the various possible arrangements, and shows that in every case better results are obtainable with the corresponding Group AA arrangement.

Group Ba.—This group refers to motors in which different coils form a given phase with the two numbers of poles, and in which there is only one coil per phase per pair of poles. This group also, on investigation, proves to be less satisfactory, both as regards uniformity of field and as regards the flux and magnetising current values, than the corresponding arrangements of Group AA.

Group Bb.—To this group belong windings having one coil per pole per phase, coupled up with different coils in a given phase for the two number of poles. The group has the serious disadvantage of requiring a large number of change-over leads and terminals, so that although one or two of the arrangements show slight improvements in flux density and magnetising currents as compared with Group AA, these improvements are not sufficient to justify the increased complications.

THE RELATION OF THE HYPOTHESIS OF COMPRESSIBLE ATOMS TO ELECTRO-CHEMISTRY.*

BY PROF. T. W. RICHARDS.

Theoretical electro-chemistry may be divided into two closely related sections—that which treats of the phenomena at the electrode, and that which treats of the phenomena in the unchanged electrolyte. The former of these sections is the more important practically, and is likewise a more certain domain theoretically.

In the first place, then, one may ask: How would a compressible atom behave on leaving an electrode and going into solution as an ion? It would then be attacked by an entirely new set of affinities, being in its new position surrounded by molecules of the solvent, instead of by atoms similar to itself, and those new affinities exerting new intensity of pressure would be expected to change its volume. Moreover, the solvent being itself in part exposed to new internal pressures would also change in volume. As a matter of fact, a marked change of volume is always observed when a positive and negative element go into solution in the ionised condition. For example, a litre of a normal solution of potassic chloride occupies 43 millilitres less space than the solid potassium, liquid chlorine, and water, from which it may be made; the change of volume in the common salt is 31 millilitres, and that in the case of lithic chloride 17 millilitres. Potassic bromide in the same way gives a contraction of 33 millilitres. Among these similar compounds and in many other cases it usually appears that the greater the electrical potential afforded by the double ionisation the greater the change of volume; also, the greater the compressibility of the elements concerned the greater the change in volume. It is worth while also to call attention to the fact that these changes of volume on ionisation seem to be approximately parallel with the changes of volume on forming the corresponding hydroxides; just as the heats of ionisation are approximately parallel with the heats of formation of the hydroxides. This parallelism may indicate that the effective agency causing ionisation or galvanic solution of a metal is the attraction of the metal for the oxygen or the hydrogen of water—most probably the oxygen.

Although these regularities are fairly prominent on comparing the properties of similar elements in a natural group, exceptions are not hard to find on comparing very dissimilar substances. Reason for these irregularities may partly be found in the extremely complex mathematical relations which must obtain if the atom is really compressible; but, probably, at least, a part of the exceptions may be traced to the expected simultaneous contraction of the solvent already predicted. That the solvent really often contracts is manifest from the fact that in some cases (notably the hydroxides of lithium, sodium, and barium, and the sulphates of zinc, cobalt, nickel, and magnesium) the solution occupies less space than the water alone from which it is made. In this connection it is worth while to call attention to the well-known fact that during the formation of 18 grm. of water from its ions in the neutralisation of a strong acid by a strong base, an increase of volume of 20 millilitres occurs, an increase greater than the volume of the water formed.

Although by no means all possible cases can now be studied, because of lack of data, there is good reason to believe that in all cases both the solvent and the dissolved substances change in volume under the readjustment of internal pressures of ionisation, and the resultant effect is so complicated that it is impossible at present, except in the most exaggerated cases, to determine the mode of the distribution of the change. Nevertheless, since changes of volume actually occur on ionisation, and since in the more marked cases this volume-change seems to correspond roughly to the known compressibilities of the substances and to the free-energy change during the reaction, the theory of compressible atoms is supported. At least, even supposing that the explanation herein given is rejected, the theory is here able to call attention to an interesting series of facts concerning volume-change, which must receive an explanation before a complete interpretation of the nature of a dissolved electrolyte is obtained.

Another less direct relation of the theory of compressible atoms to electro-chemistry is to be found in the effect of change of volume of reacting systems upon their specific heats. Thomsen pointed out long ago that a contraction in a reaction between aqueous solutions is usually accompanied by a loss of heat capacity of the reacting system; and it is possible to cite many other cases in which this is true. Probably, however, the cause of this loss is not so much the decrease in volume as the irregular stress caused by the simultaneous presence of very different affinities. In terms of the hypothesis of compressible atoms, atomic distortion seems to cause a diminution of heat capacity. As a kinetic conception this interpretation is plausible.

The relation of this change of heat capacity to electro-chemistry is very important. Recent study has made it appear highly possible that a change in heat capacity during a reaction is the chief, if not the only, reason why the total energy change (or the heat of the reaction) is not equal to the electrical work which the reaction performs in a galvanic cell. In colloquial language, the heat energy which is displaced or forced out by a diminution of heat capacity does not seem to be able to perform work. If this be true, change of heat capacity is responsible for the "bound energy" of a galvanic cell, and therefore, according to Helmholtz's equation, for its change of potential with the temperature. If, further, the preceding conclusion,

* Abstract of paper presented before Section C of the International Electrical Congress of St. Louis.

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based upon the theory of compressible atoms, be also accepted, the fundamental cause of this temperature coefficient of the E.M.F. is referred back to atomic compression and distortion, which diminish the possibility of heat vibration in the compressible atom.

One essential condition of ionisation has not yet been dwelt upon—namely, the relation of ionisation to the quantity dimension of electricity. Recent investigation has shown that Faraday's law is not merely an approximation, but is rather one of the most exact of the laws of Nature. If the atomic theory be accepted, one must therefore admit that each similar atom, on ionising into a liquid, receives or releases exactly the same charge, which is a precise simple multiple of a given unit. What, now, does this unit of change signify? In other words, what are the essential attributes of electrical quantity, and what explanation for this exact and fundamental law can be found in the theory of compressible atoms?

To the electro-chemist who has nothing to do with electrical capacity, the quantity dimension of electricity is important merely as a number. He recognises it only because it is proportional to equivalent weight of deposited metal, or to equivalent volume of evolved gas. Still more simply it may be said to represent to him nothing but the number of atomic contacts which are made or broken in a given reaction. Therefore, the electro-chemist attempting to discover the relation of the compressible atom to galvanic deposition naturally first seeks to imagine what would happen to a compressible atom on making or breaking a firmly united atomic contact with another atom.

Evidently for each union with other atoms a given atom would give and suffer a shock of impact or combination. The exact effect of this shock upon the atom itself cannot be determined, but if the atom is compressible throughout, many forms of vibration or temporary rhythmical distortion might be possible because of the shock. One of the most probable forms is perhaps a vortex motion; and it will be seen that this form lends itself best to further interpretation. If the atom were perfectly elastic, such a vortex would continue to exist indefinitely when once formed. Let us imagine, then, that each collision of atomic combination starts or transfers a vortex or some other form of self-perpetuating shock. Then the deposition of a given number of chemical equivalents will result in the transfer of a given number of shocks, or a given quantity of electricity; and Faraday's law is explained. In short, in order to conceive logically of this law, one need not ascribe weight or mass to the electron—permanent vortex will represent the needed unit as well as a ponderable particle. But only a compressible atom could hold or carry such an infinitesimal vortex, hence this hypothesis is dependent upon the hypothesis of compressible atoms.

This easy explanation of Faraday's law without a material conception of electricity leads one to enquire whether or not other relations of electricity might not likewise be satisfied by a vortical conception of the unit of electrical quantity. A complete study of the details of this possible explanation would be out of place, but a few of the electrical properties of substance may be mentioned in this connection. For example, the electrical conductivity of solids is in many cases what it would be expected to be if their atoms were compressible. Atomic distortion would be expected to interfere with the ready transference of the vortices. The simpler the crystalline form the less distorted would be the individual atoms, and the more easily would the vortices be received and transmitted from one atom to another. On the other hand, with irregular atoms permanently distorted by chemical affinity, the uneven structure would receive and transmit the vortices less easily, and the potential energy of the mutual repulsion would be converted into heat. As a matter of fact, the two best electrical conductors among metals, silver and copper, crystallise in the regular system, and the poorest solid conductors among pure metals, bismuth, antimony, and arsenic, are of less symmetrical crystalline structure. The non-metals, which are all poor conductors, are still more noticeably complex in symmetry, and such non-conducting substances as bromide and iodine must be very much distorted in atomic shape if their atoms are compressible, because these atoms must be much compressed on one side by their firm union to form the diatomic molecules, and only slightly compressed on the other sides by their feeble cohesion, indicated by great volatility. The relatively slight conductivity of alloys and compounds points in the same direction, for heterogeneity of atomic structure would imply irregular internal pressure, great atomic distortion, and hence poor conductivity. The considerable effect on conductivity of even slight impurity in a metal, and the extremely low conductivity of substances like glass and cellulose, are well known, and accord with this interpretation.

Again, it is easy to see how increased thermal energy, which, if atoms are compressible, must be supposed to exist as a simpler oscillation of a portion of the atomic centres, would interfere with the reception and transmission of this new vortex motion, and hence to see why the conductivity of solids should decrease on raising the temperature. Moreover, one would expect the slightly-distorted atoms, easily receiving the electrical vortex, should usually likewise transmit more rapidly the simpler oscillations of heat energy, which is a fact. In applying the vortex idea to the statical and magnetic manifestations of electricity, one must imagine the vortex to cause stress in the surrounding wave-bearing medium, giving rise to the repulsion of similar vortices. Such a stress must be imagined whatever conception one forms of the electron, and is at least as easily conceivable from a vortex as from a small particle of matter.

The explanation of the brilliant experiments of J. J. Thomson and his pupils on the basis of the vortical electron is possible, if one admits, as Thomson is quite willing to do, the existence of electrical inertia independent of gravitational effect. In this case the cathode ray is to be considered as a collection of disembodied vortices, which may only be driven through the wave-bearing medium under the stress of great difference of potential. Another alternative must be adopted if one doubts the somewhat complicated evidence concerning the relative masses of the cathode corpuscle and the atom, and believes the two to be identical. In this case it is necessary to imagine that a single atom can receive many vortices under the peculiar circumstances attending the cathode discharge—*i.e*, that it is polyatomic.

Other possible relations of the hypothesis of compressible atoms to electro-chemistry, and to the new and surprising facts of radioactivity, might be pointed out, but these examples will serve the present purpose. The object of this paper has been to show that the hypothesis is a suggestive one, because it views well-known phenomena from a new standpoint, and therefore may excite the imagination into devising new methods of experimental attack. The discovery of the probable relation of the change of heat capacity on the temperature coefficient of a galvanic cell is among the new relations to which this hypothesis has already led.

The long-continued illusion of phlogiston, supported by eminent minds not much over a century ago, is enough to show the danger of a one-sided scientific consciousness, and the familiar conception of inflexible atoms may also to a less degree lead the literal mind into an intellectual rut. Of course, no claim is made that the hypothesis of compressible atoms represents truly the actual fact; indeed, atoms in any shape are an imaginary conception, which may have no counterpart in reality. Even if the thinker progresses no farther than to admit that, provided atoms exist, they may be elastic and compressible, he has broadened the train of his thought and enlarged the realm of his imagination.

It has been claimed by a few that any hypothesis is harmful, but some of the most brilliant of scientific workers have used them as a continual inspiration. Faraday, one of the greatest of pioneers, dreamed thousands of such scientific day-dreams. To him these were nothing but a benefit; for although led on by visions he knew well the difference between substance and shadow. He never confounded hypothesis with fact; and when new facts overthrew a favourite imagination, he would discard the latter gladly, rejoicing that it had led him to the discovery of new truth.

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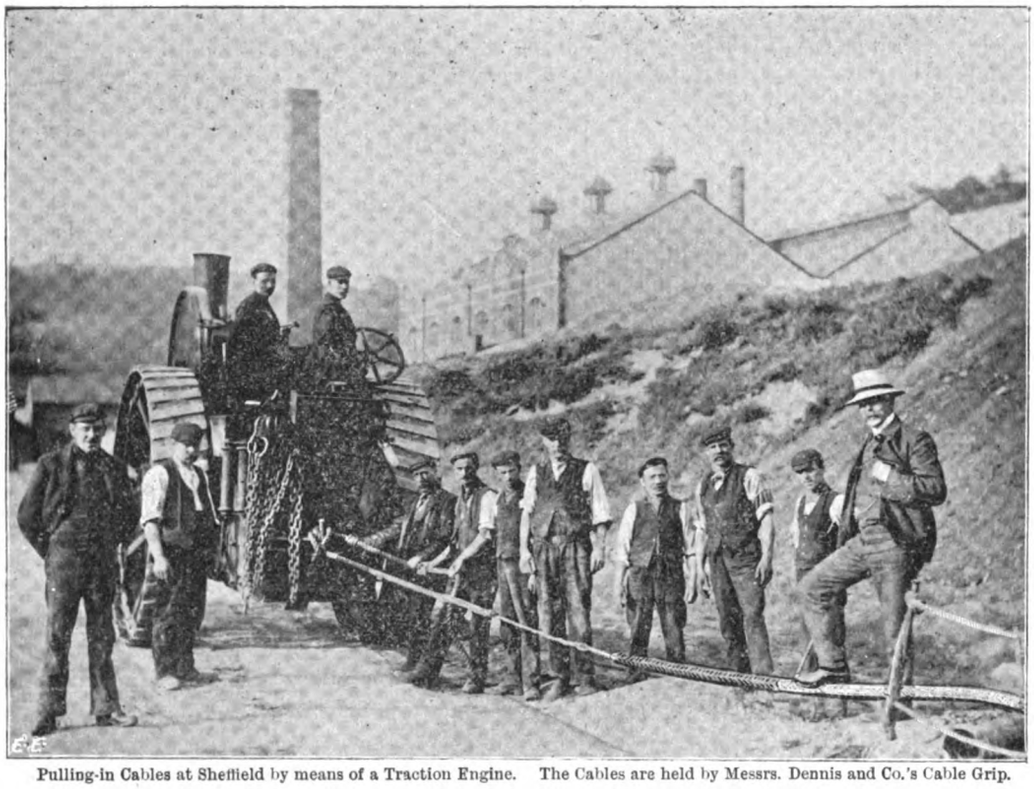
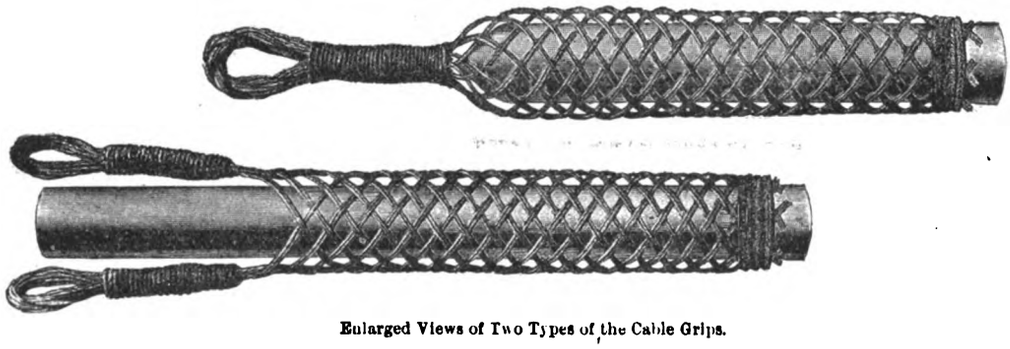
TRADE NOTICES AND NOVELTIES.

A Useful Attachment for Cable-Drawing.

A novel manner of drawing cables at Sheffield is brought to our notice by Mr. Rowland Hibbins, of the Corporation electric supply department. The photograph depicts a feeder cable being drawn with a Felten and Guilleaume cable grip attached to a powerful traction engine. Most engineers will at once appreciate the enormous strain upon the grip, which holds on with such tenacity that either the rope or the cable will have to give way before a failure in drawing can occur, as, on account of the construction of the grip, the greater the pull the more securely it holds. The great feature of the grip is that no hand, mechanical, or soldered connection is made with the cable, but it is gripped uniformly by the pliable sheath, which, when expanded, automatically locks itself. Mr. Hibbins hopes, by giving publicity to the great utility of the grip, that other engineers to corporations and supply companies may share with him in the benefit he has derived from its use, and although he has put the grips to the severest strains, they have given every satisfaction, and come out of the ordeal with great credit to the manufacturers. We may add that the grips can be obtained from Messrs. W. F. Dennis and Co., 49, Queen Victoria-street, E.C.



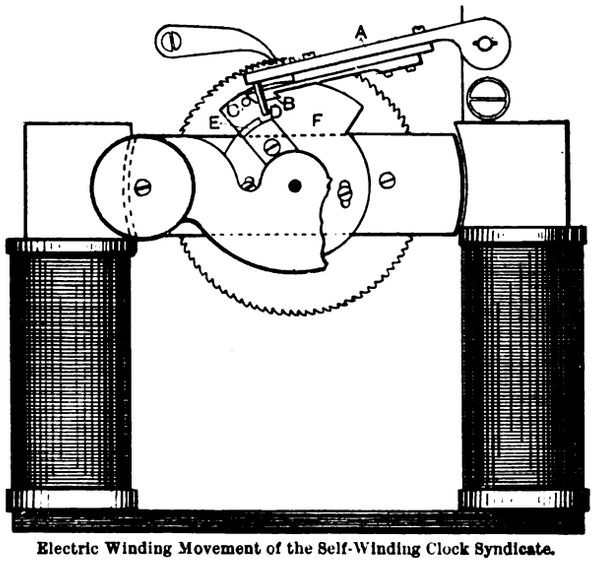
Pulling-in Cables at Sheffield by means of a Traction Engine. The Cables are held by Messrs. Dennis and Co.'s Cable Grip.



Enlarged Views of Two Types of the Cable Grips.

Self-Winding Clocks.

The Self-Winding Clock Syndicate, of 27, Audrey House, Ely-place, E.C., have designed a pretty device for the electric winding of a clock from two dry cells. The idea is not new, but the details are interesting. The electrical movement is illustrated in Fig. 1. The self-winding is actuated by an electric magnet, between which an armature is pivoted so that it can swing. To this a pawl is attached, which engages a ratchet wheel connected with the gear train of the clock, and a spiral spring attached to the armature draws it slowly out of line with the magnet poles, and thus drives the clock. The electrical contact is made about once every seven or eight minutes, and as the current energises the magnet the armature is drawn back to its horizontal position against the tension of the spiral spring. To ensure continuity during the fraction of a second occupied by this action, the clock movement is driven by a second small spring, which is put under tension by the movement of the armature itself. The contact is made as shown in the detail sketch. One terminal, E, consists of a metal segment which is carried on a plate, F, secured to the armature. The other terminal, D, consists of a pin which is secured to a swinging arm, A. Fastened to this arm, but insulated therefrom, is a flat spring, provided at its free end with a head or cam, B,



Electric Winding Movement of the Self-Winding Clock Syndicate.

adopted to engage a pin, C, on the plate, F. The ends of the cam, B, are bevelled, as illustrated, so that when the

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armature moves away from the poles, the cam will ride over the pin, C, lifting the contact pin, D, out of engagement with the segment, E. When the pin C passes the inner end of the cam, the pin D will drop on to the segment, B, completing the circuit through the magnet coils, and causing the armature to swing back, and the cam then riding under the pin C will press the terminal D down against the segment, E, ensuring a perfect contact. Both the contact surfaces are of platinum. One of these clocks has been tested at the Charlottenburg Institution, and from the report received we gather that about 0·017 of an ampere-second is used at each contact. The two dry batteries provided can easily supply this for a long time. After 13 months' trial the voltage of each of the two cells used had fallen from 1·51 volts to 1·41 volts. This resulted in a decrease in the movement of the armature at each contact, and a consequent decrease in the period between successive windings. The period in question fell from six minutes on Nov. 13, 1902, to 4 minutes 48 seconds on March 16, 1903.

Catalogues, etc.

ELECTRIC HEATING APPARATUS. Isenthal and Co., 85, Mortimer-street, Cavendish-square, W.—Section 1 contains appliances for domestic purposes and use in private houses, nurseries, hotels, and clubs for heating and cooking. Section 2 is perhaps the most interesting as it describes appliances for technical purposes in factories and laboratories. Among these we note electrically-heated soldering bits, glue-pots, melting-pots, hot-plates, cauldrons, warm-water reservoirs, and large immersion heaters. In each case particulars are given as to dimensions, capacity, consumption, weight, and price.

HAULING PLANT. Lahmeyer Electrical Company, Limited, Bank-buildings, 109-111, New Oxford-street.—We have received an illustrated pamphlet describing electric plant designed to lift at a speed of 8m. per second 105 tons of coal out of a shaft 400ft. deep. It was laid down by the Frankfort house of the above company at the Ligny-les-Aire coal mine.

ALTERNATING REVERSE-CURRENT TIME-LIMIT RELAY. Ferranti Limited, electrical engineers, Hollinwood, Lancashire.—Catalogues Nos. 9 and 10, for automatic switches, moving-coil instruments, edgwise type, for continuous currents.

"E.V." ENCLOSED ARC LAMP. Union Electric Company, Limited, 151, Queen Victoria-street, E.C.—We are informed that this lamp burns for 100 hours with 1ft. of carbon. It is a successor of the firm's old D.V. pattern arc lamp, that has been largely used both for public and private illumination throughout the country. The improvements consist chiefly in the diminution of the size without decreasing the burning hours, and other improvements, such as making the fit of the globe easier, while the price of the lamp is considerably less. The company report numerous sales of these lamps, and they supply also lamps 3½in. longer than those shown in the list—viz., 2ft. 3½in.—which will burn for 200 to 250 hours with 18in. of carbon, and a range of lamps with single enclosure and ornamental design, with about 70 to 75 hours' burning.

FIELD RHEOSTATS, MOTOR-STARTING RHEOSTATS. British Thomson-Houston Company, Limited.—Pamphlets Nos. 173 and 174, the former superseding June 9, 1902, and the latter No. 126, Sept. 6, 1902.

PERSONAL.

The Hereford Corporation have appointed Mr. Walter C. Kerr electrical engineer at a salary of £400 per year.

The *Halifax Guardian* says Mr. W. M. Rogerson, electrical engineer to the Halifax Corporation, having been offered a similar position under the South Metropolitan Electric Supply Company at a salary of £700 per annum, a proposal to retain his services in Halifax was brought before the Town Council. The following resolution was carried *nem. con.*: "That the salary of Mr. W. M. Rogerson, electrical engineer, be advanced from £400 to £500 per annum on Jan. 1 next, with further advances of £50 per annum on Jan. 1, 1906, and Jan. 1, 1907, subject to Mr. Rogerson entering into an agreement to remain in the service of the Corporation for a period of three years from Jan. 1 next." We understand Mr. Rogerson will accept the offer.

Mr. Lewis Slattery, of Blackpool, has been appointed tramways manager of the Oldham Corporation, at a commencing salary of £300 per annum.

We refer elsewhere to Mr. John Young's new appointment.

APPOINTMENTS VACANT.

Station Engineer, Woolwich, Oct. 7. See advertisement.

Switchboard Attendant, Stockton-on-Tees. See advertisement. Also Eccles, 24s. per week, Oct. 12.

Meter Fixer and Inspector, wages 30s. per week, 56 hours. See advertisement.

Draughtsman used to transformer design. See advertisement.

Junior Tester for calibrating electrical instruments and general factory testing. See advertisement.

Shift Engineer, Hornsey, £2 per week, Oct. 15.

Resident and Tramway Engineer, Pontypridd, £300 per annum, Oct. 12.

LEGAL INTELLIGENCE.

TRAMWAY AMALGAMATION.

In the Vacation Court on Wednesday, Mr. Justice Warrington heard an application by the City of Buenos Ayres Tramways Company, Limited, and its liquidators, to sanction a scheme of arrangement with the Anglo-Argentine Tramways Company, under the Joint-Stock Companies Arrangement Act, 1870.

His Lordship having asked how the new debentures were to be secured, **Counsel** stated that after the sale to the Anglo-Argentine Tramways Company had been carried out the petitioning company would hand over to the new company, to be formed under the scheme, certain property which included an annual payment by the Anglo-Argentine Company.

His Lordship said he wanted to see that the debenture-holders would get some substantial security in place of the present debentures.

Counsel said the debentures would be secured by a floating charge on the whole undertaking of the Anglo-Argentine Company. The companies owned rival systems of tramways, and the present arrangement was to enable the Buenos Ayres Company's lines to be electrified, when the two systems would be worked together.

His Lordship sanctioned the scheme, subject to certain formalities being carried out.

TRAMWAY CONSTRUCTION.

At the Chesterfield County Police Court on Saturday, four summonses against employés of the contractors for laying the Chesterfield tramways—the British Insulated and Helsby Cable Company—were heard. The proceedings were taken by the Newbold Urban District Council, who were represented by Mr. W. E. Clegg, of Sheffield, the ground of complaint being that the contractors had diverted the traffic from Sheffield-road up some other streets without the necessary authority. It was pointed out that in accordance with the Act consent in writing of a neighbouring authority affected had to be obtained before any road could be stopped, and in the case in question that consent was not obtained.

Mr. T. E. Ellison (Sheffield) urged on behalf of the defendants that the Council's surveyor had acquiesced in the diversion of the traffic, and led the defendants to believe that it was not necessary for the formal written consent to be obtained.

The **Chairman of the Bench** said that it was a pity two such important bodies could not settle their differences without coming into court.

Three of the summonses were dismissed, a fine of 10s. being imposed upon the excavation foreman for putting a pole across the roadway.

COMPANIES' MEETINGS AND REPORTS

WILLANS AND ROBINSON.

The ordinary general meeting was held on Wednesday at the Cannon-street Hotel, Mr. Mark Robinson (the chairman) presiding. The report appeared in our issue of last week.

The **Chairman,** commenting upon the industrial depression, observed that there had been times nearly as bad before, and the Company had passed through them unscathed; but then their speciality had a more distinct lead than it was possible to command now. The Company had no longer a monopoly of high-speed engine work, and they had also suffered from trouble which had lost them in a measure the support of some of their best and oldest friends, who at one time would have a Willans engine or nothing. The directors, aided by the action of the shareholders in adding Mr. Peache to the Board, were giving this matter their earnest attention. In his skill in design and mastery of works management his colleagues saw much hope for the future of the Company. On two points discussed at the last meeting he could reassure them. There was much criticism because trade debtors on Dec. 31 last stood for £186,000 owing, although nearly two-thirds of the amount had not been invoiced for more than a few weeks. This time the debtors stood at only £153,000, and he regretted they had not the right to claim more from such sound people as these had always proved to be. The other point referred to certain shares in other companies, taken in part payment for work under contract. They had now sold a large proportion of these shares at exactly the price at which they had been valued in the accounts. The Board had gone in heartily for all possible reductions and economies. Specific economies had been effected in standing charges, mainly in reduction of staff, at the rate of more than £10,000 per annum, irrespective of a reduction to a larger amount in the labour bill at Queen's Ferry, and of a further reduction in the staff when certain agreements for services now in force should run out. On the other side they were striving to add more remunerative branches to the business, and they had the strongest belief that after a time these combined efforts would bring back to the Rugby business much, if not all, of its old prosperity. Such new business, however, could bear no profit for some time, and must for the present be a source of actual loss. If the stress of bad times could play such havoc with an old and hitherto profitable business, such as that at Rugby, it was easy to realise how disastrous it had been to the new business started at Queen's Ferry. More than a year was lost in experiments and failures in producing an essential part of the new type of boiler, although in the end they had completely succeeded. The manufacturing difficulties were now over, but the heavy loss in keeping the works open during the long unproductive period had crippled their resources, and they could not put down the extra capital to properly complete the plant or carry on the works upon other than

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a scale just large enough to entitle them to rank as a going concern. The directors were using every endeavour to dispose of the Queen's Ferry works, and negotiations were in progress to that end. The financial position of the Company was more satisfactory than at the date of the last meeting, and they hoped to set free working capital to strengthen them in several directions. The chairman concluded by moving the adoption of the report.

Mr. F W. Clarke (a shareholder) seconded the resolution.

Mr. J. C. Peache (director) believed that they must look in the future, as in the past, to the Willans engine as the mainstay of the business. He read a letter from a consulting engineer who testified to the capacity for continuous running and the high economy shown under exacting conditions by a Willans plant installed on his advice. They were also making gas-engines, which they had comp'eted to the satisfaction to the customers, and had at present on hand orders for steam-turbines amounting to 80,000 kw. They had also concluded a contract for the manufacture of Diesel oil-engines. The shareholders would, no doubt, ask when a profit was likely to be earned; but he could not suggest an early date, many orders being taken at the low prices ruling.

Two or three shareholders criticised the Queen's Ferry venture as a rash speculation.

The **Chairman**, in replying, said that the Queen's Ferry works had been undertaken so that the company might make their own boilers, and but for the initial manufacturing difficulties, which had now been surmounted, he did not think there would be much cause to regret the step. He added that of late years the conditions of the trade had changed greatly, owing to the advent of the great electrical companies, which were able to undertake contracts as a whole.

It may be added that Mr. Mark Robinson and Sir Gilbert East have accepted, *pro rata*, reductions in their remuneration, so as to provide for the salaries of the additional directors, and Mr. Arthur Lazenby, who takes an active part in the management of the business, expressed his willingness to do the same, but the shareholders fully approved the view of his fellow directors that his remuneration should remain as at present.

The report was adopted *nem. con.*

FERRANTI LIMITED.

A meeting of the unsecured creditors of Messrs. Ferranti, Limited, was held last week at Winchester House.

Mr. John Macdonald Henderson presided, and explained that the meeting had been called by order of the court, in order to obtain the consent of the unsecured creditors to a scheme of arrangement for the reconstruction of the Company, particulars of which were given in our issue of the 23rd ult. Some discussion took place with reference to clause 7 of the scheme, as to whether the word "cumulative" should remain in or not. Eventually a resolution approving of the scheme was carried unanimously.

A meeting of the preference shareholders was afterwards held, at which an amendment was moved and seconded that the word "cumulative" in clause 7, paragraph 2, be deleted, and the dividend to preference shareholders be non-cumulative.

Subsequently there was considerable discussion among the holders of first mortgage debenture stock with regard to the protection of their security in the event of the second debentures becoming enforceable. Ultimately, on the assurance of the chairman that the solicitors would see that the first debenture holders were fully protected, the scheme was unanimously approved.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

The sixth general meeting of the Electric Railway and Tramway Carriage Works, Limited, was held last week at the works, Strand-road, Preston, Mr. G. Richardson, chairman of directors, presiding.

The **Chairman**, in an explanation of the reduced dividend, said the trade of the country had certainly not been so prosperous as heretofore, and especially in connection with this class of business. There had also been serious competition, but two of their most serious competitors had gone into liquidation, and the works had been sold, and consequently they were now out of the running, and they must look forward to getting better prices. He did not like to prophesy, but the directors thought they would not have an unsatisfactory balance-sheet to present to them next year. One of the awkward things in connection with the business was the position taken up by the Federation of Engineers, which was, of course, the trade unions. They were now working with great zeal to do away with overtime, and also to do away with bonuses for prompt and quick delivery. This latter practically meant that a bad workman must be in a position to earn the same money as a good one, and this was one of the points which would have to be fought later, particularly in all businesses connected with engineering.

The report was adopted.

Messrs John Kerr, M.P., and R. B. Barningham, Manchester, the two retiring directors, were unanimously re-elected.

TRAMWAYS AND GENERAL WORKS.

The report of the Tramways and General Works Company, Limited, for the year ended June 30 last, to be submitted at the meeting on the 3rd prox., states that the directors have delayed calling the shareholders together in order to be able to announce the completion of the negotiations referred to below as to the Calais Tramways Company. The delay is of less importance, as the directors, having the money available for dividend in hand, were able to pay the same as an interim dividend in April last. The accounts show a profit for the year of £1,361. Adding to this £548 brought in from the previous year, and deducting £1,500, which the directors distributed as dividend in April last, there remains £409 to carry forward. The profits of the Calais Tramways Company for 1903 show an improvement on 1902, and an increased dividend was distributed by that company in January. The dividend for the past half-year has not yet been declared. The directors of the Calais Company have for some time past been in treaty for the sale of the undertaking to a Belgian company, and the resulting contracts will be submitted to the Calais shareholders for approval on Oct. 3. The directors of this company, having had an opportunity of considering the agreements, will give them their support, as they consider them to be advantageous to the shareholders. The Lombardy Road Railways Company, as in 1902, have paid a dividend of 5 per cent. on their preference shares out of the profits of 1903. There still remains a sum of £121. 10s. due to 23 shareholders, who have not yet produced the necessary documents to enable the 6s. per share to be repaid on their holdings.

NEW COMPANIES REGISTERED.

London Electrical Syndicate, Limited.—Capital, £10,000. Objects: to adopt an agreement with the London Electrical Syndicate, Limited (in liquidation), and G. Pearson, the liquidator thereof, and to carry on the business of electricians, mechanical engineers, etc.

Liens Registered.

C. C. Braithwaite and Co., Limited (Engineers, London).—£500 debentures, created Aug. 31, and dated Sept. 22, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Northampton Electric Light and Power Company, Limited (23,640).—Issue on Aug. 25 of £100 debentures, part of series created June 3, 1896, securing not more than two-thirds of the subscribed share capital for the time being charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £32,100.

Bowen's Electric and Motor Boats, Limited, London, W.C.—Lien registered Sept. 16, for £4,000 5 per cent. debentures. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital.

Burnand Transformer Company, Limited, Manchester.—Lien registered Sept. 21, for £1,000 debentures. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Barrow-in-Furness.—The Corporation invite tenders for arc lamps and accessories. Tenders by 18th inst.

Melbourne.—The Federal Postmaster-General requires tenders for 6,000 yards of telegraph cable. Tenders by Nov. 15.

Crejour (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Middleton.—The Corporation invite tenders for dust destructor, boilers, etc., at the electricity station. Tenders by 25th inst.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Ipswich.—The Corporation invite tenders for the supply of continuous-current meters for the ensuing 12 months. Tenders by 24th inst. See advertisement.

Blackheath.—The County Council require tenders for electric wiring and fittings, etc., at the ranger's house. Tenders by Oct. 11. See advertisement.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Wandsworth.—The Borough Council require tenders for electric lighting and ventilation of Council House. Tenders by Oct. 18. Full particulars in advertisement columns.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

Great Western Railway.—The Directors of this Company are prepared to receive tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1905. Tenders by Oct. 17. See advertisement.

Brighton.—The Town Council require tenders for the installation of electric light, telephones, and fire-alarms in the diphtheria pavilion, borough sanatorium, Bear-road, Brighton. Tenders by 13th inst.

Fulham.—The Council invite tenders for the supply and erection of a 3,000-volt main generator switchboard at their generating station, Townmead-road, Fulham. Tenders by 19th inst. See advertisement.

Almendralejo.—The municipal authorities require tenders for the electric lighting of the town for 10 years. Particulars may be obtained from the Alcalde of Almendralejo, province of Badajos, Spain. Tenders by Oct. 13.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Cumberland and Westmoreland Lunatic Asylum, Carlisle.—Tenders are required for plant. Copies of tender may be inspected at the office of the Consulting Engineer, Electricity Works,

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Northallerton, Yorks. Tenders to the Clerk to the Committee of Visitors by Nov. 1.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Sunderland.—The Corporation invite tenders for the supply of two 300-kw. three-phase generators, 5,500 volts, to be coupled to existing Belliss engines, and two 300-kw. synchronous three-phase motors, 5,000 volts, to be coupled to existing multipolar Silvertown dynamos. Tenders by 28th inst. See advertisement.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Rochdale, Lancs., of three ejector condensers, three electrically-driven circulating pumps, and the necessary extensions of the steam, exhaust, and water pipes, valves, and accessories. Tenders by Oct. 10. See advertisement.

Philippopolis (Roumelia).—The Municipality requires tenders for a concession to construct and work electric lighting and tramways for 50 years. A guarantee of £6,000 is required. Tenders by Oct. 15. On the next day a second adjudication will take place in case there is an offer of £5 per cent. less per kilowatt-hour than the minimum.

Craivo (Roumania). — The *Moniteur des Intérêts Matériels* (Brussels) announces that the adjudication will take place at 4 p.m. on Oct. 25 (Nov. 7) at the Mayoralty of Craïova, of the concession for construction and working of a line of tramways (mechanical traction) in the town of Craïova. The duration of the concession is fixed at 50 years. A provisional deposit of £200 is required.

Antwerp.—The Municipality of Ghent invite tenders for the construction of 10 electric cranes at that port in accordance with the specification, a copy of which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C. An initial deposit of 2,000fr. (£80) is required to qualify each tender, and for the tender accepted a further deposit of 18,000fr. (£720). Tenders, in registered envelopes, addressed "Au Collège Echevinal de la Ville de Gand," must be posted not later than Oct. 17. The adjudication will take place on Oct. 19.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

RESULTS OF TENDERS.

Hull.—The Baths Committee have accepted the tender of the Lancashire Electric Engineering Company, at £180, for electric light fittings at the Beverley-road baths.

Birmingham.—Messrs. T. Sugden, Limited, 180, Fleet-street, London, have secured an order to instal 14 of their superheaters in connection with the Lancashire boilers for the Corporation electricity works.

Mortlake.—The Urban District Council have accepted the tender of G. and H. Turner, 11, High-street, Harlesden, N.W., at £105. 15s., for wiring their isolation hospital, South Worple-way, Mortlake, for electric lighting.

Hammersmith.—The Guardians have accepted the tender of the Private Wire and Telephone Installation Company, Limited, 5, Palmer-street, Westminster, S.W., for a complete installation of telephones, fire alarms, and electric bells in the new workhouse and infirmary at Wormwood Scrubbs.

Aberdeen.—The Tramways Committee have received tenders for the supply and delivery of 20 top-deck car-covers from R. and. J. Shinnie, Union-row, Aberdeen (accepted); Brush Electrical Company, Limited, Loughborough; Hurst, Nelson, and Co., Motherwell; Milnes, Voss, and Co., Birkenhead.

Broxburn.—The following tenders have been accepted for the erection of the power station for the electric installation: P. Orr, jun., at £272. 16s. 6d., brick and concrete work; M. M'Gavin, at £125. 17s. 4½d., joiner work; G. Paris, at £52. 15s. 10d., slater work; W. J. Nicol, at £26. 7s. 4d., plumber work.

Wrexham.—The Town Council have received the following tenders for Section 1 of the proposed extensions, including the distributing cable, disconnecting boxes, service boxes, and wood troughing: Callender Company, £2,269. 13s. 4d.; St. Helens Cable Company, £2,138. 17s. (recommended for acceptance).

Scottish Central Supply Company.—Messrs. Bruce Peebles and Co., 25, Victoria-street, S.W., report acceptance of the following tender: complete engine-house equipment for the above, including one 1,200-i.h.p. set, two 600-i.h.p. sets, two 150-kw. sets, exciters, switch-gear, etc.; electrical plant, first installation, £15,500.

West Ham.—The Town Council have received the following tenders for the supply, delivery, and erection of all poles, fittings, wires, and pillars required for the electrical equipment of approximately 3 miles 3 furlongs of tramway track:

R. W. Blackwell and Co., 59, City-road, E.C. (accepted)	£3,851	0	4
Brush Electrical Engineering Company, Belvedere-road, S.E.	4,141	2	9
British Insulated and Helsby Cables, Prescot, Lancs.	4,502	2	6
British Electric Equipment Company, 11, Queen Victoria-street, E.C.	4,567	13	6
Dick, Kerr, and Co., Abchurch-yard, Cannon-street, E.C.	4,579	2	2
Borough Electrical Engineer, West Ham	4,887	5	2
Macartney, McElroy, and Co., 53, Victoria-street, S.W.	4,911	10	8

London County Council.—The Bridges Committee have received the following tenders for renewing the electric light installation on the Woolwich ferryboats "Duncan" and "Gordon":

Scott and Mountain, Limited, Newcastle	£718	0	0
Newtons, Limited, Taunton	807	12	0
	815	12	0
Siemens Bros and Co., London*	812	0	0
Johnson and Phillips, Charlton	890	0	0
General Electric Company, Limited, London	1,068	0	0
Electric Construction Company, Limited, Wolverhampton	921	0	0
	969	0	0
	1,085	10	0
	1,131	10	0
	1,221	0	0
	1,265	0	0
Belliss and Morcom, Limited, Birmingham	1,282	0	0
	1,306	0	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Halifax.—The Council have rejected a proposition to institute ½d. fares for children.

Cheltenham.—The work of extending the light railway was commenced last week, and excellent progress is being made.

Nantes.—A decree authorising the tramways company to extend their system has just been signed by the President of the Republic.

Rochdale.—The Oldham-road and Milnrow-road routes have been completed. The Manchester-road section is also approaching completion.

Colchester.—The Council are to make application for a loan of £50,000, being part of the loan of £61,164 authorised for tramways purposes.

Leeds.—The Corporation have decided to apply for a provisional order authorising the construction of two further lines in the direction of Pudsey.

Handsworth.—Following on our last week's note stating the terms agreed upon between the Council and the company, the former have now executed the lease.

Birkenhead.—Sunday running has been discontinued on the Claughton-road and the docks routes, the Corporation finding the receipts to be inadequate.

Dover.—The *plébiscite* on the question of Sunday running has resulted in a negative vote, the numbers being: against, 3,021; for, 2,887—majority against, 134.

Norwich Electric Tramways Co.—For the year ended June 30 the directors recommend a dividend of 3 per cent., leaving £609 to be carried forward after placing £1,012 to reserve.

New York Underground Railway.—It is reported that on an experimental trip on Monday a train covered the seven miles' trip in 10 minutes 45 seconds. The air was clear and no dampness was apparent.

Beckenham.—The Urban District Council have approved the draft of an agreement with reference to the £20,000 debentures to be given by the British Electric Traction Company as security for the performance of the tramway contract.

Goods Traffic.—It is reported that a concern, entitled "The South Wales Transport Company, Limited," is to be promoted for the purpose of providing a system of electric cars for haulage purposes, and electric 'buses to tap those parts of Swansea and district not served by the tramcars.

Perth.—Perhaps the Corporation will now turn their attention seriously to electrification. Notwithstanding the favourable accounts given two or three weeks ago, the petrol cars have been found not to give unmixed satisfaction, and it is expected that this idea will now be abandoned.

Brighton.—At the meeting of the Steyning East Rural District Council the clerk was instructed to obtain counsel's opinion as to the proper steps to be taken against the Brighton Corporation for the alleged trespass in laying the tramways not in accordance with their statutory powers.

Anglo-Argentine Tramways Co.—The scheme of arrangement with the City of Buenos Ayres Tramways Company (in liquidation) having now been sanctioned by the Court, the liquidators have decided to make forthwith the first cash distribution under the scheme of 4s., in lieu of the usual dividend to June 30 last.

Leicester.—The Corporation have sanctioned the expenditure of £60 000 upon additional plant and cars. The Chairman of the Tramways Committee, in proposing this step, remarked that there was ample room for the new cars, which will bring the total up to over 120. A new design of top cover is in contemplation.

Pontypridd.—After appointing an arbitrator, it appears that the District Council and the British Electric Traction Company have agreed upon terms, the company having decided to accept £5,500. Application is to be made to the Board of Trade for borrowing powers in order to convert the line to electric traction. The Council will work the system itself.

Chesterfield.—In another column will be found an account of the legal proceedings instituted by the Newbold Urban District Council in connection with the laying of the electric tramway. At a subsequent meeting of the Urban District Council a more conciliatory tone prevailed, reference being made to the advantages which Newbold may expect from the new service.

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Accrington.—In framing their scheme of tramway extensions, the Corporation encountered some little difficulty with the Oswaldtwistle District Council, which required somewhat onerous terms, and there seemed a likelihood of this section being omitted from the Bill to be promoted by the Corporation next session. After exchanging views, however, the difficulty has been practically settled, and at its next meeting the Corporation will decide upon the details of the extension scheme.

Dunfermline.—At a meeting on Wednesday of the Dunfermline District Committee of the Fife County Council a letter was submitted on behalf of the promoters of the Dunfermline and District Tramways Company for approval to a provisional order for tramways from Dunfermline to Lochgelly and from Dunfermline to Inverkeithing. In the first-mentioned case the line would pass through the populous districts of Lumphinnans, Cowdenbeath, and Crossgates. The matter was referred to committee.

South Shields.—The tramways question still awaits settlement. At the meeting of the Town Council on Monday a resolution in favour of municipalisation was moved, and several members expressed themselves in accord with the scheme, as the terms offered by the companies did not promise to yield much profit to the municipality. The Mayor approved of construction by the Corporation, but was not prepared to support municipal management. Finally, the matter was adjourned until next week's meeting.

Leith.—The sub-committee which recently inspected various electrical systems of tramway tramways in England and Scotland have issued their report. The deputation state that they have come to the conclusion that, financially and mechanically, the overhead electric system is the most suitable for Leith. The deputation prefer a neat centre pole with arms for the wider streets and brackets in other parts, and advocate cars like those in use at Liverpool and Leicester, some of them to be provided with top covers.

Aberdeen.—The convener of the Tramways Committee has compiled some interesting figures in regard to the interchange of traffic between the Corporation and the Suburban trams. During one week it was ascertained that on the Donside section 4,153 persons came on to the Corporation cars from the Suburban, and that 4,255 persons went to the Suburban cars from the Corporation cars. On the Deeside section 2,782 passengers came off the Suburban cars and boarded the Corporation cars, while 2,764 left the Corporation cars and went on to the Suburban.

Bettws-y-Coed.—The Urban District Council have confirmed the letter drafted by a committee asking the Board of Trade to require the line to be taken past the Swallow Falls through a tunnel, to avoid spoiling the wooded cliff opposite the falls. Instead of the proposed bridge over the road at Pont-y-Pair, Bettws-y-Coed, the Council ask that there shall be a level crossing, so as not to spoil the fine view. As to Sunday traffic, the Council are anxious that the peaceful state of the district on Sundays should remain undisturbed, and would like the Board of Trade to stipulate that no trains be run on Sundays except for mail purposes.

Proposed New Tramway.—It is reported that application will be made next session on behalf of one of the principal electric traction companies for a Bill to authorise the construction of a continuous line of electric tramways along the coast from Ramsgate to Hastings, *vid* Dover, Folkestone, and Littlestone-on-Sea. The proposed undertaking, it is understood, forms part of a still larger project which will link up the tramway systems of Brighton, Worthing, and watering places still further westward with the existing electric light railways in the Isle of Thanet. Strenuous opposition is to be expected from the railway companies affected.

Bury.—At a special meeting of the General Purposes Committee on Monday, the Tramway and Parliamentary Committees submitted a recommendation that a Bill be promoted in the next session of Parliament authorising the extension of the present Bury tramways to the borough boundary on the Jericho, Lime Field, and Bolton-road sections. The recommendation was approved, and referred to the Council meeting for adoption. The extension of the Bolton-road section will connect with the proposed extension of the Bolton system, and will give Bury direct tramway communication with Liverpool. The Tottington section has been completed.

Edinburgh.—The Lord Provost's Sub-Committee has considered the recent memorandum issued by the directors of the tramway company to the members of the Council on the rent to be paid for the undertaking. The memorandum asked practically for a remission of £50,000 of the capital sum on which interest is paid, on the ground that the company understood that the capital sum was not to exceed £1,300,000. The points in the memorandum were gone over seriatim, and it was stated the town clerk had pointed out the inconsistency of the position taken up by the tramway directors, and the inaccuracies the memorandum contained. It was agreed that the town clerk should prepare an answer to the several points raised in the memorandum, and present it to a future meeting of the committee.

Birmingham.—The Works Sub-Committee received a deputation from the local Trades Council, who urged that local labour should be employed in the construction of the tramways and that the work should not be let out to contractors. The Chairman expressed sympathy with the object which the Trades Council had in view, but said it was impossible for the committee to give a definite promise to carry out the suggestions which the deputation had laid before the sub-committee. Every case must be considered by the committee on its merits, having regard to the special circumstances, and the interests of the ratepayers as a whole. The matter would, however, receive the consideration of the sub-committee, and they would use their influence as far as possible to secure the employment of local labour.

Remarkable Construction Performance.—Messrs. Dick, Kerr, and Co. have excelled themselves in the construction of the permanent way for the Birmingham Corporation tramways. It was an essential condition of the contract that the work should be completed in a short space of time, besides which the contractors had to preserve a portion of the road intact, not only for ordinary traffic, but to allow of the steam cars continuing their service. Notwithstanding these difficulties, Messrs. Dick, Kerr, and Co. have completed the work, comprising 9,820 lineal yards single track and 11 junctions with 20,000 square yards of new paving outside the tramways, in 12 weeks, during a part of which the work was proceeded with at the rate of over 2,300 yards per week—surely a record, considering the conditions.

North-Eastern Railway Company.—A trial was made on Sunday with the new electric locomotive which will ultimately be used to haul goods trains from the Quayside at Newcastle to the higher level. A train was made up of 18 10-ton trucks of coal (averaging 16 tons 5cwt.) and two vans (10 tons each), dragging an ordinary locomotive in case of accident or breakdown, so that, exclusive of the electric locomotive, the deadweight was more than 390 tons. The new engine is available for use either on the Quayside, which has the overhead system, or on the upper track and live rail. The trial was very successful. Only one stop was made, at Tynemouth, to cool down the friction surfaces. The experiments were watched by representatives of the Thomson-Houston Company, as well as by North-Eastern Railway officials from the locomotive department.

Gloucester.—The Corporation have decided, by way of experiment, that the fares on workmen's cars be reduced to ½d. for journeys between the Cross and any part of the city system. The general manager has been instructed to consider the question of providing a parcels service, and to prepare a scheme for the consideration of the committee. The following details have been announced concerning the working of the tramways: The receipts for the 20 weeks' running, from the time the cars commenced to run up to Tuesday, totalled £7,222. 3s. 3d., the average per car mile being 8·12d. The passengers carried were 1,846,000, of whom 750,000 were ½d. fares. The passengers at 1d. were 706,000, and 294,000 paid higher fares. There had been issued 25,000 workpeople tickets and 10,749 school tickets, with 8,640 specials for school excursions, etc.

Durham Light Railway.—The Neville's Cross Parish Council have instructed the clerk to address the following communication to the Board of Trade: "I am directed by the Parish Council for the parish of Neville's Cross to inform you they have received notice that the British Electric Company intend to make application to prolong the time for the completion of the railways under the Durham and District Light Railways Order, 1901, until Oct. 4, 1905. The Parish Council also directs me to inform you they object to the application on the ground that nothing whatever has been done within the parish of Neville's Cross to carry the order into effect, although the order has been in force for nearly three years. In the event of the company giving a sufficient guarantee for the completion of the work before October, 1905, the Parish Council will favourably consider the desirability of withdrawing their objections."

Bury, Rochdale, and Oldham.—It will be remembered that the arbitrator awarded the company £159,075, to which has to be added £3 600 agreed upon for street improvements. Mr. More has now allocated the purchase money between the different authorities on the basis of car mileage in regard to plant, rolling-stock, buildings, etc., while the sum for permanent way has been divided according to the value of the respective sections. The £162 675 is thus apportioned: Rochdale and Wardle, £70,390. 6s.; Littleborough, £7,033. 15s. 9d.; Royton. £15,544. 2s.; Heywood, £20,436. 16s. 3d.; Bury, £38,441. 19s.; Tottington, £4,191. 13s. 6d.; Unsworth, £3,016. 15.; and Whitefield, £3 620. 1s. 3d. The taxed costs of the arbitration will probably be allocated on the basis of mileage. The respective authorities will be credited *pro rata* with the proceeds of such of the old stock as is not now required when the same has been realised.

Derby.—The manager has been instructed to allow the use of special electric cars, when it can conveniently be arranged, upon payment of 5s. and the full fare for a minimum of 40 passengers. A petition having been received, signed by numerous ratepayers, asking for the extension of the tramways route to the Market-place, the committee have decided to inform the petitioners that the suggested extension cannot be made until the next scheme is taken in hand. The committee have decided to discontinue the running of cars from the Midland Railway Station to Alvaston. The Tramways Committee have had under consideration the question of establishing an insurance fund against third-party risks, and they have decided, subject to the approval of the Council, to place the sum of £1,000 from the proceeds of the accumulated revenue of the tramways to the credit of a reserve fund, and also to contribute to such fund £10 in respect of each car per annum. The penalty incurred by J. G. White and Co., Limited, contractors for the construction of the electric tramways by reason of the works not having been completed within the prescribed time is £28,032. The Finance Committee have informed the Tramways Committee that no further certificates to J. G. White and Co., Limited, will be honoured until accounts between the contractor and the Corporation have been adjusted.

Newcastle.—At the meeting of the Corporation last Friday, Alderman Ellis, chairman of the Tramways Committee, in presenting for confirmation the estimates for the year ending March next, of which we gave particulars last week, remarked that the gross profit of £67,275 only left an estimated balance of £2,541 to be set aside as the nucleus of a depreciation fund. He attributed this result to excessive expenditure and over-capitalisation In regard to the former the committee had effected economies in the staff, and proposed to obtain a further saving by the same means. He also considered it unfair that the undertaking should have to pay £3,105 for income tax. Two or three councillors expressed confidence that the work of revising the methods of conducting the undertaking would result in reduced traffic expenses, as at present the car mileage was excessive. A somewhat

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lengthy discussion ensued on the depreciation question. Eventually the estimates were adopted on the understanding that this matter shall receive further consideration at a future meeting. The new line which has been laid over the railway bridge in New Bridge-street has been joined to the old one which runs between Pleasant-row and New Bridge-street Station. Cars are running on the new section towards the city, and when the line to Heaton has been connected up there will be a direct route from Pleasant-row to the city, obviating one of the most dangerous routes on the system.

Belfast.—The minutes of the Tramway Committee presented to the Corporation at its meeting on Monday stated that the city surveyor (Mr. Cutler), electrical engineer (Mr. M'Cowen), and general manager (Mr. Nance) had issued a joint report, stating that they proposed to issue separate specifications for track work, overhead electrical equipment, underground feeder cables, buildings for the extension of the generating system, engine-house plant, boiler-house plant, single-truck double-decked cars, and to issue a form of tender containing each of the heads above enumerated. A deputation from the Belfast branch of the United Kingdom Society of Coachmakers had been received by the committee, and were informed that 220 cars would be required, and it was intended that 50 of these should be built in Belfast, and that after the original number had been supplied any additional cars or repairs would be provided for locally. The city surveyor submitted to the committee draft specification for the permanent way, and was instructed to provide for work being commenced within two months of the tender. The penalty for non-completion within the time contracted for to be £1,000 per week after the expiration of the said period. After a lengthy discussion the minutes were adopted. Previous to the sitting the Corporation received deputations from 11 industrial organisations, whose delegates urged that the conversion of the tramways and the building of the cars should be done by local labour under the control and supervision of the Corporation.

Aston.—The Public Works Committee presented to the Town Council on Wednesday a report relating to the purchase from the City of Birmingham Tramways Company of tramways belonging to the company in the borough. The purchase is of the tramways in High-street, Birchfield-road, Witton-road, Lozells-road, and Wheeler-street, together with the land and buildings in the Witton-road, and the rolling-stock required to work these lines; also the prospective profits which the company would have been entitled to had they worked the lines for their own benefit from June 1, 1904, to Dec. 31, 1905, and to June, 1911, in the case of the Wheeler-street line. The price was to be settled by arbitration, and the committee reported the award of Mr. Robert Green as £26,045. The Council has to pay interest at the rate of 4 per cent. per annum on this sum from Jan. 1, 1904, the Council taking the profits from the working of the undertaking as from that date. The arbitrator's fees and charges, to be paid by the Council, amount to £361. 18s. The committee also reported in regard to the Aston Station railway bridge. As a result of a lengthy correspondence and several interviews between the town clerk, the consulting engineer (Mr. Robert Green), and the chief officials of the London and North-Western Railway Company, terms have been provisionally arranged for the rebuilding of that part of the railway bridge extending over the Lichfield-road. The railway company has intimated its willingness to reconstruct the bridge and to make such alterations thereto as are desirable at an estimated cost of £5,760, the work to be done under the direction of the company's engineer at the expense of the Council. Just as we go to press we learn that the Council have confirmed this arrangement. It is not intended to commence the reconstruction of the above-mentioned lines until the new year. The chairman of the Tramways Committee proposes to confer with the Birmingham Corporation, as the latter apparently object to continuing their service beyond Aston Cross, with the result that communication between the city and Witton is greatly restricted.

London County Council.—At Tuesday's meeting of the Council a resolution was moved that, in order to facilitate the traffic requirements of South London and the public generally, the Highways Committee be instructed to bring up in time for the next parliamentary session a scheme for joining the tramway termini at Blackfriars Bridge and Westminster Bridge by means of a tramway constructed across the two bridges and along the Victoria-embankment, in order to provide a continuous circular route by which the blocks in Blackfriars-road and Westminster Bridge-road might be obviated. This found a ready seconder, but the Chairman of the Highways Committee pointed out that a difficulty would arise from the fact that Blackfriars Bridge was the property of the City Corporation, which would have to be consulted. He agreed that no improvement was more important than that proposed, but thought that a mere reference to the Highways Committee instead of an instruction would better meet the circumstances of the case. This suggestion was accepted, and the resolution, amended accordingly, agreed to. The report of the Highways Committee contained recommendations that a capital vote of £1,000 be made for a site on which to erect a sub-station in connection with the Battersea and Wandsworth lines; that Messrs. H. Lovatt, Limited be accorded permission to sublet the work of plumbing, painting, and glazing in connection with the Greenwich generating station; and that an agreement be sealed for the acquisition of a site near Old-street for a sub-station. The committee also reported that they were considering the best course to adopt in regard to the London, Camberwell, and Dulwich tramways, which has now been acquired by the Council, and that the Board of Trade has appointed Major Cardew, R.E., as arbitrator in reference to the acquisition of the Woolwich and South-East London Tramway Company's undertaking. In a report just issued by the Stepney borough engineer, Mr. W. M. Jameson, reference is made to the forthcoming electrification of the tramways, and to the proposal of the London County Council to use the overhead system on some of the East-end routes. Mr. James deprecates the overhead system on æsthetic principles, besides which he alludes to danger from falling wires, and the likelihood of electrolysis resulting from the return rail. The report hails the advent of electric trams, as their increased speed may be expected to appreciably relieve the congestion, but Mr. Jameson suggests that it would be advisable to remove the terminus 124 yards eastward from the present point in Aldgate.

LIGHTING AND GENERAL.

Bray.—The engineer is to report fully and submit a scheme for arc lighting.

Birkenhead.—The Local Government Board have sanctioned a loan of £6,500 for electrical works.

Bournemouth.—The Town Council on Wednesday decided to apply for a municipal telephone license.

Havant.—The laying of underground wires by the Municipal Telephone Committee has been sanctioned.

Southampton.—Provision has been made out of the profits of the past year for the repair of the older mains.

Broxburn.—The opening of the streets for the laying of the cables for the electric lighting of the district was commenced on the 29th ult.

Walthamstow.—An enquiry has been held into the application of the Council for £46,000 for further extension of the electric lighting station.

Stepney.—The Borough Council have decided to apply to the London County Council for a further loan of £220,000 for supply purposes.

Leicester.—The profit made by the Corporation during the half-year ending in June last on the water and electric lighting undertaking was £11,000.

Litherland.—The ratepayers' association have passed a resolution suggesting that the Urban District Council of Litherland apply for an electric lighting provisional order.

Lowestoft.—An enquiry has been held into the application of the Corporation for sanction to borrow £3,600 for purchase of property in connection with the light undertaking.

Removal.—Messrs. John Davis and Son, Limited, Derby, have removed their London offices from 26, Victoria-street, Westminster, S.W., to Camomile-street-chambers, London, E.C.

Cheltenham.—The monthly report of the electrical engineer shows that there are 778 customers, with the equivalent of about 50,660 8-c.p. lamps connected to the private supply mains.

Paris.—The *Journal Officiel* publishes a decree authorising the Algiers Chamber of Commerce to borrow 16,000fr. for the construction of a telephone line between Boghari and the Algiers system.

Bishop's Stortford.—After discussion, a resolution to the effect that an application be made for a provisional order, the Urban District Council last week adjourned the subject for further information.

Gloucester.—An agreement between the Electrical Power Storage Company, Limited, and the Corporation for the maintenance of the battery for 10 years has been approved. Some of the new arc lamps are now in use.

Tottenham.—The Council are inviting offers for the supply of electricity in bulk, or otherwise, under the Council's electricity order, the proposals to be received not later than Friday, Oct. 21. Particulars appear in another column.

Devonport.—A further report is to be prepared in reference to the provision of additional plant in the Stonehouse power station. The committee do not recommend the turbine. The estimated cost for the proposed additions is about £10,000.

Oulton Broad.—The Urban District Council have discussed a proposal to apply for a provisional order for electric lighting. Finally, the matter was adjourned pending an interview of a deputation of the Council with Messrs. Barber and Croft.

Hammersmith.—The premises of nine additional consumers, representing a maximum of 577 8-c.p. lamps, have been connected to the mains; seven consumers have been disconnected. The present number of consumers taking current from the mains is 1,502.

Wednesbury.—Sanction has been received to a loan of £465 for the purposes of lighting with electricity the town hall, municipal offices, public library, art gallery, and public baths. The extension of the electrical main in the King's-hill district is receiving attention.

Dublin.—The Corporation on Monday adopted a report on the supply of electrical energy to the old electric lighting area by Mr. Ruddle, city electrical engineer, recommending the laying of new mains in St. Stephen's-green, Westmoreland-street, and Kildare-street, at a cost of about £1,300.

Leigh.—At a recent special meeting of the Town Council, it was stated that extensions at the electricity works were so urgently required that it was proposed to go on with the work before they got the sanction of the Local Government Board to borrow the money. The extensions were approved.

Woolwich.—The electrical engineer's scheme for the supply of electricity to Shooter's Hill and Eltham has been referred back for further consideration. Section A, dealing with the Shooter's Hill district, was estimated to cost £13,008; and Section B, dealing with the further extension to Eltham, would cost £12,585.

Colchester.—The last report of the borough electrical engineer contains the following figures: output of electricity in units during August, 1904, 65,444 (1903, 19,093; 1902, 12,043); number of consumers at end of August, 529 (370; 292); total number of 8-c.p. lamps connected, 26,728 (23,206; 17,462).

Village Post Offices.—The telegraph at various village post offices in Northamptonshire has been abolished, and the telephone has been installed in its place. It is understood that the telephones at village

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post offices will be less expensive than ordinary A.B.C. telegraphic apparatus, less liable to accidents, and require less technical knowledge on the part of the village operator.

Brighton.—The Town Council propose to extend the basement flooring of the power station at Southwick so as to cover the whole of the engine-room area, instead of part only, as provided for under the contract with the British Westinghouse Company; also to construct a switchboard gallery at the North-road converter house. It is proposed that the work be done by the British Westinghouse Company for £5,285 and £820 respectively.

London County Council.—On Tuesday tenders were received, and referred to committees, for the erection, etc., of condenser water-pipes, etc., at the Greenwich tramways generating station; for the erection, etc., of three electric car traversers at the London County Council tramways depôts; for the erection, etc., of pumping plant at the Greenwich tramways generating station. A number of notices of intention to lay mains was agreed to.

Barrow.—The accounts of the electricity department for the year ended March 31, 1904, show a total capital expenditure of £78,575. £11,202 being expended during the past year, principally for additional plant and machinery for the purpose of supplying current to the trams. Loans have been borrowed to the extent of £73,575, and £6,078 has been repaid. The deficiency in this department was reduced last year by £478, and the loss on previous working of the undertaking now stands at £1,181.

Wood Green.—At the last District Council meeting the electricity scheme and the Local Government Board's refusal to sanction the borrowing of £43,570 were considered, and the following resolution was passed: "That this Council regrets the decision of the Local Government Board, but still adheres to the repeatedly expressed policy of obtaining a municipal supply of electricity according to the powers granted it by Parliament; and instructs the Electricity Committee to submit a report for consideration."

Underground Telegraph to the North.—The *Carlisle Journal* says: "On Wednesday, Sept. 28, another stage in the work of providing the public of the North of England and Scotland with a telegraphic system which will not be affected by storms was completed. On that evening the workmen drew the cable across Eamont Bridge, thus bringing the work into Cumberland, and in a few days Penrith will be reached. Should the weather continue favourable, it is hoped that the cable may be laid to Carlisle by the end of the year, though this scarcely appears likely to be accomplished."

Handsworth.—In reference to the announcement in the *London Gazette* that the Board of Trade had revoked the Handsworth Electric Lighting Order, 1901, the *Birmingham Post* says that upon enquiry at the office of the clerk to the Handsworth District Council Mr. Ernest Ward, the assistant clerk, stated that the notice in the *London Gazette* did not apply to their district, but must refer to the village of Handsworth, near Sheffield. So far as the neighbouring district of Handsworth is concerned, the electric supply scheme is so forward that the cables have been laid, and the erection of a generating station in Piers-road is in progress.

Loughborough.—The Town Council hope to start in the course of a week or two to supply electric current in the town. The boiler-house at the works contains two dry-back boilers, built by Danks and Co., of Dudley, two boiler steam-feed pumps, a storage tank of 15,000 gallons capacity, and an economizer of 200 tubes. In the engine-room are two Brush turbines, connected direct to two generators of 250 kw. capacity, and a Siemens balancer-booster. The battery-room contains 260 cells, giving 50 amperes for 10 hours' current. The buildings have been erected by Mr. A. Faulks from plans prepared by Mr. A. E. King.

Stoke-upon-Trent.—The Town Council have passed a vote of thanks to the North Staffordshire Railway Company for the kind services of Mr. Rock in connection with the testing of the mains. The Princess-road main is to be extended from Quarry-road to opposite the Mount. The works being almost completed, the Mayoress will be requested to perform the opening ceremony at the end of the month. There are now 54 premises in the borough wired up for immediate supply, and a considerable number of orders have come in since then. The committee are very gratified with the promising prospect for the use of electric energy for motive purposes in the borough.

Retford.—Mr. A. B. Mountain, in his report on the supply of electric light for the borough, estimates that a steam plant would cost £14,000, and a gas plant £10,000, to supply 300 houses. After the first three years there would be a surplus balance of £410. He proposed to put down a small plant of £5,070 first, which would leave a balance of £177 to be provided for the first few years, but this would gradually be worked out. He strongly urged the Corporation to undertake the work themselves, as they could supply it much cheaper than any outsider, and if they did not do so, someone else would take it up, and the town would afterwards have to buy them out at a very much higher figure.

Beckenham.—At the last Urban District Council meeting it was reported that the claim of the Crystal Palace District Electric Lighting Company, amounting to £7,897. 12s., for the transfer of so much of their undertaking as is within the district of Beckenham, has been received. A draft agreement with the Penge Urban District Council as to the laying of the necessary connecting cable is being examined. The British Insulated and Helsby Cables, Limited, have agreed to pay one-fifth of the expense of appealing against the assessment of the electric lighting works. Tenders are to be invited for the erection of the baths in connection with the dust destructor and electric lighting works, and application is to be made for sanction to a loan of £210. New cables are to be laid at a cost of £64, £35, and £110.

Worthing.—With reference to the proposal of the Post Office to erect telephone posts in various roads, the Post Office authorities have pointed out that the proposed new telephone line was incidental to the development of telephonic communication within the borough, and that its erection was in the interests of the ratepayers. The Postmaster-General considers the cost of underground wires prohibitive, and is not disposed to have recourse to expensive underground work when a suitable route for the line of posts is accessible in the public streets, of which he has the right to avail himself under the Telegraphs Acts. One of these roads accommodates standards for electric arc lamps already. The Highways Committee being still of opinion that it is undesirable to consent to the erection of the posts in the locality named, have again recommended the Council to withhold consent. At the meeting of the Council on Monday the recommendation was sent back for reconsideration.

York.—The report of the electrical engineer (Mr. C. A. Midgley) on the fourth year's working shows an increased sale of current of 114,542 units, the total being 776,542 units, representing an increase of 20 per cent. on last year. The number of motors connected to the system is now 110, representing 530 h.p., while the number of units sold under this section has increased to 184,472 units, showing an advance over last year of 54,472 units, equal to an increase of 42 per cent. The number of consumers has increased from 386 to 470, being a growth of 22 per cent. The maximum load on the station has increased from 550 kw. to 651 kw., the capacity of the plant being 720 kw. The total capacity of the plant now the extensions are completed is equivalent to 54,000 8-c.p. lamps burning at one time. This will admit of a total lamp connection with sufficient reserve of plant of 62,000 8-c.p. lamps being connected, and to date there are connected to the mains a total of 55,200 8-c.p., and 1,500 8-c.p. awaiting connection. Notwithstanding an increase in sales, the expenditure has been less than the previous year by £225, and the net balance on the year of £350 clears the department of all liabilities.

London Gazette.—An adjudication order has been made out in the estate of Henry Coles, electrical engineer, 10, York-street, Swansea. A general meeting of the Renewable Electric Lamp Company, Limited, will be held at 12, St. John's-lane, Liverpool, at 12 o'clock noon on Nov. 5, 1904, to receive the liquidator's accounts, showing the manner in which the winding up has been conducted and the property of the company disposed of. A general meeting of the Electric Extension Company, Limited, will be held at 12, St. John's-lane, Liverpool, on Nov. 5, 1904, at 11 a.m., to receive the liquidator's accounts, showing the manner in which the winding-up has been conducted and the property of the company disposed of. The London Electrical Syndicate, Limited, has been wound up voluntarily, and George Pearson, 196, Abbott-road, Poplar, appointed liquidator. A general meeting of the members of the Clayton Engineering and Electrical Construction Company, Limited, will be held at the Grand Hotel, Manchester, on Nov. 4 at 12 o'clock noon, to receive the liquidator's report showing how the winding-up of the company has been conducted and its property disposed of. The partnership between Charles Herbert Offord, Frank Clemens Wilson, and Archibald Carlyle Barfield, carrying on business as electrical engineers at Woodcock-street, Birmingham, under the style of "Offord, Wilson, and Barfield," has been dissolved by mutual consent.

Fulham.—In February the Council passed the following resolution: "That the offer of the directors of the Granville Theatre of Varieties to take the whole of their electric current from the Council's mains for a term of seven years at 3d. per unit, and to guarantee during that period a minimum consumption equivalent to £450 per annum, be accepted, subject to their entering into a satisfactory agreement embodying this arrangement and safeguarding the Council's interests." It is now proposed that the resolution be rescinded so far as regards the guaranteed minimum consumption of current equivalent to £450 per annum, and that a guaranteed minimum consumption of current equivalent to £430 per annum be accepted by the Council, and the agreement with the directors of the Granville Theatre of Varieties completed accordingly. The borough electrical engineer has submitted the following statistics: Refuse destroyed—previously reported since April 1, 1904, 8,603 loads, 13,220 tons; from Sept. 8 to 22, 1904, 716 loads, 1,103 tons—total, 9,319 loads, 14,323 tons. Trade refuse—previously reported since April 1, 1904, 302 loads, 292 tons; from Sept. 8 to 22, 1904, 28 loads, 28 tons—total, 330 loads, 320 tons. Clinker disposed of—previously reported since April 1, 1904, 3,416 tons; from Sept. 8 to 22, 1904, 211 tons—total, 3,627 tons. Connections—previously reported, 1,260 (59,893 8-c.p.); from Sept. 8 to 22, 1904, 18 (744 8 c.p.)—total, 1,278 (60,637 8-c.p.).

Wrexham.—The electrical engineer's last report on connections and supply was as follows: August, 1904—used for tramways, 11,995 units; August, 1903—14,157 units. August, 1904—used for lighting, etc., 18,167 units; August, 1903—17,646 units. August, 1904—power (private), 835 units. Total consumption: August, 1904, 30,997 units; August, 1903, 31,803 units. New consumers connected, one; 8 c.p. equivalent of additions to connections, 84; total number of consumers, 139; against 132 in August, 1903. The Wrexham and District Electric Tramways Company require the current to be left on the lines all night during the winter months for the lighting of the depôt, the arrangement to commence Nov. 1 next, and consequently the electrical engineer has been authorised to order the special meter required for the purpose of correctly registering the quantity of electricity used at the higher rate of charge under the agreement with the tramway company. Tenders for the supply of distributing cable, disconnecting boxes, service boxes, wood troughing, complete fittings for converting gas standards and brackets to incandescent electric lighting, and enclosed arc lamps complete, have been referred to a sub-committee, to consist of the Chairman, the Mayor, Councillors Francis, Taylor, and Williams, with a view to recommendations for acceptance being made to the next meeting of the Council. A canvasser is to be appointed. The borough treasurer's statement relating to contracts in connection with the electricity department and alterations to destructor, shows that the total

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amount of the contracts in connection with the department, including destructor, buildings, boilers, engines, dynamos, cables, lamps, switchboard, battery, crane, new chimney, and additions and alterations to many of the same, was £27,204; there were also extras amounting to £2,025, making the total £28,973.

Govan.—In a recent special report Mr. T. C. Parsons says it would be as well to reckon on using £20,000 for completing the present electricity extensions. With regard to the future requirements, he estimates that at the present rate of progress, in three years' time another 750-kw. steam dynamo with condensing plant and another boiler will require to be added to the station equipment. He adds that in the present year, 1904-5, an additional feeder will have to be laid to the foot of Helen-street. In the year 1905-6 a new feeder to the Plantation district will be required, and in the year 1906-7 a new feeder to the district round Albert-street. It was not very easy to estimate the amount required for purchasing motors to be let out on hire, as the department had only just started this branch of business, but in the two months in which they had been offering them applications for 51·5 h.p. and promises for eight more had been received, totalling about 180 h.p., and he thought it best therefore to allow £5,000 for this purpose. The estimated capital expenditure, therefore, up to the year 1906-7 is: Year 1904-5—completing present extensions, £28,753; new mains, £4,500; motors, £1,500; meters, £400—total, £35,153. Year 1905-6—mains, £5,000; motors, £2,000; meters, £400—total, £7,400. Year 1906-7—steam dynamo, £4,900; condensing plant, £750; boilers, £1,250; pipework, £150; sundries, £250; mains, £4,000; meters, £400; motors, £1,500—total, £13,200. Total for three years, £55,753. This brings up the total to the end of 1907 to £55,753, and as the department have £8,753 unborrowed although authorised, there remains £47,000 for which borrowing powers are required. To complete the present extensions only £20,000 is required. The engineer suggests that powers be sought to borrow the whole sum of £47,000. The income of the department for the year ending May 15, 1902, from all sources amounted to £4,915, the expenditure to £3,132, and the units sold were 409,397. For the year ending May 15, 1903, the income was £6,585, expenditure £4,264, units sold 597,910. For year ending May 15, 1904, the income was £9,291, expenditure £5,933, units sold 894,702. Mr. Parsons's estimate of income, expenditure, and units sold for the next three years is: for year ending May 15, 1905, income from all sources £11,912, expenditure £6,233, units sold 1,350,000; for year ending May 15, 1906, income from all sources £15,302, expenditure £7,544, units sold 1,926,000; for year ending May 15, 1907, income from all sources £18,542, expenditure £8,300, units sold 2,362,100. The capacity of the plant in the station at present is 1,100 kw., and, allowing a sufficient margin for stand-by, this plant would supply current to light 23,400 8-c.p. at one time. By the time the present extensions are completed the department will have plant capable of dealing with 46,400 8-c.p. alight at one time, and when the second 750-kw. machine is added this will deal with 69,800 8-c.p. alight at one time.

Islington.—The Council will to-night consider a report from the Lighting Committee, dated Aug. 26, 1904, as follows: "(1) Since the laying of the mains in the Canonbury and Hornsey Rise districts on the solid system, and the erection of feeder pillars for the purpose of regulating and controlling such mains, we have taken into consideration the general question of the electrical requirements of above-ground switchgear with a view to a minimum of public inconvenience, for while there is little objection to feeder pillars on broad footways in districts where the traffic is comparatively small, the multiplication of obstructions on the footways becomes a serious matter in the main arteries of the borough. In connection with the extension of mains being carried out this year in Stroud Green-road and Blackstock-road, and the mains already laid in Hornsey-road and Highbury New-park, it is necessary that, at the earliest possible date, switch and feeder pillars should be provided in Seven Sisters-road, Holloway-road, and Highbury New-park. Arc lamps have already been erected in these roads, but we consider for the reason stated above that it would be inadvisable to place separate feeder pillars in their immediate vicinity, and that the feeder pillars should be combined with, and form part of, arc lamp standards. Six ordinary high-tension feeder pillars are scheduled in the contract with the British Insulated and Helsby Cables, Limited, and as the manufacture of this class of apparatus is a speciality, and the cables have to be connected up by the cablemakers to the feeder pillars, we have asked the company to quote a price for a combined arc lamp column and feeder pillar in substitution for such of the ordinary feeder pillars as may not be required. They offer to supply and erect 12 combined feeder pillars and arc lamp columns, provided with high or low tension fittings in such numbers as may be required, at £77. 5s. each, making a total of £927, and we are of opinion the offer should be accepted. We propose to erect one of the pillars on the north-east side of Hornsey-road outside the London County Council school, and to substitute another for the present arc lamp column at the junction of Hornsey-road and Seven Sisters-road. The first proposal will necessitate an additional expenditure of £50 in respect of mains, connections, etc. We have forwarded these estimates, amounting in the aggregate to £977, to the Finance Committee, and subject to their being adopted and submitted by them we recommend (*a*) that the estimate of £977 submitted by the Finance Committee be approved, and that application be made to the London County Council for sanction to the borrowing of this amount; (*b*) that the offer of the British Insulated and Helsby Cables, Limited, to supply one dozen combined feeder pillars and arc lamp columns, provided with high or low tension fittings as may be required, including delivery and erection, in lieu of such of the feeder pillars scheduled in the mains contract for 1904-5, as the Lighting Committee may determine, be accepted, and that a contract under seal be entered into accordingly on the sanction to the loan being obtained; (*c*) that one of the combined pillars be erected on the north-east side of Hornsey-road in front of the London County Council school, at an estimated cost of £50. (2) We have received a requisition for an extension of mains in Crouch Hill to supply the North London Home for Aged and Christian Blind Men and Women in Hanley-road, together with a guarantee that the consumption of energy shall produce a revenue of not less than 20 per cent. per annum for the first two years of the cost of providing and laying the necessary distributing main, and having regard to this guarantee, we are of opinion that the requisition should be complied with, and have accordingly given instructions (the Council being in recess) for the work to be proceeded with under current contract at an estimated cost of £200. We have forwarded this estimate to the Finance Committee, and, subjected to its being adopted by them, we recommend (*a*) that the estimate of £200 submitted by the Finance Committee be approved; (*b*) that application be made to the London County Council for their sanction to the borrowing of a sum of £200 for the purpose."

Weymouth.—The newly-installed electric light works were inaugurated on Sept. 26. Messrs. Kennedy and Jenkin were the consulting engineers. The plans for the supply station were by Mr. Stanley Peach, F.R.I.B.A., Westminster, and the contract for the erection of the buildings was secured by Messrs. J. and H. Bagg. A complete modern plant has been laid down under the supervision of Mr. A. W. Wigram, A.M.I.E.E., A.M.I.E. Mr. Archibald Brown was clerk of the works. The engine-room is 60ft. long, 36ft. wide, and of a considerable height, and for the most part lined with white glazed bricks. It is spanned by a 12-ton travelling crane running the entire length of the room and worked by rope gear from the floor level. At present the room contains two sets of generators of 122 kw. each and four generating sets of 38 kw. The engines are identical in all respects, the smaller sets containing two and the larger three units. All the parts of these are interchangeable, so that the spare gear provided can be used in any of the 10 cylinders. Each engine has a duplicate source of power, and, as in the boiler-house, any section of pipes can be isolated from the rest. The engines are by Messrs. Reavell and Co., of Ipswich. They are of the single-acting compound type, running at 425 revolutions a minute. The steam in ordinary working will be condensed by water pumped out of the Backwater, for which purpose a pumping station has been built 20 yards from the end of the battery-room, but an alternative automatic arrangement is provided for turning the steam to the atmosphere. The larger engines each drives one generator of 122 kw. capacity, which work at a pressure of 480 volts. The two smaller engines each drives two generators of 38 kw. capacity, each generating current at a pressure of 240 volts. Arrangements have been made for further developments of the plant if required. That at present installed is capable of an output of about 400 kw., or, say, 560 h.p., being equivalent to the supply of 12,000 8-c.p. lamps. In the room at the end of the engine-room a storage battery of 240 cells has been installed by the Tudor Accumulator Company, and a motor-generator for charging it stands close to the battery-room. The station is lighted with Nernst and incandescent electric lamps, put up by Mr. W. D. Orchard, of St. Mary-street. The boiler-house, which is about 50ft. square, contains three Lancashire boilers, 28ft. long by 8ft. in diameter, suitable for working at a pressure of 160lb. per square inch. Coal is delivered from carts into bunkers, each holding about 50 tons, in front of the boilers. An economiser, consisting of 96 cast-iron tubes is fitted in the main flue, and through these the water is pumped on the way to the boiler. The water supply is procured from the town mains, and delivered into a tank with a capacity of 5,600 gallons placed on the top of the roof of the pumping-room, whence it is pumped by apparatus supplied by Messrs. J. E. G. Weir and Co., of Cathcart, Glasgow. There are six main cables and distributing mains in 8½ miles of streets. The cables laid are enclosed in wooden troughs boiled in tar, the troughs being filled with bitumen and covered with hard blue bricks. Across the Backwater Bridge and along the shore of the Backwater the cables are protected with steel armouring, those on the Backwater Bridge being supported on iron brackets outside the northern parapet of the bridge, and enclosed in a sheet-iron case. About 64 miles of conductors have been laid, including the cables for the public lighting. All the cables have been made and supplied by Messrs. Johnson and Phillips, of Old Charlton, Kent. A number of 800-c.p. lamps are on the Esplanade. The lamps, with their posts and gear, have been supplied by Messrs. Oliver and Co., of Woolwich. Each standard carries two small incandescent lamps. The remainder of the streets are being lighted by over 200 Nernst lamps of 40 c.p. to 150 c.p., put up by Messrs. Johnson and Phillips. The following contracts were carried out in connection with the electric lighting of the borough: Messrs. Johnson and Phillips, Old Charlton-road, Kent, for feeders, mains, roadwork, incandescent lamp posts and fittings, £11,413. 17s. 10d.; Messrs. Edwin Danks and Co. (Oldbury), Limited, Birmingham, for boilers at engine-house, £1,850; International Electric Engineering Company, Limited, London, dynamos (£3,192) and switchboard and motor-generators (£1,860. 9s.); Messrs. J. and H. Bagg, Weymouth, for electric lighting station, £8,490; Messrs. Oliver and Co., Woolwich, accumulator lamps, posts, and gear, £704. 3s.; the Tudor Accumulator Company, Limited, London, supplying storage battery, £1,156; Messrs. Aitou and Co., Willesden, for pipe work, feed pumps, economiser, ejector, condensers, etc., £2,889. 17s., together with an additional £96 for Weir twin compound feeding pump, and £220 for other works, in all £3,195. 17s.; Messrs. John Hitchin and Sons, Halifax, for overhead travelling crane, £280. 10s.—making a total expenditure of £32,142. The management of the new works under the supervision of the Electric Lighting Committee is in the hands of two skilful electricians of experience—Mr. R. G. Simpson, borough electrical engineer, and Mr. W. Drysdale, assistant borough electrical engineer. During the past week a number of the hotels and business premises were supplied by the Corporation. The contractors were W. D. Orchard, W. Gee, 28, Abbotsbury-road, Westham, and C. Tett, Queen-street. A number of Jandus arc and Nernst lamps are being installed.

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PROVISIONAL PATENTS, 1904.

SEPT. 26.

20653. Invention for deadening live rail used for electric railway traction purposes, and also indicating when the said rail is alive. Richard William Scott, 3, East Mount-terrace, Haughton-road, Darlington.

20656. Continuous electric furnace for reducing metallic oxides or other compounds. Peter Auchinachie, 65, Chancery-lane, London.

20667. Improvements in intercommunication switchboard for telephone and other electrical instruments. John Alexander Romer, 1A, Lausanne-road, Peckham, London.

20670. Improvements in a commutating switch and circuits for controlling electric carriages and like purposes. Henry Francis Joel, 74, Windsor-road, Forest Gate, Essex.

20689. Improvements relating to the regulation or control of dynamo-electric machines and electric motors. Charles Prosper Eugene Schneider, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20713. Improvements relating to electric transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

20714. Improvements in bearings for the shafts of delicate instruments. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

20715. Improvements in insulations for edgewise-wound coils. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

SEPT. 27.

20725. Safety contact trippit for electric trains. William Coates and George Wright, 18, Armstrong-street, Bensham, Gateshead-on-Tyne.

20749. Improvements in trolley boom controlling apparatus for electric tramcars and the like vehicles. Samuel Hindley, 28, Rangeley-road, Sheffield.

20759. Improvements in and relating to mechanism for electrically-operated pianos and other musical instruments. Arthur Joseph Clarke, 60, Dinsmore-road, Balham, London.

20782. Improvements in the electrolytic extraction of zinc from its ores, and apparatus therefor. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société Anonyme d'Etudes Electro Chimiques, Switzerland.)

20783. Improvements in electrical telegraphs and controlling apparatus. Arthur Vyell Vyvyan and Leonard Newitt, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20783. Improvements in the winding for monophase or polyphase alternating-current electric machines. Elektrizitäts Act.-Ges. vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Nov. 12, 1903, being date of application in Germany.) (Complete specification.)

20791. A device for supporting electrical conductors. Charles Fredrick Bettmann and John Zapp, 13, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20804. Improvements in and connected with wireless telegraphy systems. William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

20809. Improvements in electric furnaces. The British Thomson-Houston Company, Limited, 13, Cannon-street, London. (The General Electric Company, United States.)

20810. Improvements in electric furnaces. The British Thomson-Houston Company, Limited, 13, Cannon-street, London. (The General Electric Company, United States.)

SEPT. 28.

20833. Improved method of and means for operating the rail and wire points in overhead wire systems of electrical traction. Alfred Charles Virgin, Lloyd's Bank-buildings, Bristol.

20846. Circuit breaker. John Liddle, 154, St. Vincent-street, Glasgow. (Ernest Robert Hartman, United States.) (Complete specification.)

20849. Improvements in electric blow-outs and fuses. William George Allan, 55, Market-street, Manchester.

20877. Improvements in and relating to magnetic separators. Arnold Goodwin and William James Hollidge, 46, Lincoln's-inn-fields, London.

20896. Improvements in or relating to the manufacture of water-jackets, casings, and the like by electrolytic means. Alexandre François Bosquet, 18, Buckingham-street, Strand, London. (Complete specification.)

20898. Improvements in or additions to pipes or tubes for containing underground electrical cables or conductors. Edward John Chambers, 7, Staple-inn, London.

SEPT. 29.

20927. Improvements in the mode of suspending incandescent lamp-holders. James Mackersie, 41, Reform-street, Dundee.

20931. Improvements in the manufacture of switchboards for electrical purposes. Frederick Charles Ruddle, 29, Azalea-road, Blackburn.

20953. Improved electric igniter for simultaneously igniting and simultaneously or successively extinguishing gas-burners. Oreste Candi and Cesar Candi, 18, Buckingham-street, Strand, London. (Complete specification.)

20965. Improvements in and relating to the leading-in conductors for electric incandescent lamps and the like. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

20968. Improvements in or relating to central-station electric installations. John Somerville Highfield, 322, High Holborn, London.

20970. Improved braking device for electric motors. Arthur Hultqvist, 322, High Holborn, London.

20975. Improvements in or relating to electric lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Ad. Wagner S. Brechtel und Co., Germany.) (Complete specification.)

20976. Improvements in or relating to electric traction. Robert Stewart Clouston, 111, Hatton-garden, London.

SEPT. 30.

20997. Improved means for controlling the flow of electricity into third or operative railway rails, or similar appliances for vehicular or other traffic, the said means being also available for signalling purposes. James Graham and Ramsey Kendal, North-Eastern Railway, Darlington.

21027. Improvements in apparatus for controlling the supply of electricity. Adolph Schneider, 1, Queen Victoria-street, London.

21028. Improvements in electrical measuring instruments. George Keith Buller Elphinstone and Harry F. Fast, 24, Southampton-buildings, Chancery-lane, London.

21038. An improved electric bell-push. Joseph Henry Hilliar, 94, Gore-road, South Hackney, London.

21040. Improvements in or connected with electric arc lamps. Frederick William Edward Schuer, 4, South-street, Finsbury, London.

21042. Improvements in and relating to electric arc lamps. Edwin Rudolph Grote and Milton Victor Ely, Palace-chambers, Westminster, London.

21043. Improvements in alternating-current electric motors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

21045. Improvements in single-phase dynamo-electric machines. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

OCT. 1.

21081. Improvements in or connected with magnetic separators for ores or the like. John Thomas Dawes, 4, Clayton-square, Liverpool.

21131. Improvements in automatic electric switching devices applicable to flash advertising signs and the like. Percy Benson Harrison Seabrook and Henry Herbert Parkes Seabrook, 322, High Holborn, London.

21132. Improvements in and in the arrangement of switch-gear for electrical driving. William Phillips Thompson, 6, Lord-street, Liverpool. (Louis Dill, Germany.)

21135. Improvements in or relating to fuses for electric circuits. Alfred Richard Pritchard and Robert Whipp, 6, Lord-street, Liverpool.

21138. New or improved electromagnetic therapeutic apparatus. Emile Bachelet, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 2, 1903, being date of application in United States.) (Complete specification.)

21144. Improvements in electric lighting of trains. Henry Leitner and Richard Norman Lucas, Lynton, Dartnell-park, Byfleet, Surrey.

21145. Improvements in means for automatically controlling electric circuits. Henry Leitner, Lynton, Dartnell-park, Byfleet, Surrey.

21146. Improvements in accumulator plates. Henry Leitner, Lynton, Dartnell-park, Byfleet, Surrey.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 20, 1904.

1903.

14269. Electrical fire-alarms and other electrical signalling systems. Pulford.

14299. Electrical telegraph apparatus. Braun.

18251. Processes of insulating coils. Carolan. (General Electric Company.)

18319. Electric battery jars. Ford-Lloyd.

21027. Electricity meters. Hamilton.

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21362. Automatic telephonic installations. Kugelmann.

21384. Magnetic separators for ores or the like. Dawes.

21652. Form of electric accumulator or secondary battery. La Croix.

21861. Simultaneous telegraphy and telephony. Sayers and Holt.

22909. Dynamo-electric machines. Carolan. (General Electric Company.)

22912. Dynamo-electric machines. Carolan. (General Electric Company.)

24142. Regulating means for mercury, vapour, or like electric lamps. Levis. (Davis.)

24283. Electric switch with indicator. British Thomson-Houston Company, Limited. (General Electric Company.)

24285. Electric switches. British Thomson-Houston Company, Limited. (General Electric Company.)

24286. Double-throw electric switch with indicator. British Thomson-Houston Company, Limited. (General Electric Company.)

24806. Process for the electrolytic manufacture of peroxides of magnesium and zinc. Hinz.

25381. Circuit breakers and closers especially suitable for the transmitting instruments used in wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Gray.

25577. Electric arc lamps. Davy.

25658. Coin-freed mechanism especially applicable to prepayment gas or electricity meters. British Thomson-Houston Company, Limited, and Holden.

25849. Electric rheostats. British Thomson-Houston Company, Limited. (General Electric Company.)

25853. Insulating material for electric conductors. British Thomson-Houston Company, Limited. (General Electric Company.)

25969. Safety device for use in electric traction on the contact-stud system. Griffiths and Bedell.

25990. Electrical brush-holders. Mavor, and Mavor and Coulson, Limited.

26842. Electric automatic cut-outs or switches. Crompton and Co., Limited, and Hodgson.

26843. Arc lamp suspension apparatus. Crompton and Co., Limited, and Hodgson.

1904.

26. Electric fuses for blasting purposes. Curtis and Harvey, Limited, and Malson.

1851. Apparatus for obtaining a flow of electric current in one direction from an alternating-current source. Hewitt. (Date applied for under International Convention, Feb. 3, 1903.)

4487. Process and apparatus for the manufacture of sulphate of copper and caustic alkalies by the electrolysis of alkaline chlorides. Granier. (Date applied for under International Convention, April 6, 1903.)

9008. Self-registering electrically-operated sectional targets. Peters.

13216. Telephone exchange systems. Aitken.

15452. Systems of electrical distribution. Peck. (Date applied for under International Convention, Aug. 8, 1903.)

15732. Electric light fittings. Veritys, Limited, and Sothcott.

16205. Electric furnaces and the extraction of zinc by means of the same. Edelmann and Wallin. (Date applied for under International Convention, July 23, 1903.)

16894. Apparatus for electrically indicating the position of railway signals, points, or other gear. Siemens Bros. and Co., Limited, and Ferreira.

17527. Commutators for dynamo-electric machines. Siemens Bros. and Co., Limited, and Berry.

17879. Spring terminal clips for electric conductors. Schade. (Date applied for under International Convention, Oct. 29, 1903.)

18342. Electric incandescent lamps. Phelps.

18343. Electric incandescent lamps, connections, and switch mechanism therefor. Phelps.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	½-⅝
Ason Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	½-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5¼-6
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	—	2⅞-3¼
—— 4 per cent. Mortgage Debenture Stock	100	—	86-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	—	½-¾
—— Non. Cum., 6 per cent. Pref.	2	—	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	—	94-97
—— 4½ per cent. 2nd Debenture Stock	100	—	70-75
Callender's Cable, Debentures	100	—	101-105
—— Ordinary	5	—	8¼-10¼
—— 5 per cent. Pref.	5	—	5-5¼
Crompton and Co.	3	—	1¼-2
—— 5 per cent. Debentures	100	—	90 95
Edison and Swan United, "A" Shares, 1-99,261	3	—	½-¾
—— "A" Shares, 01-017,139	5	—	1-1¾
—— 5 per cent. Debentures	100	—	78-83
—— 4 per cent. Deb. Stock, Red.	100	—	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1-1¼
—— 7 per cent. Cumulative Pref.	2	—	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	—	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	—	91-95 xd
W. T. Henley's Telegraph Works, Ordinary	5	—	10¼-11¼
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	19-20
—— 4 per cent. Debentures	100	—	99-103 xd
Parker, Thos., Limited, Ordinary	10	—	10-10¼
Telegraph Construction and Maintenance	12	—	35-38
—— 5 per cent. Bonds	100	—	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	—	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	10¼-11¼
—— 4½ per cent. Debenture Stock. Red.	100	—	103-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	101-104
Brompton and Kensington, Ordinary	5	—	10⅜-11¼
—— 7 per cent. Preference	5	—	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	7¼-8
—— Nos. 20,001-30,000	5	—	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	—	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	—	107-110
Charing Cross and Strand, Nos. 1-70,000	5	—	8 8¼
—— 70,001-80,000	5	..	7¼-8
—— 4½ per cent. Cum. Pref.	5	—	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	4¾-5
—— 40,001-80,000	5	—	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	—	103-106
Chelsea Electricity Supply	5	—	6¼-7
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	—	10¼-10⅝
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	102-105
County of London Electric Supply, Ordinary	10	—	8-9
—— 6 per cent. Cum. Pref.	10	—	11¼-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	101-104
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	—	6-6¼
—— 6 per cent. Cum. Pref.	5	—	6-6¼
—— 4½ per cent. First Mort. Deb.	100	—	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-50,000	5	—	1¼-2⅛
—— 5 per cent. Debenture Stock, Red.	100	—	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	—	5¼-6 xd
—— 4½ per cent. First Deb. Stock, Red.	100	—	101-104
Havana Electricity, Limited, 1-15,000	10	—	9¼-10¼
Hove Electric Lighting, Limited, Ord., 1-15,000	5	—	7¼-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	—	101-105
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	—	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-91,000	5	—	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	—	100-103 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9⅜-10¼
London Electric, Ordinary	3	—	1⅜-2¼
—— 6 per cent. Pref.	5	—	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	97-100
Metropolitan Ordinary	10	—	15⅜-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-115
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	—	86-89
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	—	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	—	98-101
—— Preference	4	—	100-103
Notting Hill Electric Lighting	10	—	14¼-15¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	99-102 xd
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510	5	—	5⅜-6¼
—— 4 per cent. Debenture Stock	100	—	99-102
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	—	93-101 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2⅜-3¼
—— 4 per cent. Debenture Stock	100	—	83-87
South London, Ordinary	—	—	4¼-4⅜
South Metropolitan Electric Light and Power Co., Ord.	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	..	104-108 xd
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-30,080	5	—	14¼-15¼
—— 7 per cent. Pref.	5	—	8-9
—— 3½ per cent. Deb.	100	—	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	—	4¼-5 xd
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	4¼-5 xd
Westminster, Ordinary	5	—	12¼-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	—	5-5¼
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	—	5⅛-5⅜
—— Ord.	5	..	6¼-6⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	139-142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	100-102
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld., Pref. Ord. Shs., 75,001-150,606	1	..	½-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	¾-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	—	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	—	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	86-101
British Columbia Electric Railway Co., Ord. Def.	100	—	97-100
—— Ord Pref.	100	..	100-105
—— Non. Cum. 5 per cent. Pref.	10	—	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	—	104-106 p.e.
—— 4½ per cent. Vancouver Power Deb.	100	—	97-100
British Electric Traction Ord., 1-300,000 & 50,001-80,000	10	—	9¼-10
—— 6 per cent. Cm. Pf., 50,001-80,000	10	—	10⅜-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	115-118 xd
—— 4½ per cent. 2nd Deb. Stock	100	—	94-97

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	–	3⅜-3⅝
—— "A" 5 per cent. Cm. Pf., 1-40,000	5	–	5½-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5-6½
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	102-105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	94-99
Calcutta Tramways, Limited, 1-102,268	5	..	7-7⅜ xd
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways, Nos. 1-480,000	1	–	1⅛-1¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9¼-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100	–	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000	5	–	3¼-4
—— 4 per cent. Debenture Stock	100	–	88-91
Kidderminster and District Lighting and Traction, Pref.	5	–	8 8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10½-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	5/16 5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¼-1
—— 4½ per cent. Deb. Stock, Red.	100	..	99-101
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	0	-	½
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100	–	88-93

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12-12½
—— 5 per cent. Cum. Pref.	10	–	9½-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	–	102-105
Potteries Electric Traction, Ordinary 20,001-40,000	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8¾
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,132 6 per cent. Preference	1		1
—— £628,093 4½ per cent. Debenture Stock	10	c. –	100 p.c.

Electric Railways.—

Central London, Ordinary	100	–	87-90
—— 4 per cent. Pref.	100	–	100-102
—— ,, ,, deferred	100	–	79-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid).	100	–	107-110
City and South London, Consolidated Ordinary	100	–	47-49
—— 4 per cent. Debenture Stock	100	–	105-108
—— 5 per cent. Pref. Stock '91	100	–	122-125
—— ,, ,, ,, '96	100	–	117-120
—— ,, ,, ,, '01	100	–	113-117
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10½
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	..	98-98½
Waterloo and City, Ordinary	100	–	86-89

Telephones.—

National Telephone, Preferred	100	–	104-106
—— Deferred Stock	100	–	92-94
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅝
—— ¼ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	104-106
—— 4 per cent. Prov. Cert.	–	..	67-69
Ottoman Telegraphs and Electric Company	1		15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1¼-1¼

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 24	1,451	1,243	+ 203	+27,518h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	July 11	360	359	+ 1	—	8	8	,, 15	14,160	3,201,586	316,049	1·03	10·11	1,770	5·04
Barking Corporation	Oct. 1	43	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 2	1,078	1,167	– 89	—	23·33	23½	March 31	56,073	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Tramways	,, 1	5,755	5,476	+ 279	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	Sep. 23	1,014	8 9	+ 65	+ 2,514	24	23	,, 25	43,374	7,742,692	951,484	—	10 94	—	4·59
Blackpool Corporation	Oct. 1	1,512	1,113	+ 399	+ 5,375	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	Sep. 5	1,463	1,368	+ 95	– 40	16½	16½	Dec. 31	32,021	2,258,981	600,757	3·34	12·75	2,001	7 05
Bolton Corporation	Oct. 2	1,844	1,872	– 28	—	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·22	3,766	5·89
Bournemouth Corporation	Sep. 28	1,136	1,120	+ 16	+ 1,804	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 24	4,774	4,049	+ 725	+ 21,643	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	Oct. 2	1,017	948	+ 69	+ 3,013h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 1	5,017	5,220	– 203	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 1	1,124	829	+ 235	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 4	345	418	– 73	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·81	1,570	7·57
Cardiff Corporation	,, 1	2,065	2,059	– 3	+ 1,852	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 1	2 2	215	– 13	+ 274	—	—	Dec. 31g	9,937	2.805,277	334,393	—	7·17	—	—
Central London Railway	,, 1	6,473	6,183	+ 290	– 828h	6	6	,, 31	362,471	44,933,938	1,292,674a	1·87	64 87	58,229	35·60
City & South London Railway	,, 2	2,515	2,544	– 29	– 1,131h	6¼	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	Sep. 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Oct. 1	512	550	– 48	– 2 408	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 1	233	228	+ 5	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·66	1,707	9·36
Dover Corporation	,, 1	236	249	– 13	– 283	4½	4½	,, 31	11,255	2,871,332	280,901	0 91	9 63	2,503	—
Dublin & Lucan Electric Ry.	,, 1	125	138	– 13	— h	7	6¼	Dec. 31g	6,231	688,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 1	3,927	4,119	– 192	} —	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 1	924	938	– 64											
Dundee City Tramways	Sep. 28	882	937	– 55	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Oct. 1	698	577	+ 121	+ 1,530	10·77	10·75	March 31	34,312	12,950,289	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 1	15,776	15,667	+ 109	+ 1 915h	145	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	Sep. 21	342	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 21	3,162	2,815	+ 347	+ 3 381	33	30½	March 31	68,283	16,322,054	1,387,885	1·0	11·79	2,0·9	8 77
Huddersfield Corporation	Oct. 1	1,552	1,229	+ 323	+ 2,751	35	35	,, 31	65,545	11,893,287	1,652,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 1	2,131	1,906	+ 224	+ 7,735	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 1	430	436	– 6	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	Sep. 28	148	181	– 33	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 28	216	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Oct. 1	5,856	6,111	– 255	+ 9,923	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	Sep. 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 24	10,684	11,072	– 388	+12,214	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	Oct. 2	1,538	1,672	– 134	– 855h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 1	13,641	10,916	+2,725	—	46½	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 1	212	231	– 19	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 1	165	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 1	12,585	12,137	+ 448	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 1	1,913	1,341	+ 572	+ 6,257h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 1	123	98	+ 25	+ 1,081	2½	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 1	3,940	3,685	+ 255	—	45	38½	,, 25	135,027	39,715,120	4,059,907	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	Sep. 24	498	510	– 11	+ 1,277	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	July 23	2,492	2,026	+ 466	+ 3,051	29	29	,, 31	91,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	,, 11	179	165	+ 14	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·68
Rotherham Corporation	Oct. 1	449	521	– 72	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	Aug. 8	4,242	4,066	+ 176	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	Oct. 1	163	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 4	4,691	4,865	– 174	+ 2,709	34½	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	Sep. 22	1,048	1,095	– 46	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 21	443	384	+ 59	+ 1,205	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 23	625	411	+ 214	+ 6,481	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	Oct. 2	1,216	1,218	– 2	+ 390	19·51	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10 46	—	6·08
Swindon Corporation	,, 1	312	—	—	—	3¼	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 1	744	705	+ 38	—	10·5	10·5	,, 31	35,873	6,564,493	757,688	1·31	11·36	3,415	7·65
West Ham Corporation	Sep. 29	1,120	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 28	712	464	+ 248	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·006	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
j Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Electro-Harmonic Society.—The society inaugurates its season to-night in the King's Hall, Holborn Restaurant, with a concert of which we gave particulars last week. Mr. J. S. Raworth will take the chair at eight o'clock.

Institution of Mechanical Engineers. — This institution opens its session on the 21st inst., when Mr. R. M. Neilson will read a paper entitled "A Scientific Investigation into the Possibilities of Gas-Turbines." The dates of other general meetings are as follows: Nov. 18, Dec. 16, Jan. 20, Feb. 17 (annual general meeting), March 17, and April 14. The anniversary dinner is fixed for April 13. Graduates' meetings will be held on the second Monday in each month.

New Publications.—"The Testing of Continuous-Current Machines," by C. Kinzbrunner (London: Harper Bros. 6s.); "Electric Furnaces and their Industrial Applications," by J. Wright (London: Archibald Constable and Co. 8s. 6d.); "Smoke Prevention and Fuel Economy," by W. H. Booth and J. B. C. Kershaw (London: Archibald Constable and Co. 6s.); "Electric Lighting for the Inexperienced" (the Wallet Series of Hand-Books), by H. Wallet (London: Edward Arnold. Paper 1s., cloth 2s). We learn that Messrs. F. H. Parshall and H. M. Hobart have in hand a new and important work on electric traction of an exhaustive nature, which will shortly be published by Messrs. A. Constable and Co.

Pyroradioactivity.—Mr. T. Tommasini contributes a paper on this subject to the *Arch. Sci. phys. nat.* Metals, when heated by an electric current, become radioactive and are capable of discharging electroscopes, etc. All the metals emit rays capable of discharging either electrification, but the difference between the two actions is generally very great. Iron, copper, and platinum produce a more rapid discharge of negative electrification, whilst for silver and zinc the opposite is the case. If the current increases, however, the difference between the two effects tends to disappear, and at bright incandescence the metal discharges both electrifications almost equally. The radioactivity of a metallic thread heated to redness by a current diminishes along an asymptotic curve, but its power is regained by rest for some time, or by light friction. When the radioactivity has become weak it continues for some time after the heating of the current, but is lost if the wire is struck. A mantle of glass or aluminium surrounding the wire also becomes radioactive. Three types of emissions exist: the α, easily arrested by screens, the β, more penetrative, and the γ, which discharge either electrification, induce fluorescence, etc. They are, however, less penetrative than the γ-rays of radium.

Wireless Telephony.—Experiments in wireless telephony have lately been conducted by a naval man in Monmouthshire. As the invention has not yet been patented a detailed description is not available, but the reports concerning it do not err on the side of pessimism. It is proposed that the receivers and transmitters shall consist of three classes—first, long distance; second, medium distance; and third, short distance. For short distances the inventor states that a dynamo is neither necessary nor desirable, as it destroys the tone of the voice. He found that eight ordinary cells with a good coil would carry the voice over five miles of sand, so as to be quite audible and recognisable. For 10 miles he uses 12 up to 20 cells, but no dynamo. For very long distances greater power would be required, and a small dynamo necessary. It is further stated that for land messages a central station would not be needed except under certain conditions, and that the tall poles used in wireless telegraphy would also be unnecessary. The apparatus is reported to have operated with considerable efficiency at 10 miles, the limit of the experiments, but the inventor expresses confidence that the system can be used for long distances.

Rontgen Rays in Cable Factories.—It has been known for some time that Röntgen rays could be advantageously employed in connection with cable testing, and a portable apparatus suitable for the purpose has, according to the *Elektrotechnischer Anzeiger*, been put on the market recently by the Elektricitäts Gesellschaft Sanitas of Berlin. The object in view is the detection of impurities, air bubbles, etc., in the insulating covering of the cable during manufacture. The apparatus consists of a case mounted on an iron frame on wheels and containing the induction coil and condenser. The whole can be readily moved about by means of the handles provided. One side of the case is removable, to permit the interrupter and the motor working it to be easily inspected. A switch panel is also fitted containing two fuses, adjustable resistances for varying the speed of the interrupter motor, and for altering the primary current and main switches for the motor and for the induction coil. A framework is fixed over the top of the case and carries two roller guides for the cable under test. Beneath these guides the Röntgen tube is held in a wooden clamp, and above them an adjustable fluorescent screen is fixed. As the cable is drawn past any irregularities in its structure are reproduced on the screen. By enclosing the screen in a light-proof covering the test can be readily carried out without darkening the room in any way

Personal.—We hear that Mr. A. W. Heaviside, I.S.O., M.I.E.E., first president of the Newcastle-on-Tyne Section of the Institution of Electrical Engineers, has retired from the position of superintending engineer under the Post Office, having taken advantage of the age limit. We are pleased to note that Mr. Heaviside has come to London, and that in future his address will be 12, Tring-avenue, Ealing Common, W. Of the work done by this engineer at Newcastle we have a very high opinion. In telegraph work Mr. Heaviside was responsible for the development of the telegraph system in the North-East of England. For many years he enjoyed the distinction of being practically the only telephone engineer in this country who controlled a fairly large exchange not belonging to the National Telephone Company, which he developed on the Bridge system (which he invented, and also secured privacy). As Mr. Heaviside is undertaking consulting work, his experience will be now at the disposal of anyone who may wish his advice either in telephone matters or in electric lighting undertakings. The work carried out under Mr. Heaviside's control when the first station of the Newcastle-on-Tyne Electricity Supply Company was constructed was also of a pioneering nature, and his control of that undertaking as consulting engineer lasted for a large number of years.

Electric Railway Practice.—The opinion expressed by Mr. Philip Dawson in "Modern Electrical Practice," that the third rail will become obsolete in a few years, receives confirmation from Prof. S. P. Thompson, who contributes the following to the daily Press: "In view of the numerous fatal accidents which have occurred at the 'live rails,' lately laid down for electric propulsion on some of our railways, the public is naturally beginning to ask for something more than a makeshift protection. Unfortunately, neither the public nor the not-electrically-trained railway engineers appear to realise that the 'live rail' is itself already an obsolete device, discarded in the latest types of electric railway. In 10 years' time there will probably be no 'live rail' left. I am no lover of overhead wires or

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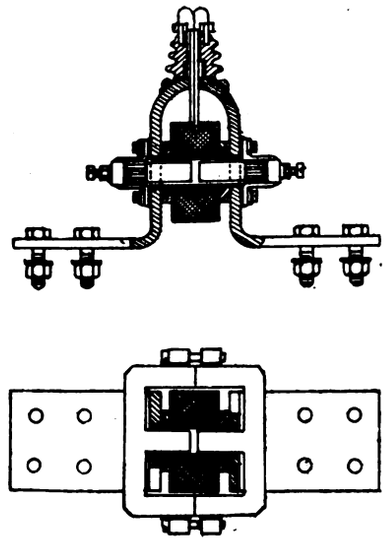
conductors in places such as our city streets, where they endanger the public; but if there is one situation where overhead conductors can be placed and maintained safely, that situation is over a railway, particularly an underground railway. Already the 'live rail' has been discarded in at least two places in the United Kingdom. It is an engineering blunder. I would therefore ask whether the time is not ripe for public opinion in some effective form, such as a departmental enquiry, to step in and prevent the railway engineers in England from committing our railway systems any further to this dangerous and unnecessary device."

Glasgow Technical College.—The Scientific Society of this college opens its thirteenth session on the 15th inst., when Mr. R. D. Munro will deliver his presidential address. The following is the programme for the season: Oct. 15, presidential address, by Mr. R. D. Munro, M.I.Mech.E.; Oct. 29, "The Law of Workmen's Compensation," by Mr. W. Boyd Anderson; Nov. 12, "The Diesel Internal-Combustion Engine, as applied to Electrical Generation," by Mr. A. J. Lawson; Nov. 26, "The Electrical Drive of Large Reversing Engines Working Intermittently," by Mr. Maurice Georgi; Dec. 3, symposium; Dec. 10, "Electro-metallurgy—Some Notes on its Present Position," by Mr. John D. Mackenzie; Dec. 17, thirteenth anniversary dinner; Jan. 21, "Notes on Toolroom Organisation and Practice," by Mr. George Blair; Feb. 4, "Kathode Rays and Allied Phenomena," by Prof. Blyth; Feb. 18, "High-Speed Tool Steels from the User's Point of View," by Mr. E. H. Robertson; March 4, "Steam-Generators and their Failures," by Mr. George Ness; March 18, "Independent Condensing Plant," by Mr. Charles Day; April 1, annual general meeting. At the annual general meeting it was agreed that the annual subscription for members be increased from 5s. to 7s. 6d., and for student members from 2s. 6d. to 5s., to enable the society to undertake the publication of papers. The council trust that this development will receive the hearty and united support of all members.

Dundee.—Reference has already been made in these columns to the practice of certain customers who generate power for themselves in using the municipal system merely as a stand-by after the Corporation have incurred considerable expense for equipment. The authorities appear to have now realised the position of affairs, and have given a general approval to the report presented by Mr. H. Richardson, the borough electrical engineer, last week, in which he recommends that the Corporation should follow the example of other towns, and obtain the insertion of a clause in their Act to the effect that no person having a separate supply should be entitled to obtain energy from the Corporation unless he agreed to take a reasonable minimum—say £7 per kilowatt per annum, which represents an approximate average of the terms prevailing in other towns. Apparently the Corporation have not at present decided to apply for the inclusion of such a clause, but Mr. Richardson has been instructed to negotiate with the customers coming under this head upon the lines indicated, so that the authorities have presumably awakened to a sense of the fatuity of giving a supply merely as a stand-by. We notice, by the way, that the Corporation have decided to substitute modern cables for the copper strips in their lighting distribution system. This will entail an expenditure of about £3,000, and is expected to result in materially increased efficiency.

The Telegraph, Telephone, and Cable in War.—This subject was treated in a paper read before the International Electrical Congress by Major S. Reber, of the U.S. Army, and we are indebted to the *Electrical World* for the following abstract of same: "The use of electrical means of communication is now absolutely necessary to success in war, not only in the grand strategical combinations of a compaign, but also in the varying technical situations on the field of battle. The development of the use of the means of communication in war has been along lines similar to those of commercial practice. The engineering principles are the same, but the operative conditions are more exacting and difficult. The essential requirement is absolute certainty of service, independent of dictates of economy. The service of communication is separated into field and fortress work. The fortress system consists of the permanent lines, usually underground, the details of which are zealously preserved as Government secrets. For armies operating in the field a complete chain of communication should exist from the outposts to the main base of operation. By the use of light field cable and bare wire a detached cavalry column can be connected during its movement with the main body. The paper contains an historical sketch of the use of electrical means from 1839 down to the present time. The part played by the cable in the history of recent years has completely proved that its *rôle* is scarcely inferior to those of the military and naval forces themselves. In the war of the future between two naval powers, the result will depend largely upon coal and cables."

Transformer Exhibits.—The detailed construction of the Siemens and Halske transformers exhibited at St. Louis is shown in the accompanying illustration, which we



reproduce from the *Electrical World* of New York. These transformers are used in connection with the firm's recording instruments in the cases of very heavy alternating currents The plane of winding of the secondary coil is at right angles to the primary current loop, and this transformer gives results independent of frequency, and uninfluenced by neighbouring currents. The exhibit also includes a number of potential transformers, which are built as high as 30,000 volts, for use in testing high-tension apparatus.

Electrical Club for Birmingham.—The proposal to form an electrical club for Birmingham, concerning which we published a communication from Mr. W. Dalby last week, looks like bearing fruit. A meeting was held at the Colonnade Hotel on Saturday night, when Mr. J. W. Innis presided over a gathering representative of the Post Office Telegraph Branch, the National Telephone Company, Municipal Technical School, Midland Railway Telegraph Department, and the electrical trade. The chairman stated that for some considerable time a feeling had existed amongst the allied workers in the electrical trade that a club or institute should be formed, the membership of which it was proposed should be confined to those engaged in the manufacture and use of electrical apparatus and machinery in all its aspects. It was thought that a club of

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the character suggested would be of considerable value to the members engaged in the trade. The basic principle would be mutual, social, and intellectual help to its members. Several speakers expressed the opinion that the social side should be developed to its fullest extent, and that the subscription should not be prohibitive to the ordinary worker. After some discussion, the following resolution was unanimously adopted: "That a committee consisting of seven be appointed to consider the advisability of promoting an electrical club, and to present a report at a subsequent meeting." Messrs. J. Innias (consulting electrical engineer), W. H. Whitehouse and W. Smith (Municipal Technical School), E. R. Wood (electrical engineer), H. W. Dipple (National Telephone Company), M. G. Waggot (Post Office), and W. Dalby (Midland Railway) were appointed a committee to give effect to the resolution.

Durham College of Science.—The annual report was presented last week to a meeting of the governors. During the past session there was a record entry of first-year students, but owing to a slight falling-off of second-year students, the total was reduced from 513 to 507, notwithstanding which the amount received in fees reached £8,170—the highest in the history of the college. A regrettable diminution is noticeable in the number of colliery engineers and miners who attended the special Saturday lectures. The corner-stone of the final section of the college was laid in the course of the year, and the subscriptions for the completion of the buildings have reached over £30,000. The report observes that one of the most anxious concerns of the executive must now be the formation of an endowment fund to secure and ultimately to increase the emoluments of the teaching staff. A benefactor has presented £1,000 as a nucleus of such a fund, and it is hoped that other donations will speedily follow. The executive have urged the claims of the college upon the Government and the local authorities, and in February last an influential deputation of colleges attended upon the Treasury, with the result that the Chancellor of the Exchequer made a substantial increase in the grants, which may be further enlarged this year. The expenditure for the year, including £14,077 for salaries and fees of staff and examiners, amounted to £20,759, leaving a deficit of £1,182. Lord Armstrong, Dr. Hodgkin, and Mr. R. Redmayne were re-elected to the council, to which Mr. C. Cochrane, Sir Andrew Noble, the Hon. C. A. Parsons, and Mr. G. E. Henderson were also appointed. The name of the institution has been changed to "Armstrong College, Newcastle-upon-Tyne, in the University of Durham."

Goods Traffic.—The Vice-Chairman of the London County Council Highways Committee, interviewed the other day in reference to Mr. Bellamy's suggestion that tramways should be used for bringing agricultural and dairy produce into the towns, remarked: "London is not ready yet for its trams to be used to carry agricultural produce, but I believe we are bound to see something of the kind in the immediate future." At the present time such a scheme is not feasible, for the simple reason that the cars do not penetrate far enough; but with the network of tramways that will ere long connect the Metropolis with rural districts in all directions, the proposal may come within the sphere of practical economics. Of course, it will be a question at first of negotiations between the outside authorities and the County Council. This will be necessary in order to secure through services for passengers. Then as the vice-chairman proceeded to point out, it would be no use to bring market produce to the present termini, as that would entail goods brought to Covent Garden from, say, Kent being unloaded at the bridges. This provides an additional reason for sanctioning the Council's application for power to extend their system over the river. While, however, the suggestion offers a prospect of a substantial load factor during the night, the Council are prudently devoting their energies at present to mastering the intricacies of passenger traffic. Mr. Bellamy's idea may bear fruit earlier at Glasgow, where the Corporation contemplate instituting municipal cemeteries, in connection with which it is suggested that the Tramway Committee should make arrangements for accommodating the cortège. This sombre method of increasing the revenue of tramway undertakings is common among our Transatlantic cousins.

The Alternating-Current Theory of Transmission Speed over Submarine Telegraph Cables.—In a paper presented to the International Electrical Congress, Prof. A. E. Kennelly remarks that the law of cables enunciated by Kelvin in 1855 has been found inapplicable to overhead land-line telegraphy and telephony, and the working theory of telephony has therefore grown up independently of that of submarine cables—an unnecessary and unnatural division. If, however, the theory of alternating-current transmission can safely be extended to include the case of signalling over submarine cables, then the same theory can readily cover every case of signalling over wires. Such a theory can be made not only very comprehensive, but also very easy. The paper outlines this application of general alternating-current theory to submarine telegraphy. In dealing with power transmission circuits operated at ordinary commercial frequencies below 100 cycles per second, a simple solution is reached by placing all the capacity in a lump at the centre of the circuit; and the results are sufficiently accurate for practical purposes. For higher frequencies, however, such as are presented in telegraphy and telephony over long circuits, the method of lumped capacity is usually unreliable, and hyperbolic formulæ must be resorted to if simple expressions and arithmetic are desired. Hyperbolic trigonometry is, therefore, the natural and simple key to the solution of the problem. The theory is worked out on this basis and shows that the highest speed is obtainable from a given laid cable by placing a large condenser at the sending end, impressing the assigned maximum E.M.F. on the sending end, and making the impedance of the receiving instrument (assumed of maximum sensitiveness in construction) equal to the sending end impedance, but with the opposite angle.

Alternating-Current Motors.—A paper on this subject was presented by Mr. C. P. Steinmetz at the International Electrical Congress opened at St. Louis on the 12th ult., a summary of which is given in the *Electrical World*. The paper gives a mathematical discussion of all standard types of alternating-current motors—synchronous, induction, and commutator motors. Under induction motors the polyphase, single-phase, and single-phase condenser motors are treated, while of the commutator motors the polyphase shunt, polyphase series, plain single-phase series, inductively and directly compensated series (Eickemeyer, Steinmetz, Lamme), repulsion and compensated repulsion (Latour, Winter-Eichberg) motors are discussed at great length. The author treats the general alternating-current commutator motor as a machine consisting of two field coils in quadrature and two sets of brush circuits, also in quadrature, and derives general equations for expressing the E.M.F. in each circuit. The various types of motors differ according to in which circuits the impressed E.M.F. is zero (short-circuited), and in which circuits the current is the same (series connected). The treatment is essentially more complete than any previously given, since the short-circuit of the brush is taken into consideration. It is shown that of the various machines the repulsion motor possesses the highest starting torque and the most

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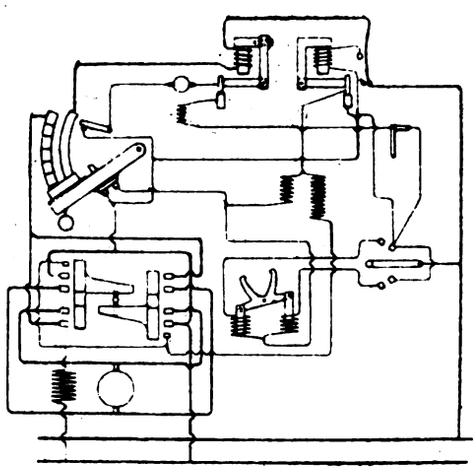
rapid decrease in torque and power with increase of speed, and reaches zero torque and power at a definite speed. The single-phase series motor shows the lowest torque in starting, the highest at high speed—that is, its torque decreases least with increase of speed, so that in the case illustrated it almost approaches a constant torque motor. The compensated motor is intermediate between the repulsion and the series motor, but rather nearer to the former at low and to the latter at high speeds—that is, its torque is high at starting and at low speeds, but does not fall off as rapidly at high speeds as that of the repulsion motor. The repulsion is a low-speed motor, the series a high-speed motor, while the compensated motor is intermediate between the repulsion and series motors.

Regulation of Motors.—A patent has been obtained in the United States by Mr. G. Rennerfelt for an electric motor provided with an automatic regulator adapted to successively increase the speed of the motor, in combination with an acceleration controller connected to and driven by the motor and adapted to stop the regulator when the acceleration rate exceeds a predetermined limit. An account of this invention is given in the *Electrical Review* of New York, and is accompanied by a diagram, which we



reproduce. The inventor has in view the prevention of damage to motors from the current having been switched through in excessive quantities, particularly when the motor is carrying or moving a relatively heavy load, and also to obviate greater acceleration in starting than may be desired. A pilot motor is used for intermittently moving the regulator, its movement being stopped when the starting current exceeds a predetermined limit, and also when the acceleration rate exceeds a predetermined limit, and means are provided whereby both of these limits can be easily adjusted, so that the same apparatus may be used for motor installations with varying requirements. The objects of the invention are thus summarised: the prevention of an abnormal flow of current through an electric motor upon starting the same; the prevention of abnormal speeding of an electric motor upon starting the same; the provision of an arrangement for automatically rupturing the current flow through an electric motor in the event of overheating; to devise apparatus in which all the aforesaid three objects will result automatically, and in which the manual operation shall be limited to the closing of a single electrical contact; and to so arrange the apparatus that a minimum amount of energy will be wasted in its operation.

Transformer Decision.—The United States Circuit Court of Appeals recently delivered its decision in the case of the Westinghouse Electric and Manufacturing Company *v.* Stanley Instrument Company, reversing the judgment of the court below, which dismissed a suit to prevent alleged infringement of patents issued to Nikola Tesla relating to the conversion of alternating currents, on the ground that the plaintiff company had failed to establish a conception of the invention by Tesla prior to April 22, 1888, the date of a certain publication in Italy known as the Ferraris publication. The contention of the defendant company was that the Tesla patent was not directed to the utilisation of two-phased currents in a motor, but to a new way of producing the necessary two out-of-phase currents; that this specific way of producing two out-of-phase currents was old and well known in the art, and was old and well known as an equivalent of the method in a prior patent; that all the methods of producing two or more out-of-phase alternating currents set out the Tesla patents were, in and of themselves, old and well known in the art as means and methods of producing such out-of phase currents; and that their laws and limitations had been known and set out in a way not even approximated in accuracy or fulness in any of the Tesla patents. They further maintained that the feature of the Tesla patent involved merely the substitution of one means of obtaining two-phase currents for another means, which two means were old and well-known equivalents. In regard to this contention, the Court says: "Of course, all this was with the purpose of maintaining that there was no invention in any view of the patents now in issue. It unavoidably concedes, however, that, if there were invention, it was fundamental. When under special circumstances a particular practical application of a known principle proves to be of advantage in the arts, and yet the thought of making it had not occurred to those expert therein, such application, at times, involves invention. The corollary of this proposition is that, in cases of this character, where the originator has boldly struck out into a practical application, and stated it, though only in general terms, he has, for the most part, made his conception clear, even though the mechanical details have not been expressed or thought out. Therefore Prof. Main was right in testifying that, if Tesla made clear his conception in a general way, he made clear his invention, leaving the artisan skilled in electrical science to work out the practical details required in applying what was previously within the bounds of philosophical knowledge."

New Trolley Apparatus.—The ordinary trolley apparatus being quite unsuited to the San Francisco, Oakland, and San Jose Railway system, Mr. J. Q. Brown, the engineer-in-charge, devised a new type, an account of which is given by the *Scientific American*. The conditions were of an exacting character. This company operates trains up to eight-car formation, weighing, approximately, 350 tons, at speeds as high as 50 miles per hour, which require at times 2,500 to 3,000 amperes to be collected from the overhead conductor. A device was required that would operate at high speed on curves without leaving the wire in any direction. It was also requisite that it should have a range of not less than 6ft. in height for passing through subways and over surface railroad crossings. The apparatus consists of a double diamond iron frame made up of four conjoined frames. These are connected on each side by elongated joints to give stiffness, while at top and bottom the frames terminate in segmental gears. The gears at the bottom cause the side frames to move in unison, while the gears at the top keep the guards always in a vertical position, as shown. The roller is carried at the top on a shaft, the ends of which are fastened rigidly in a casting to which the guards are secured and on which pivot the segmental gears. The roller is made of 24in. of 5in. non-arcing metal tubing with hubs in each end, which have graphite bushings forming the bearing. The bearings are lubricated with oil carried in a cavity in the hub. The guards, which are

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essential to the satisfactory operation at branch-off wires, are made of sheet steel pressed into the required shape. The arrangement of the tension springs, which keep the roller in contact with the overhead conductor, is worthy of notice. The springs are in practically the same plane as one side of the bottom frame. This arrangement gives practically a uniform upward pressure on the roller for all positions of the trolley wire, those now in use operating with a pressure of 24lb. Two trolleys are used on each train of two or more cars, as such an arrangement always ensures a continuous and low-resistance circuit to the motors. It has been found that this apparatus simplifies the overhead construction greatly, doing away with all trolley frogs and switches except at right-angle crossings, where a simple crossing of special design is used. The wear on the trolley wire is less than that caused by the ordinary wheel, and the life of the roller which is used is not known, as the original rollers are still in service after a year's use. These wear to a bright smooth surface, instead of being corrugated or pitted, as was expected. The device is practically noiseless, the rollers being packed with non-resonant matter to destroy the vibration. It is stated that the company, which has 26 of these trolleys in use, has found them work perfectly, and another railway has arranged for a similar installation.

Preparation and Electrolysis of Pure Molten Zinc Chloride.—A description of the tests conducted by Mr. Siegfried Grünauer appears in the *Zeitschrift fuer anorganische Chemie.* When commercial zinc chloride is heated until the evolution of steam is no longer perceptible and then electrolysed, either in a crucible over a free flame or in a U-tube, hydrogen is evolved at the cathode, the amount of hydrogen gradually diminishing until finally only zinc separates. As various specimens of commercial zinc chloride exhibit different behaviour on being electrolysed, the author has studied the conditions for the preparation of pure zinc chloride. The experimental conditions under which the various specimens of zinc chloride were electrolysed are very fully described. Those specimens which were readily electrolysed were found to contain ammonium chloride, and the influence of ammonium chloride on specimens of zinc chloride, which suffered electrolysis with difficulty, was accordingly investigated. In none of the latter cases did the separation of zinc take place at once. Experiments were next conducted with mixtures of zinc chloride and ammonium chloride in varying proportions, the mixtures having been dehydrated at 260deg. as far as possible. Another set of experiments is described where the mixtures were dehydrated with dry hydrogen chloride. With increasing amounts of ammonium chloride, the electrolysis proceeds with less ease; the molten masses remain free from zinc dust, but the preliminary evolution of gas at the cathode persists for a long time. The most favourable result was obtained with a mixture in the proportion of 11 mols. of zinc chloride to 1 mol. of ammonium chloride. The gases evolved at the anode were chlorine, hydrogen chloride, oxygen (resulting from the moisture still retained by the fused ammonium chloride), carbon monoxide or carbon dioxide (resulting from the oxidation of the carbon poles), and nitrogen (resulting from the oxidation of ammonium chloride by chlorine), whilst hydrogen, ammonia, and nitrogen were evolved at the cathode. The amounts of these gases were determined by gasometric methods. Anhydrous zinc chloride is prepared by heating ordinary zinc chloride which has been dehydrated, as far as possible, with concentrated hydrochloric acid. It may also be prepared by passing dry chlorine into fused zinc, or by adding zinc to molten lead chloride. An apparatus is described by means of which zinc chloride was dehydrated by a stream of hydrogen chloride. The electrolysis of pure zinc chloride was next studied under varying conditions of current strength. A description of the separation of iron and zinc by the fractional electrolysis of their fused chlorides is given. Mixtures of zinc chloride with potassium and sodium chlorides respectively were also electrolysed with varying current strengths. The metallic cloud, which separates during the electrolysis of zinc chloride at the initial stage, has a lustre like that of mercury.

The American Tour.—After the Electrical Congress at St. Louis, described in our last issue, the party left on Sept. 17 by special train for Pittsburg, where the visiting delegates were divided into six groups, and, under the guidance of members of the local branch of the American Institute of Electrical Engineers, were taken by chartered trolley cars to the various industrial establishments. One party went to the Carnegie Steelworks at Homestead, another to the Edgar Thompson Steelworks at Bessemer, another to the factory of the Nernst Lamp Company, another to the Westinghouse Electric and Manufacturing Company's works at East Pittsburg, another to the works of the Westinghouse Air Brake Company and of the Union Switch and Signal Company, and the sixth made a general tour of all the places, paying only a brief visit to each. Special attractions were provided for the ladies. Later the party reunited at the works of the Westinghouse Electric and Manufacturing Company. Here a section of one of the largest aisles in the new east machine shop had been cleared for the occasion, and served admirably as a reception room and banquet hall. Tables had been arranged in the form of a figure 8, with covers laid for 400. The hall was decorated with the colours of the various nations represented, and was illuminated by Bremer arc lamps, while Cooper Hewitt lamps were provided for a photograph which was taken when the guests were seated. Mr. George Westinghouse, in appropriate remarks, expressed his pleasure at the opportunity of meeting and greeting the guests of the evening. After a pleasant evening, the guests were conducted to the railroad station near by and embarked on the special train waiting to carry them to Washington, where they arrived early on Tuesday morning. A visit was paid to the new buildings of the National Bureau of Standards, after which the visitors were conducted to the Capitol, and thence to the new Congressional Library by members of the local entertainment committee. Having inspected these buildings, a luncheon was served in the café of the library building. The party then divided into groups, each group being taken in charge by a member of the local committee and conducted to a specified point of interest or group of places. The various divisions united for dinner, after which the special train left for Philadelphia. On Wednesday the party were conducted over the chief electrical works of Philadelphia, and were then entertained to luncheon at the Bellevue-Stratford Hotel, where the mayor delivered an address of welcome. Subsequently the party returned to New York in time for the "Arabic," which left for England the next day. In the interim, however, the party were entertained by Mr. T. A Edison at his laboratory at Llewellyn Park, while in the evening the visitors assumed the function of hosts, and entertained the members of the New York committee and others to a farewell supper at the Waldorf-Astoria. President Gray and Colonel Crompton spoke felicitously of the success of the visit, and of the cordiality which had been extended on every hand, suitable responses being made by President Arnold and others. A large number of members of the American Institute attended at the White Star dock on the Friday afternoon, when the "Arabic" left for home.

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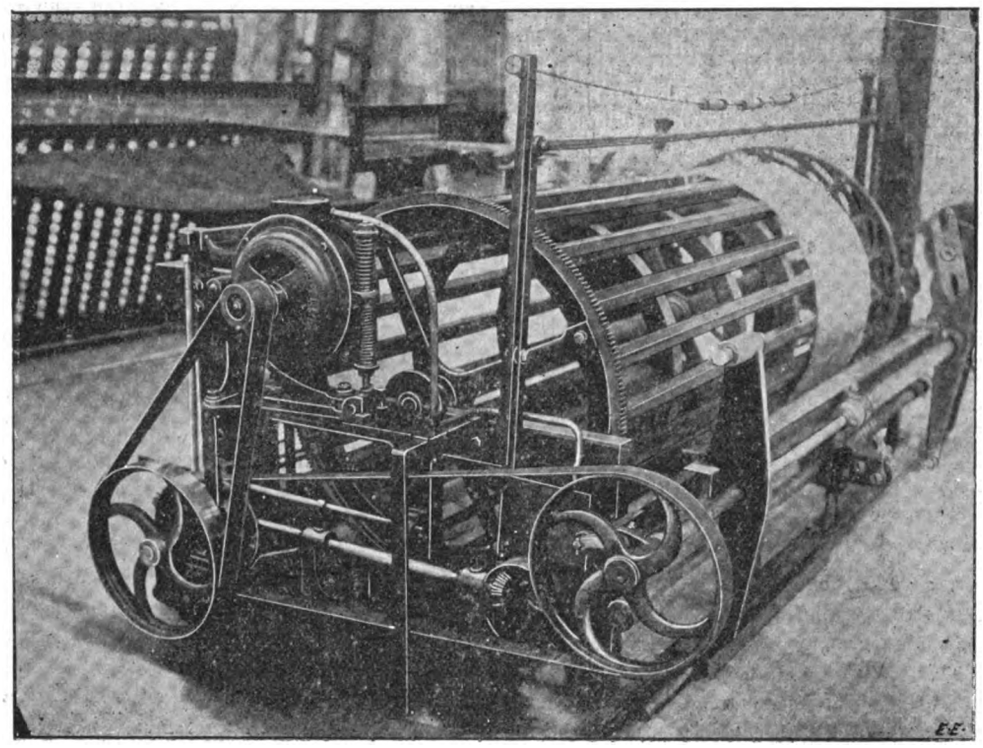
THE USE OF ELECTRICITY IN WEAVING FACTORIES.

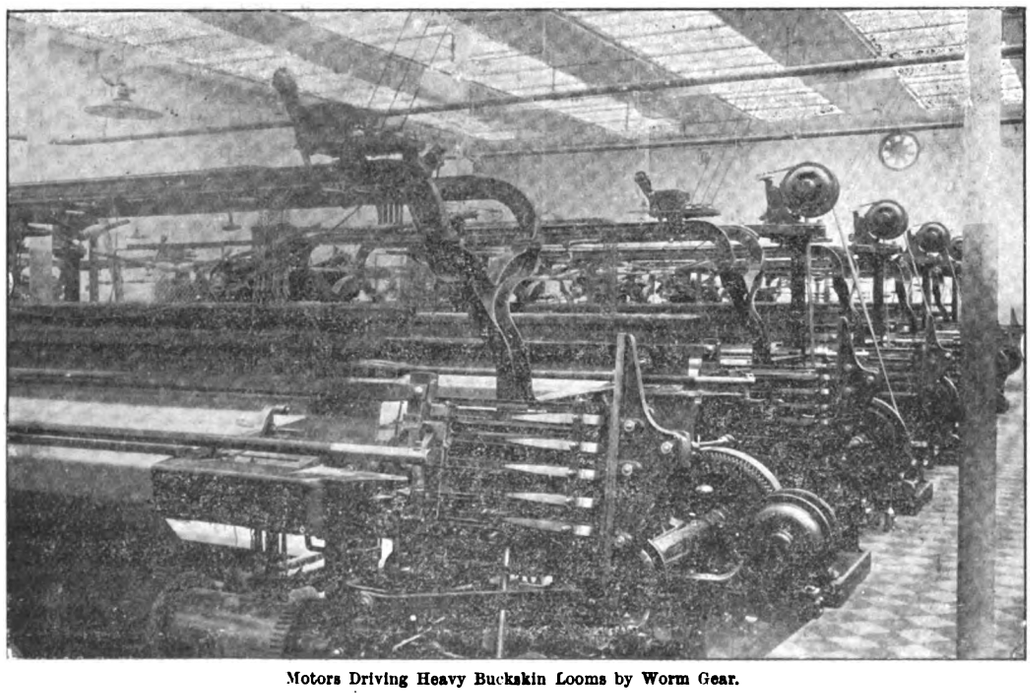
BY DR. ALFRED GRADENWITZ

The use of electricity in spinning, weaving, and finishing factories has for a long time been practically limited to the lighting of the shops. Incandescent lamps proved especially advantageous in this connection on account of their easy handling and adaptability to any special conditions, as well as of the fact that any danger of fire is practically eliminated by their use. Whereas incandescent lamps are being employed for the individual lighting of single machines, arc lamps have to be resorted to wherever the general illumination of whole machine shops is concerned. By their use a more uniform and stronger illumination than in the case of incandescent lamps of the same candle-power is secured with equal consumption of energy, while this illumination will approach daylight, especially as regards the distinction of colours. Such arc lamps are fitted with ground-glass globes, so that the light thrown downwards is dispersed to a great extent, the remainder being thrown from the glass globe on to the ceiling of the rooms, which, being painted in white, will reflect it downwards. As, therefore, electricity had long been a familiar feature in weaving factories, its application for power purposes was greatly facilitated.



Electrically-Driven Beaming Machine.

About 50 years ago the whole weaving trade was practically a domestic industry. In the factories themselves warps were only made by means of hand-driven machinery. After receiving these warps and the corresponding woof, the weavers had to do the further working of the warps at home, the completed fabrics being delivered at the factory. This process of manufacture was continued for years, until the mechanical loom was invented and gradually improved so as to be adopted on an ever-increasing scale. These mechanical looms, being capable of a much more continuous and rapid operation than the ancient hand-driven looms, were installed in workshops, the workmen now operating wholly in the factory itself, so that domestic industry eventually was practically replaced. Like the method of



Motors Driving Heavy Buckskin Looms by Worm Gear.

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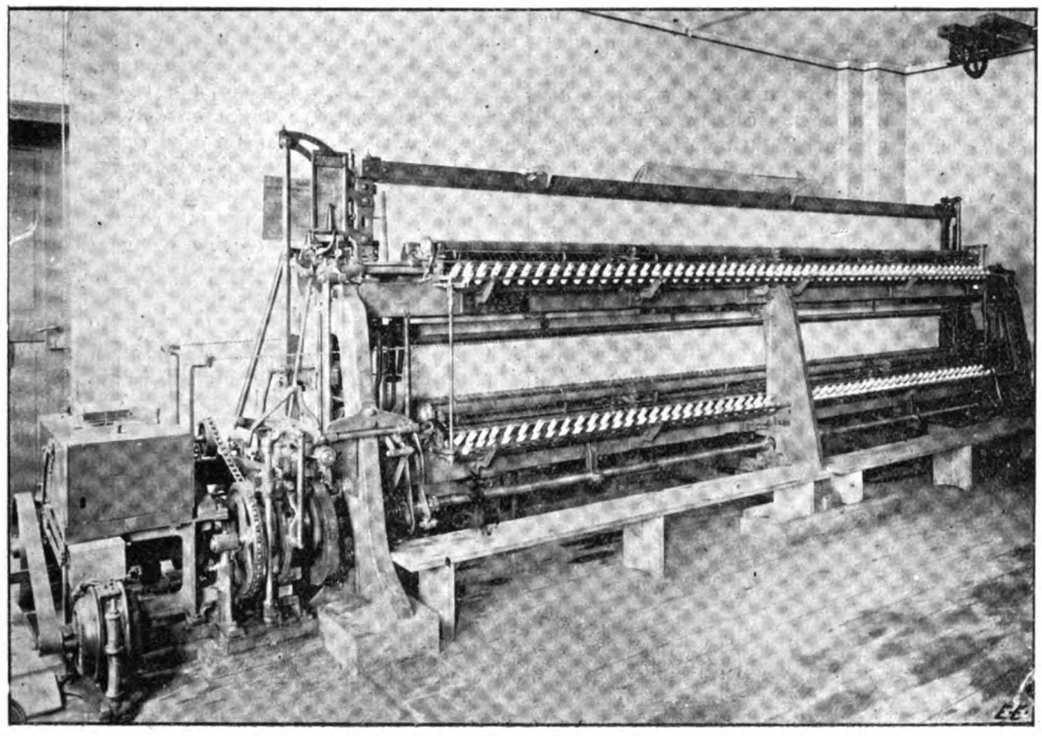
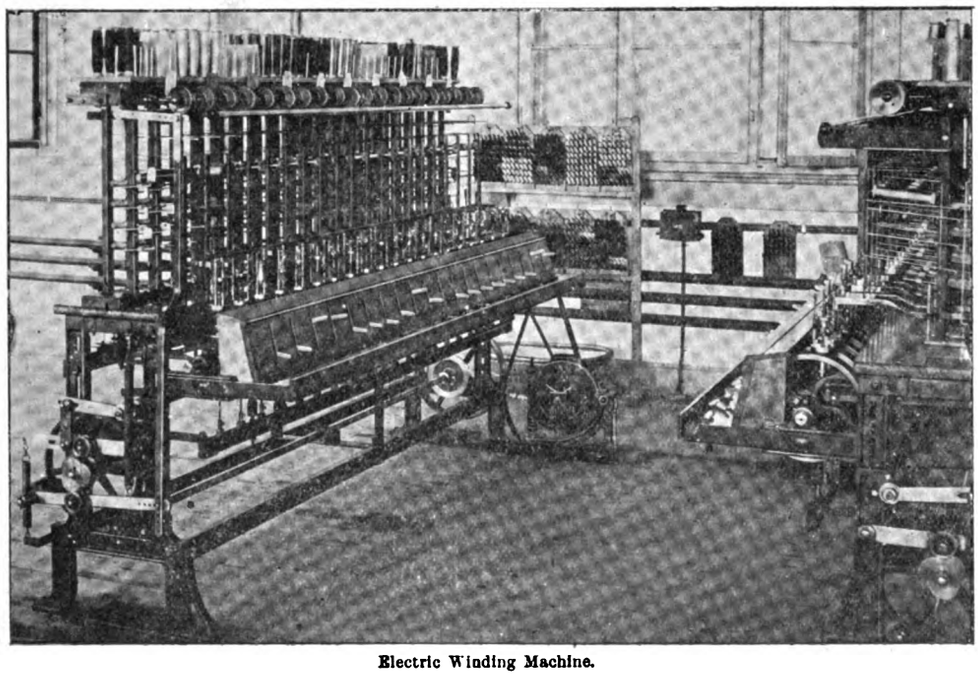
operation, the raw material has been considerably improved. Whereas once upon a time the warp and woof material had in most cases to be dyed previously, the raw material at present used is nearly always worked in an undyed state, the dyeing process taking place afterwards on the completed fabrics.



Shuttle Embroidering Machine.

As regards the operation of these mechanical looms, shafting driven by a steam-engine and actuating several groups of looms were used in the beginning. Whereas these shaft and belt transmissions, as a matter of course, received in course of time many improvements and simplifications, further advances were to be anticipated from the adoption of electricity, which had revolutionised so many other provinces of industry. This was the less difficult as the existing belts could be driven immediately by means of electromotors, while the weaving machines themselves remained practically unaltered; moreover, the same type of motor could be employed for many different workshops. The necessity of adapting the electromotors to the special characteristics of the machines driven by them would, however, become more and more evident in course of time, it proving suitable in many cases to adopt a special electromotor for each machine, thus using what is known by individual drives. This, it is true, was not possible before rotary-current motors could take the place of continuous-current motors, where the commutator of the armature, being made up of many individual segments, required a large amount of continuous superintendence, while being subject to considerable wear and tear. Rotary-current motors, on the other hand, required, on account of simplicity of their design, no appreciable maintenance. They start readily and safely under full load, and are not so susceptible to energy oscillations during operation. Thus they allow of individual motors being introduced on a large scale. By the way, it is satisfactory to state that this use of electricity for the operation of individual looms allows of the domestic industry, which was disappearing on account of the overwhelming competition of factory operation, being preserved and in many cases restored to new life, any sanitary dangers of weaving being eliminated now, and persons of even limited physical strength being enabled to devote themselves to the art of weaving.



Electric Winding Machine.

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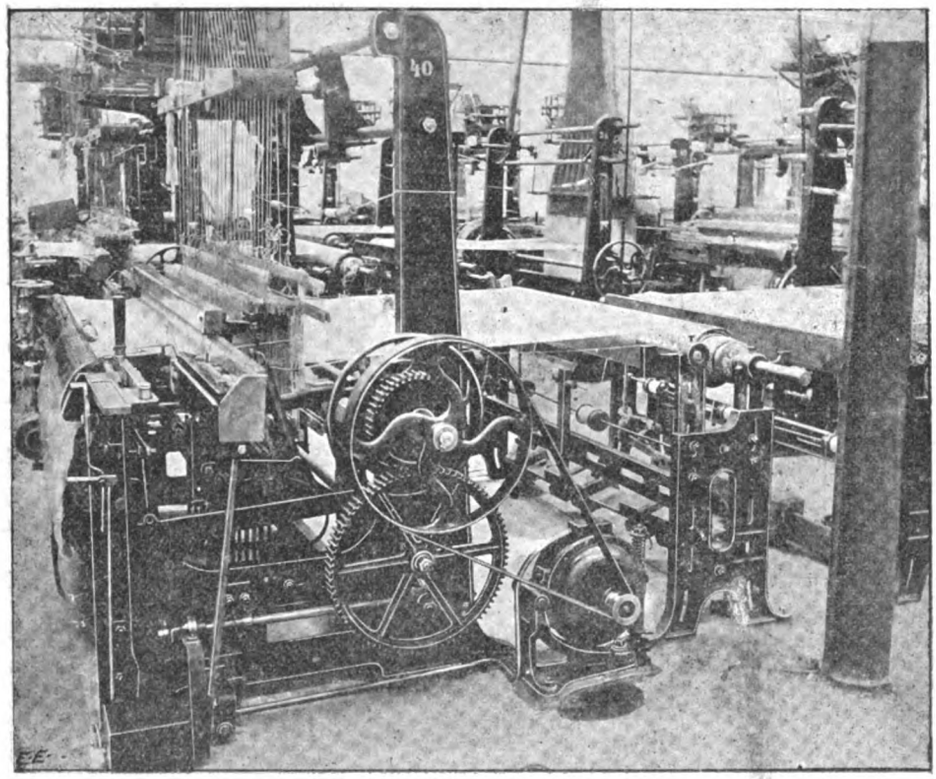
Some typical instances of electrically-driven looms are represented in the accompanying photographs, kindly supplied by the Allgemeine Elektrizitäts-Gesellschaft, of Berlin. In the loom motor constructed by this company a short-circuit rotor is used, consisting simply of an iron core with notches arranged at the periphery and containing copper rods. On both front sides of the armature these rods are connected with one another by means of metal rings, no current being supplied to the rotating armature of the rotary-current motor. The working current from the mains has only to be introduced into the stators. No sliding contacts or brushes are thus necessary. An important feature is the easy and safe excitation of the rotary-current motor, even under full load, being much less sensitive than any other motor with respect to fluctuations of load and overloads as occurring during the operation. In virtue of their simple design, rotary-current motors are, further, smaller and lighter than direct-current motors of the same output, and nothing prevents them from being arranged in a most limited space. As these motors are fitted with shields supporting the bearings, both the coils of the stator and rotor are perfectly safe against external injury, convenient ventilating fans avoiding at the same time an excessive heating effect. The special rotary-current loom motor of the Allgemeine Elektrizitäts-Gesellschaft is, therefore, particularly simple and suitable for use in connection with weaving factories. The loom motor is connected to the machine to be driven by means of either gearings or belts, the number of revolutions being mostly too high to allow of its being operated direct.

In the case of a toothed gearing being used, a small driving wheel is mounted on the motor shaft, which gears with a larger toothed wheel mounted on the shaft of the loom to be operated. In the case of the speed of the loom shaft having to be altered, the small driving wheel of the motor will be replaced by a larger one containing a correspondingly modified number of teeth with the same pitch. As the diameter of the pitch circle is altered hereby, a modification of the distance between the centre of the motor shaft and the centre of the loom shaft will also be necessary, this being obtained by a convenient adjustment of the motor. This is effected by an eccentric bearing, capable of serving at the same time as bearing to the loom shaft. Any regulation of this bearing will correspond with a variation in the distance of both shaft centres. The speed of the loom shaft may thus be altered 30 per cent. by steps. The bearing contains two concentric sleeves, the motor being supported by the inner sleeve—the eccentric proper. After the distance of the centres has been regulated by rotating the eccentric bearing, the latter is fixed to the supporting arm of the motor, so as to make any further alteration in the relative position of motor and box impossible during operation. The motor is thus suspended like a pendulum, being liable to yield to the shocks occurring in the looms, oscillating with the eccentric bearing about the loom shaft to either side. The oscillation is limited by two spiral springs, retaining the motor placed below or above the toothed wheel to be driven. For many kinds of looms it is best to arrange the driving motor horizontally beside the toothed wheel to be driven, the motor being placed immediately between two springs, the lower of which is so designed as to compensate for the weight of the motor itself in addition to any possible shocks.

In one case of *belt gearing* being adopted the motor is mounted on a belt balance, designed in accordance with each special case. With belt balances for vertical belt operation, there is an angular jack to the upper arm of which the motor is attached. If the whole be installed on the ground, the weight of the motor compensating the tension of the belt will maintain the belt automatically stretched. As, however, the weight of the motor is too great and would result in too high a tension of the belt, the motor is further supported on the side opposite to its rotating shaft by two springs, compensating any desired fraction of its weight, the application of this belt balance in the case of an installation on the ground being shown in the illustration. The same arrangement may be used for horizontal belt operations provided it be attached to the wall or to a vertical column. This belt balance may equally be attached to the ceiling. A second kind of balance is used for horizontal belt operation of motors placed on the ground, whereas a third type is being used for vertical operation of the belts in the case of the motor being partly sunk into the ground. If a belt balance is not indispensable, motors with screwed feet are used mounted directly on the foundation or on special rails. The advantages from the single-motor driving of looms are first shown by the fact that each loom is completely independent of any other and capable of being connected or disconnected at will. Moreover, if a loom be stopped, no work for rotation at no load is consumed, whereas in the case of operation by shafts and belts, even if all the looms of one section be stopped, the main shaftings have still to be run. In the case of frequent pauses occurring in the operation,



Light Loom, operated Electrically.

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the *cost of operation* will for both methods be about the same. If, however, unsatisfactorily designed and complicated transmission plants are replaced by electric motors for single driving, the cost of operation under certain conditions would be reduced.

The question of the operation above described should be considered, especially with new plants or additions to existing factories, a considerable saving being obtained in the first cost. The independence of the looms of one another in the case of individual driving is further shown by the looms not being affected when one loom is stopped, whereas in the case of operation by shifting, any disconnection or connection of a loom will result in a corresponding modification in the speeds of the remaining looms of the same group. Though of no great significance in the case of common fabrics and textures, experiments have shown that with finer goods, especially with silk fabrics, *a more uniform texture* is obtained in the case of individual driving. This fact is due also to the uniformity of speed with different loads as exhibited by rotary-current motors. This continuous speed will result also in a considerably lesser frequency of a rupture of the threads, the efficiency of the loom being thus equally increased to some degree. Further advantages of this kind of operation are the better illumination of the workshops as due to the absence of transmissions and belts; moreover, the dust inevitable with transmission operation, as well as the spitting of oil, is perfectly avoided, the cleanliness of the goods being thus increased.

The new motor is in a most simple way switched in and out, a switch-out being mounted beside the loom on the ground, being directly connected to the present lever of the loom, operating at the same time the brake. In order to connect or disconnect the loom it is, therefore, necessary only to adjust this lever. The rotary-current loom motor, therefore, affords a means of utilising completely any advantages of electric operation for all the machines used in weaving shops, the results so far obtained in similar factories being most satisfactory. But for other branches of industry, wherever small machines have to be driven individually, the loom motor should also prove suitable, as the considerations controlling the choice of a system of operation are dependent not only on the first cost or the cost of operation itself, but as well on the safety and easiness of the operation itself and the suitable independent arrangement of the various machines.

NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(Continued from page 519.)

In the design of a perfect starting switch it should be impossible to stop the motor by the starting switch, or if it is possible, then a secondary device should be inserted to dealt with the induced shunt current. This may be part of the machine, say a high resistance connected across the ends of the shunt, or it may be an adaptation of the device mentioned above, and consist, as is the case with some of the higher-priced switches, of lamps or other high resistance momentarily connected across the shunt terminals at the time of make and break. The use of lamps for this purpose is not altogether satisfactory: they serve a useful purpose in showing the necessity for some external resistance closing the shunt circuit at these times, but they are liable to break, and as the operator will not see that they serve any useful purpose he will not replace them. In fact, in one case the writer found the operator had removed the lamps as he considered they were of no service on the starter, and could be usefully employed elsewhere for illuminating purposes. As before stated, this is one of the most important requirements, and no starting switch should under any circumstance be accepted in which due provision is not made for absorbing the induced current. The question is still further complicated, and assumes, if possible, greater dimensions when dealing with series-wound or compound-wound motors, and in these cases every precaution must be taken to prevent the bad effects due to the heavy induced currents from the series turns.

The fifth requirement is also one of considerable importance, and the true meaning does not yet seem to be grasped by all switchmakers. It is not sufficient to design a switch in which the lever moves at an even slow speed from one end of its range to the other. The process of so moving the starting lever consists of two parts. In the first place, there is the time during which the lever is making contact with the individual steps; and, in the second place, there is the time occupied by passing from one step to the next. The requirements under the two different conditions are entirely at variance. In order to have a steady start, and also to prevent fluctuations in the E.M.F. of the outer circuit, it is essential that current shall be supplied to the motor armature by easy gradations, and that there shall not be any sudden increase in the value of the current so supplied; it is also necessary that the motor attains the correct speed for the value of the E.M.F. for each increase in the current before a higher E.M.F. is applied to the armature. These requirements are met by permitting the lever to rest for an appreciable length of time on each contact. On the other hand, it is necessary, to prevent burning of the contacts, that the movement of the lever from contact to contact shall be instantaneous. It is evident, then, that a slow motion of the starting lever, such as that which obtains when the lever is moved by worm gear, is not altogether desirable, for while it fulfils one requirement, it does not the other. Several devices have been proposed to overcome this difficulty, and some of these will be described more fully in detail later, for it is possible to meet the requirement in several ways. In the first place, the switch can be designed to have a kind of jumping action, and, in the second place, only a small shunted current need be dealt with at the contacts. Each of these devices means a costly switch, as they entail the use of solenoids in the construction of the switch. Another device is to arrange the contacts in a series of steps as regards the horizontal plane, as well as in a series of steps as regards the vertical plane. The difficulty here is to arrange the switch so that the lever will fly back to the off position upon releasing the automatic no-volt device. The more familiar arrangement is to let sparking and consequent burning of the contacts occur, but to make these contacts easily renewable, and to treat the occurrence as ordinary wear and tear which cannot be prevented. It is in this particular that the liquid resistance starting switch holds its great advantage: there are no contacts to burn, and the lever, or rather its equivalent, the electrode, is only slowly immersed in the liquid.

The next requirement is one of the most difficult to deal with, and various authorities give different rules; in many places it is specified that the movement of the lever from one contact to the next shall not increase the current by more than 10 amperes, say. But this is not sufficient. Consider for a moment the conditions which obtain when a motor is started up. The first thing to be done is to excite the shunt coils, then to cause the armature to rotate. If the armature were held firmly at rest, then the circuit through the armature could be treated as a circuit having a resistance of y due to the armature alone plus a variable resistance x, which is gradually reduced as it is cut out by the action of the switch. But as soon as the armature commences to revolve the conditions are altered. There is then a counter E.M.F., which acts as an additional resistance induced in the armature windings, and the value of this counter E.M.F. depends upon the speed the armature attains, the shunt field strength remaining constant, except in as far as it is influenced by the armature reactions. Now, the condition for holding the armature fast at rest is only that of infinitely loading it, and when a motor is started from rest under load this condition is to a certain extent fulfilled. In the case of a small fan motor, there is practically the same condition obtaining whether it be started under load or not, but the difference between the conditions of starting under load or light load increases as the size of the motor is increased. Take the case of a 200-h.p. motor. Here we will assume that when started running light 10 amperes only are required; then for starting the machine only 10 amperes are requisite, and the motor will receive its full current by moving the starting switch to the second contact pieces, but when this

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machine is running under full load 400 amperes are required, and as a greater starting current is required than the normal full-load current, it can be assumed that for starting 750 amperes are necessary. This means that to fulfil the requirements the switch must be fitted with 75 steps. Now, consider the operation of starting—so long as the armature is at rest it can be treated as possessing so much ohmic resistance, and the motor will remain at rest until a large proportion of the starting current has been supplied. It is probable that the starting switch lever will be moved over 60 of the steps before the armature commences to revolve at all, and the whole of the regulation of bringing the motor to its correct speed must then be carried out during the passage of the lever over the last 15 steps only. But even in this case the switch must be specially designed for the work, as under ordinary conditions of starting light or under under partial load only the armature commences to rotate sooner, that is, with a lower current, and the maker of the switch may reasonably rely upon the effects of a counter E.M.F. of the armature. In purchasing or designing a starting switch, the work that the switch has to do should be clearly defined, and if the motor is required to start frequently under load, and is at the same time a large-sized machine, then a larger current should be permitted to flow through the armature by each earlier movement of the lever from step to step, otherwise it is almost impossible to get good regulation on the last contacts. The rule should be as stated, and not that the movement of the lever from step to step only permits an increase of current of such-and-such a value, as the conditions as to what value of current flowing will affect the E.M.F. of the supply the least will alter with different circumstances.

The following two requirements have been dealt with in treating of other conditions. The only point that needs emphasis is that every care must be taken with the insulation of the various electrical portions, and that the insulating material should not be readily affected by moisture, dampness, etc, and should also be able to withstand great variations in temperature without deterioration.

The ninth condition is important, but it is questionable whether it is better to have these devices mounted on the same slab as the starting switch proper, or if it is not better to deal with them as necessary or rather essential accessories. In the case of the liquid starter there is no good automatic no-volt release, and therefore a minimum circuit breaker ought to form part of every motor equipment when a liquid starter is used. The difficulty of this is in arranging a path for the self-induced current. In the starter with metallic resistance the object of putting the no-volt release on the starter itself is to get the lever to fly back to the off position when the current is interrupted. There is no difficulty, however, in arranging a high resistance, so that on the opening of the circuit breaker it is connected across the shunt, as was shown in the case of the lamps connected to the auxiliary switch previously referred to. The great advantage of utilising a circuit breaker is that the sparking at the switch step contacts is eliminated entirely. If the no-volt release forms part of the starting switch, then it acts by causing the starting lever to fly back, and the armature resistance is broken by the lever leaving the last contact. On the other hand, if a minimum circuit breaker is inserted, the current both to the armature and the shunt circuits is broken at the circuit breaker, and as the knives of these are usually fitted with carbon break pieces, there is no burning away of any of the vital parts of the apparatus. The same remarks hold good with regard to the overload preventer. The overload preventer, however arranged, is nothing more or less than a simplified form of a circuit breaker. In many cases it consists of a device by which, if the current flowing through the armature at any instant exceeds a previously determined amount, then the two ends of the no-volt release bobbin are short-circuited, and the current is interrupted by the lever flying back, and is broken at the switch contacts in the manner already described, and the shunt being broken at the last contact, the motor may be seriously damaged.

It is readily apparent that it is not conducive to long life of the apparatus for the current to be broken at this place, owing to the damage done through ordinary burning of the contacts. There is, however, a greater evil apparent upon considering the question more fully. If the lever flies back, owing to the action of the release coil proper, it is generally because the current has been interrupted, and the flow through the shunt coils has ceased. On the other hand, if the lever flies back owing to the action of the overload preventer short-circuiting the ends of the release bobbin, the current through the shunt has not been broken until the lever leaves the last step. The result of this is that there is no path for the self-induced current of the shunt coils, for we have seen that the path provided is through the armature, and all connection between one end of the shunt coils and the armature is interrupted when the lever is not making contact with the steps. It is well known that a motor may break down owing to overloading, but it is far more likely that a motor will break down owing to the high induced E.M.F. due to the self-induction of the shunt. The addition of such an overload preventer as that which acts in the manner above described, and which is the most prevalent type met with in practice, eliminates one source of danger only by introducing into the apparatus another much more serious source of danger.

The whole of the difficulty can be eradicated by inserting a maximum type circuit breaker, and if this be done, it is only little more costly to add the no-volt attachment to this circuit breaker, and thus to fully protect the motor apart from the starting switch, which apparatus has other most important functions to fulfil. Another advantage of so arranging the apparatus is that in the case of any breakdown to the accessories, there is less danger of breakdown to the motor. In two cases which the writer has come across of the shunt release coil burning out, the shunt coils have also been pierced, owing to the failure of a path for the induced current. If the addition of these necessary and useful circuit breakers were more general in cases where a switch with metallic resistance is employed, they would also be more often adopted with liquid switches, where their presence is more necessary. In shipbuilding yards, engineering works, and kindred places the use of the liquid starter is very general, and, as it will withstand rough usage, it is a most serviceable piece of apparatus for exposed positions and for use by unskilled labour; but it has the disadvantage that there is no good liquid switch which can be fitted with automatic no-volt release. The most usual practice is to connect the shunt directly across the mains, so that the fields are always excited, and to use the liquid starter for dealing with the armature circuit only. This practice prevents to a very large extent the burning out of the shunt coils due to self-induced E.M.F., as the shunt circuit is not broken every time the motor is stopped, but at times—for cleaning purposes, for instance—it is desirable to interrupt the shunt circuit, and then there is danger of burning-out occurring. A more important objection is that if the motor be running at the time the generator stops, or if there is any other way of controlling the motor circuit, say through a double-pole switch, and the supply is stopped, it can be connected again directly through the armature with the motor at rest, and then we get the case of a motor being started without any starting switch. The only satisfactory method of overcoming this difficulty is to insert a maximum and no-volt circuit breaker in circuit with each motor. If this be done, then the circuit breaker and the starting switch should be so interlinked that the circuit breaker will remain closed when the electrode is in the liquid, while at the same time it is impossible to perform the operation of closing the circuit breaker unless the electrode is entirely clear of the liquid. There is one objection to this. The liquid is liable to escape from the tank, and a circuit breaker, being a delicate piece of apparatus, should not be subject to damp surroundings; further, a gas is frequently given off which attacks all metal work. For these reasons it is advisable to have the starting switch and the circuit breaker a little apart, and it may be difficult to satisfactorily interlink them in the suggested manner. In this case the circuit breaker should be designed so that it is impossible to close the main circuit if there is a short, or if the resistance of the circuit is so low as to permit a current higher than that at which the circuit breaker is designed to open to flow even during the operation of closing the circuit breaker. There are several ways of

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fulfilling this condition: one of the simplest is to design the circuit breaker with two switches, one the main switch and the other a subsidiary switch. If the circuit breaker be so designed that the current will only flow freely through the apparatus when both switches are closed, and is also designed that the main switch can only be closed when the subsidiary switch is also previously closed, there is no fear of making the circuit, even momentarily, if there is a short on it.

The convenience of liquid starters is very great, and they have a most important future before them. The rough usage they will withstand, the ease with which they can be manipulated, their simple structure, and the impossibility of permitting the current to be increased through the armature either too rapidly or by jerks, make them of the greatest service, but before they can come into more general use no-volt devices must be attached, or else they must be used in conjunction with circuit breakers of the type indicated.

The tenth condition is one of the utmost importance, but it is more desirable in the case of the simpler switches than in that of those designed for special purposes, such as the controllers of teazer sets, etc. In many cases, owing to a want of skill in the manipulation of the starter, a little matter will go wrong, and if readily accessible this will receive attention and be put right, but if the working parts are hidden behind the slab, considerable time is occupied, and there is great liability for the apparatus to be neglected. In the more complicated switches this accessibility is just as desirable, but is not so essential. Here the apparatus is usually in the hands of some electrician, who, fully appreciating the importance of the starting switch, will note any peculiarity in its behaviour, and correct in time any defect.

The necessity of the eleventh condition is evident. As regards the last, it must be remembered that while theoretically there are 746 watts in the horse-power, yet in the case of motor work, owing to the absence of perfect efficiency, 850 or more watts should be allowed to the horse-power, and the starting switch should be designed on the actual brake horse-power, and not on the theoretical. In the same manner a fair margin should be allowed for overloading; in many instances the purchaser has no exact knowledge as to the power required by the machine which he wishes to drive, and this is frequently underestimated; therefore, both the motor and the starter should be designed to allow a reasonable amount of overloading. It is frequently found in motor specifications that the machine shall give such-and-such a horse-power for so many hours without heating above a specified amount, and shall be capable of developing 25 per cent. or 50 per cent. additional horse-power for periods not exceeding half an hour without any undue heating and without sparking. Provision is thus made in the motor for the overloading, but the same care should be extended to the switch, for it is upon the success or failure of this important part of the equipment that the life of the motor depends.

(To be continued.)

SHOREDITCH ELECTRICAL EXHIBITION.

The exhibition organised by the Lighting Committee of the Shoreditch Borough Council, which will continue until the 22nd inst., was opened on Monday by the Mayor, Mr. H. B. Bird, J.P. The Council have undertaken this function with the special object of bringing to the notice of the public the advantages of electricity for lighting and power purposes; and for the guidance of those contemplating its use, an office has been opened at the entrance to the exhibition, where the borough electrical engineer, Mr. C. Newton Russell, will supply every information. The Council, it may be mentioned, will allow a liberal graduated discount upon the charge of 2d. per unit for power. The exhibition is being held at the Pitfield-street baths.

The proceedings were inaugurated by a statement from the Chairman of the Lighting Committee, who was followed by Mr. Russell. The Mayor then delivered a short address and declared the exhibition open. In the course of the speeches reference was made to the advantages of electricity and its progress in the district. The efforts of the Lighting Committee, Mr. Russell, and the exhibitors in organising the exhibition were also acknowledged in appreciative terms.

There are five-and-thirty exhibitors, and the last on the programme—Babcock and Wilcox, Limited—are the first to catch the eye, their stall being in the corridor leading to the hall. Here are models of their well-known patent watertube boiler and mechanical chain-grate stoker. Photographs are to be seen of Guttmann's patent water-softening and purifying plant, and a turbine tube cleaner for removing incrustation from the interior of the boiler tubes is also on view. Entering the hall, the visitor first encounters the stall of Messrs. Isenthal and Co., of Mortimer-street, Cavendish-square, W., whose speciality is heating apparatus. The Crypto Electrical Company show a variety of their motors and dynamos, some of which are used by the Government. Messrs. J. Defries and Sons, Houndsditch, are showing the "Defresque" translucent enamel glass, which will be found effective for electric signs and facias where it is desired to obtain equally good results by night and day. They are also exhibiting the "Defresque" brilliant mosaic, an improved process of manufacture which yields highly luminous results. Besides these, they have a good display of Stewart arc lamps, and Wirt rheostats, theatre dimmers, and the special dynamo brushes which are described in our "Trade Notices and Novelties" column this week. Messrs. A. W. Penrose and Co. have an extensive display, comprising an electric goods lift, the high economy of which the makers guarantee; a combined power and lighting switchboard constructed for the Finsbury Distillery; a group of standard motors; a number of machine tools, each driven by its own motor; motors for printing work; and a quantity of domestic apparatus. Messrs. H. F. Joel and Co. show as specimens of their "Zone" dynamos and motors a 5-h.p. motor driving a large band saw, and a 1-h.p. motor driving a platen printing machine.

In the centre of the building Messrs. Crompton and Co. and the General Electric Company, of London, Witton, and Manchester, present representative displays. The former show motors from ¼ h.p. to 10 h.p., some fitted with reduction gear, rendering them suitable for hoists, etc. Special attention is directed to their buffing motors of from $\frac{1}{16}$ h.p. to 1¼ h.p. Messrs. Crompton are also making a fine display of measuring instruments. A current of ·015 ampere deflects to the limit of its scale any voltmeter whose scale is calibrated from zero, and in the case of a voltmeter having an open scale, ·015 ampere deflects the needle to the centre reading. These instruments have a special arrangement for removing them from the switchboard without access to the rear of the board. The General Electric Company show a multiplicity of apparatus from motors to cigar-lighters. A couple of Witton motors can be seen driving a band saw and a box-making machine respectively. These motors are made in all sizes from 1 h.p. to 75 h.p., but space compels the exhibits to be restricted to 10-h.p. motors. To compensate for the limited size of the machinery on view, the company are exhibiting photographs of some of the big plants they have laid down. Numerous types of telephones, bells, lamps, drills with their own motors, fans, and other apparatus are on view, and the company's representative also showed us some very neat medical coils, which are meeting with an extensive sale among physicians, thus testifying to the spread of electro-therapeutics. It may be added that, to encourage the use of electrical power, the company are offering small motors by the instalment system on very reasonable terms. In connection with the company's exhibit there is a demonstration of the processes employed in the manufacture of the Robertson electric lamp, which is very much in evidence throughout the building, while at intervals throughout the day wireless telegraphic operations are conducted for the edification of spectators. Messrs. Humpage, Jacques, and Pedersen are showing speed-reducing gears to couple to motors, and also self-contained combined gears and motors, of which we give an illustration. Their electric sack hoist, which was in operation throughout the day, attracted a

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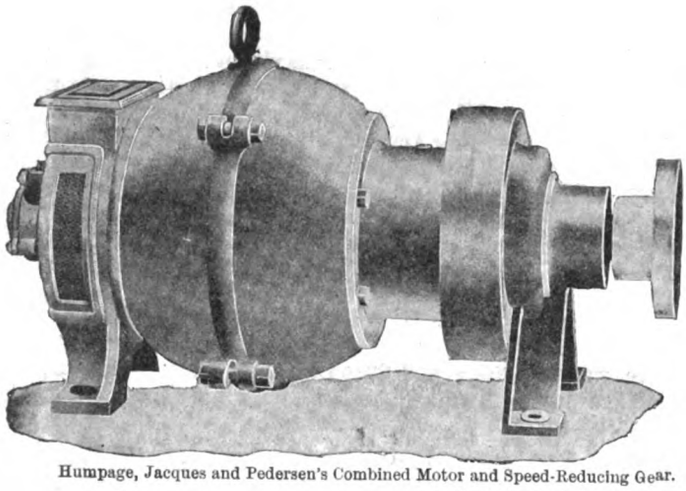
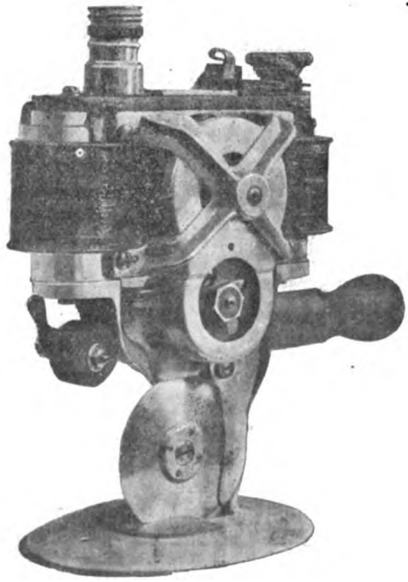
good deal of attention, and was conspicuous for its faultless action.

The Reason Manufacturing Company, Limited, Brighton, give a varied display of apparatus. Their "Lewis" arc lamps deserve special attention. Three varieties are exhibited—namely, the twin-carbon, the series, and the miniature types. All these lamps possess the great advantage of working without shunt coils, thus avoiding a fruitful source of trouble, and doing away with the cut-outs and substitutional resistances otherwise necessary. The electrolytic type of lighting meter is shown in actual working.



Humpage, Jacques and Pedersen's Combined Motor and Speed-Reducing Gear.

This meter is worked on the electroplating principle, and possesses a unique degree of accuracy and sensitiveness. The actual process of registration of the current can be easily followed by an inspection of this exhibit. Fuse boxes in great variety are also exhibited. The special advantage of these boxes is that they are so constructed as to render it impossible for a careless workman to effect a short-circuit when attending to a consumer's fuse. Reed's Electrical Engineering and Supply Company exhibit all kinds of electrical accessories, motors, wire and cable, etc.; and in conjunction with this firm Mr. W. Ruddock shows an electric cutter, of which we give an illustration. It is operated by a continuous direct current.



Ruddock's Electrical Cutter.

It is connected to the wires by a small flexible cable, suspended from a trolley wire fixed to the ceiling, and is so kept out of the way of the operator, but permits the machine to be used on any table in any part of the cutting-room. The motor drives the 4in. circular knife at a high speed, and the lines of any pattern may be accurately followed. The goods remain stationary, and the machine slides easily over the table and through the work. The current can be supplied from an ordinary light circuit, and the moment the operator turns off the switch, which is fixed on the machine, the expense for power stops. Another device by the same exhibitor is the "electric transmitter," which executes 4,000 stitches a minute. Its great features are absence of shafting, under drivers, and transmission belts, its immunity from oil drippings, smell, and dirt, and simplicity of operation.

The Electric Construction Company, Limited, London and Wolverhampton, show a motor of the well-known "Midland" type driving an improved "Expert" chain-morticing machine. Other motors and a rotary converter are included in their exhibit, and to illustrate the manner in which electric motors lend themselves to driving small tools, a portable drill, fitted on wheels, is shown. This arrangement enables the whole apparatus to be moved about without trouble, so that large or cumbersome work can be drilled without being moved from tool to tool. Messrs. Marryat and Place show a complete range of all the smaller sizes of M.P. motors from ½ h.p. up to 15 h.p., a number of motor starters, an electric furnace in which a temperature up to 3,700deg. C. can be obtained, automatic cut-outs, and also some iron-clad switches, in which class of work the firm claim to be pioneers. Messrs. Nalder Bros. and Thompson, Limited, makers of the N.C.S. electrical measuring instruments, have a representative display of such apparatus. Portable combined testing sets screened so as to be unaffected by external magnetic fields, recording instruments for current and E.M.F., illuminated dial instruments, an improved horse-power gauge for motor circuits, and automatic switches for charging accumulators are all to be seen at their stall.

In another hall the Electromotor and Dynamo Company present an extensive display of their machinery, which constitutes an admirable collection of such plant. The Brookie-Pell Arc Lamp, Limited, have a large display of their lamps—open, enclosed, and twin-carbon types—and a special feature is the patent contact gear for balancing suspended lamps at the desired altitude. An elegant exhibit is that of the Simplex Steel Conduit Company, Limited. It consists of showcases and boards mounted with samples, arranged on a framework made up of the conduits and fittings of the company's manufacture, with roof and polished boards at the back, on which are mounted the various fittings and accessories showing their application. On the boards and ceiling are displayed a number of lamps which are connected up by means of ceiling rose boxes, pendant boxes, lampholder fittings, brackets, etc., the distribution being from the six-way fuseboard, mounted on the back in the centre, the whole being connected to the supply and illuminated at night. This arrangement illustrates how, with a complete system of this kind, the whole of an insulation may be readily tested and inspected throughout by the removal of an inspection cover. Numerous samples of their specialities in wires and cables are to be seen at the stall of Messrs. W. T. Glover and Co. The remaining exhibits comprise those of the Lister Electric Manufacturing Company, of Dursley (London agents—Messrs. Pinching and Walton, 52, Cannon-street, E.C.); Messrs. Matthews and Yates, Limited, whose products include a refuse-collecting apparatus for use in sawmills and cabinet works; Messrs. Robinson and Co., Kettering, who are showing their triple-arm boot repairing and finishing machine; the Boxmaking Machinery and Engineering Company, of Turnmill-street, Clerkenwell-road, who show a number of their appliances for industrial purposes; the Electric Welding Company; Messrs. J. Sagar and Co., Limited; the Linotype Company, who show their composing machine and special arrangement for driving same; the Phœnix Dynamo Manufacturing Company, Limited, Bradford; Messrs. F. W. Potter, who, among other things, exhibit a 9ft. electric fan; and Messrs. Royce, Limited, of Hulme, Manchester, who have a good display of motors and dynamos.

If the number of novelties is not conspicuous, there are many engaging features, and the exhibition bids fair to quicken interest in the employment of electricity amongst the community. For the delectation of visitors the celebrated band of the 3rd City of London Rifles performs selections each evening, and sweet music is also discoursed by Messrs. Elman Bros. and Co.'s electric piano.

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DESCRIPTION OF THE ELECTRICAL EQUIPMENT OF AN ENGINE WORKS AND SHIPYARD, WITH NOTES THEREON.*

BY H. O. WRAITH, ASSOC.MEMBER.

The author proposes to deal, as far as in his power lies and in the short time at disposal, with the question of converting large works of shipbuilding, engineering, or ironworks type to electric driving, and where, as a rule, outlay is a very great consideration, and the rulling question rather is "How can I get a maximum saving or profit in pounds, shillings, and pence for a minimum of outlay?" rather than "What is the most perfect method and apparatus to perform the work I have to do?" Corporations, as an example, and other bodies who can get the command of large sums of capital without trouble, do not hesitate to any great extent, and rightly so, to lay out capital in the most complete and, one might almost say, lavish electrical installations, so as to obtain the utmost maximum of efficiency of working; in some cases, indeed, the refinements of efficiency do not justify the outlay of capital. However, if people did not spend money in what are really experiments we should not be as wise as we are. But the class of place the author rather has in his mind to-night is very different. There, an enterprising member of a contracting firm goes to the executive of the ironworks, or whatever the case in point may be, and, after due preliminaries, says: "Look here, we will convert your works to electric driving for £20,000, and your saving will be £3,000 a year." The executive says: "That's an awful lot of money to spend; we haven't got and can't raise so much. Besides, I don't know anything about this electricity, and I must be certain that your figures are correct." After a year or two the executive decides to convert a portion of the works to electric driving as an experiment, spends £4,000 on it, is pleased with the results if the work has been properly designed and carried out, and finally converts the whole of the works.

The author proposes to take as a groundwork a fairly large electrical installation in a shipyard and marine engine works on the North-East Coast with which he has had the pleasure of being very closely associated, to give a short description of it, and comment on various points raised. Thus, even if there is nothing new about the installation, he hopes that room for discussion will be opened up, and that, at any rate, he will be able to learn something from the discussion. This particular installation is, as you will probably agree, rather a good example of those which have been built up in sections, without having foreseen and provided for the possible magnitude of the installation when laying down the first portion of the plant, and shows defects, but it teaches useful lessons by the very reason of its defects.

Description of Works.—The works premises consisted of (1) a marine engine and boiler building shop, about 240ft. long by 170ft. wide, divided lengthwise into four bays—viz., a small machine shop for the smaller machine tools, store, and fitters' gallery above, in the north bay; a bay for erecting the marine engines, and containing the larger machine tools, shaft lathes, vertical planers, etc.; a bay for building marine boilers; and a fourth bay for blacksmiths. On the south side of the engine works was a boiler yard, where funnels, smoke-boxes, etc., were built, and at the south-west corner of the boiler yard was the pattern shop. The power-house was situated on the south side of the engine works, and at its west end, at the top of a steep embankment. (2) East of the engine works was the shipyard, containing three berths, and all the scattered machinery and stock natural to a shipyard. At the west side of the yard was a joiners' shop and sawmill, containing a large saw for cutting up logs, and other machinery. (3) At the extreme east of the shipyard was the fitting-out quay, where ships, after being launched, were brought to have their machinery put on board and to be finished off ready for going to sea. On it stood a building about 85ft. by 35ft. wide, containing a fitting and blacksmiths' shop, a plumbers' shop, riggers' and shipwrights' stores, etc. On the quay there was also a steam-driven 100-ton jib crane, used for lifting machinery and boilers on board ships lying at the quay. (4) There was also, north of the engine works and west of the shipyard, the general offices, a building about 90ft. square and containing two floors. Between the offices and the engine works was the brassfoundry, a building about 80ft. by 70ft., containing the brassfoundry and a brass-finishers' machine and fitting shop, stores, etc. The installation of electricity was begun 10 or 12 years ago in the engine works, when a compound-wound dynamo of about 22 kw. at 110 volts output was put down to run off the shop shafting and drive two overhead cranes—one, a 30-ton crane, in the boiler shop, of the three-motor type, and one, also a 30-ton crane, in the erecting shop, of the single-motor type, driving the different motions by belts run off a common countershaft with fast and loose pulleys. The other cranes—a 10-ton and a 30-ton, in the erecting shop, and a 10-ton and a 40-ton, in the boiler shop—were driven by a square shaft running the whole length of each shop. The next addition to the electrical installation was when the present offices were built. They were lighted electrically at 100 volts by a secondary battery, charged by a dynamo driven from a gas-engine and placed in a room under the joiners' shop, which adjoined the offices. Shortly after this the subject of electric driving, which had often been mooted, was once more seriously discussed, and it was decided to convert the engine works to electric driving, as the shops were underpowered. Plans were made and the work was put in hand. A power-house was formed by building a retaining wall at the embankment on the north-east of the engine works and extending the old engine-house, which was at the top of the bank, towards the east, forming a building about 60ft. long by 53ft. wide. In it were laid down two direct-coupled, 220-volt, continuous-current, compound-wound generators and triple-expansion enclosed engines, each of 168 kw. output at 380 revolutions per minute. These two were placed in the middle of the floor space, and room was left for another set of the same size on each side of the two sets, which sets were afterwards added. The distance of the engines from the boilers was about 100ft., the main steam-pipes being led inside the wall of the engine works. A surface condenser of 1,200 square feet of tube surface, with steam-driven Edwards air-pump and circulating pump, was laid down, and a Klein water-cooling tower to deal with 12,000lb. of water per hour was erected outside the power-house on the south side. The main switchboard had three panels (one spare), with an automatic overload cut-out for the generator, main dynamo switch, ammeter, voltmeter, and equalising switch on each panel, while a main pair of 'bus bars, off which the circuit switches were taken, ran right across the board. A three-ton overhead hand traveller, running the length of the power-house, was put up. Steam was supplied at 160lb. working pressure from two multitubular marine type boilers, with about 1,350 square feet of heating surface, and fitted with mechanical stokers and feed-water filters. The arrangements for feed-water heating were crude, consisting merely of leading the exhaust steam from two horizontal Tangye pumps, used for supplying the hydraulic accumulator, into the storage tank for the softened water. The water softener itself was of the Archbutt-Deeley type, capable of dealing with 600 gallons per hour. The work done by the 110-volt plant before mentioned was, of course, put on to the central-station plant, the motors on the cranes being converted to 220 volts.

Distribution and Wiring—The distribution throughout was on the two-wire system. Both power and lighting circuits were taken off the same pair of 'bus bars on the main switchboard, to distribution boards in various parts of the works, from which sub circuits were taken to motors and lights. In some cases motors and lights were kept on separate circuits, the distribution boards for motors consisting of a pair of 'bus bars on slate with double-pole fuses for the main feeders and a double-pole fuse to each sub-circuit. The lighting boards had arc lamp switches and main incandescent circuit switches, as well as double-pole fuses to each sub-circuit and to the main feeders. In the case of isolated buildings—viz., the pattern shop, quay shop, brassfoundry, and shipyard blacksmiths' shop—

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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the same distribution board was used for both power and lights, with one pair of main feeders, and although there was considerable relative fluctuation of the motor load in these places, there was no flickering of arc lamps sufficient to cause appreciable difference in the lighting of the place. Probably, if the generators had been shunt wound, flickering of lights would have been more noticeable, but even then it is so slight as not to justify the extra expense of installing separate mains for lights and motors. All conductors, whether main feeders or sub-circuits, were insulated, as a rule, with insulation graded at 600 megohms insulation resistance, for the reason that it is impossible to handle and dangerous to work near to bare conductors, and "aerial" conductors are dangerous from their apparent safety and the ease with which their slight insulation disappears in patches. A very good instance of the advisability of insulating main feeders occurred in 1901, when a disastrous fire gutted most of the engine works. All the cables to the shipyard (12 in all, of which the heaviest pair were $^{61}/_{12}$) were run along the engine works roof before the fire, and, to allow of rebuilding, were moved after the fire on to temporary poles across the boiler yard. In view of the work necessitated (which could only be done at week-ends, when the shipyard was shut down) in getting these cables back on to the roof, and their inconvenience when there, it was decided to lay them underground in the boiler yard. A cast-iron trough was laid, the cables were placed in it, and filled in with bitumen while they were alive—a job which could not have been accomplished with aerial or bare conductors without stopping the shipyard and causing very serious loss. In engineering works, where it essential that work should be carried on uninterruptedly, it is important that a system of wiring, such as the distribution board system, on which any section or sub-section of the electrical apparatus can be easily isolated, should always be adopted. Joints in main wiring should not be made, if possible. If they are inevitable, double-pole fuses should always be inserted at the joint. Earths on the system, if neglected, raise the repair cost bill very much, to say nothing of loss by stoppage due to breakdown; and it is important that as soon as a fault comes on it should be located at once, and the first possible opportunity taken to isolate and put right the faulty section. This is a much easier matter where it is only a matter of drawing fuses to isolate any portion of a circuit. It might have been advisable to have wired the lights on 220 volts with a middle wire—*i.e*, 440 volts between the outers—but the author thinks it is very doubtful, as arrangements would have to be made for balancing, and the cost of this in an installation of this size would probably have more than outbalanced the saving in copper. In addition to this, the load, when the first installation in the engine works was laid down, was carried by one dynamo, so that the three-wire system was impracticable, and later, when two or more dynamos were required, the advantage of the higher voltage across the outers was of no avail, as the heavier cables required for the 220-volt two-wire system were already installed.

Type of Engines for Generating Plant.—The choice of motive power for generating current depends largely on local circumstances—the price of coal, water, etc. Where water power sufficient is available, it is the least costly in running expenses, but as water power is so infrequent in this country, it need not be discussed. Gas and oil driving seem to be coming more or less into use, but, except in the case of works with blast-furnace plant, where an enormous power, which would otherwise go to waste, is at hand, or where the output is big enough to justify a special gas plant of the Mond type, probably does not successfully compete with steam. Where steam is used, the high-speed direct-coupled enclosed engine takes a lot of beating. If coal is very dear, and the load on the plant very variable, it may be advisable to put in slow-speed engines, with Corliss or similar valve gear, so that every possible ounce of steam may be saved up. But the capital cost of a slow-speed engine is very much greater than that of a high-speed one, and it takes up much more room, which considerations may outweigh any increased economy. It is a mistake to think, as some people do, that a high-speed enclosed forced-lubrication engine requires an inordinate amount of attention, or that it is beyond the power of an engineman who has been accustomed all his life to the old slow-speed D-valve engine to manage it satisfactorily. It is extremely simple, and if care is taken to see that the oil is kept right as to quantity, that it is drained of water, and changed and filtered at required intervals, it requires very little attention beyond taking off the doors occasionally to see that nothing is coming loose, and a thorough inspection, say, every six months or year. It will run all right with very much less attention than a slow-speed engine with complicated valve gear. The author has had no actual experience of steam-turbine driving for large generators, but is inclined to think that there is very little to choose between them and reciprocating engines, the balance, if anything, being in favour of the reciprocating engines. The steam efficiency of turbines seems, as a general rule, to be slightly less than that of well-designed reciprocating engines, though this is a question which seems to have been lately well thrashed out in the columns of technical papers. In selecting a suitable size of unit to adopt for an installation, first of all, the loads for all portions of the day and night, for power and lights, should be calculated out. In doing so it must be remembered that in altering driving arrangements it is possible, in the majority of cases, to speed up tools of all kinds and increase their output; this adds to the power required to drive them. The size of the unit should be based on the minimum regular load required, and should be, if possible, such that, whatever the load is, the generating plant, or such portion of it as is running, is running as near to full load as possible. A spare generating set, over and above the plant required for the maximum load, should be laid down. No hard-and-fast rule can be laid down for the size of the generating units, but it is generally possible to manage so that the number of units running at full load can be altered to suit the work's requirements, without making their size too small for good efficiency, and yet the cost of the stand-by plant is not unreasonably great.

Main Switchboards.—The type of main switchboard built and supplied by the leading manufacturers for installations such as that in the works under discussion, is so well known that it seems rather unnecessary to mention them. There is no doubt that the small panel system, by reason of the easiness of extending the board, ought to be used. The generator panels should be fitted with main dynamo switches and fuses, automatic overload circuit breaker, ammeter, voltmeter, recording meter, and the necessary paralleling switches for each dynamo. The dynamos feed on to a pair of main 'bus bars, off which the circuits are tapped. The circuit panels should have double-pole switches and fuses for each circuit, with preferably an ammeter in each circuit. The author does not think that overload circuit breakers are necessary on every circuit, and where it is advisable to introduce them in the circuit—as, for instance, in crane circuits where there are bare trolley wires liable to be short-circuited—it is probably best to put them in the shops where the circuits are doing their work, so that in the case of a short-circuit occurring, the switchboard attendant does not try to switch them in circuit again, and so, perhaps, bring out the dynamo circuit breaker. A very necessary fitting on a switchboard is an earth lamp with a two-way switch connected on to the 'bus bars. It can then be seen at once whether any earths exist, a thing that is not always bothered about if someone has to take the trouble to rig up a lamp with a couple of wires and test at intervals.

Motors.—The motors in the engine works and shipyard used for driving the constantly running machinery were all shunt wound and of the enclosed or semi-enclosed type. The sizes varied from 6 h.p. to 40 h.p., and the standard sizes adopted were 6, 10, 15, 20, and 40 h.p. Wherever possible, any new motors put in were of these standard sizes, so as to keep spare parts to a minimum and inter changeable. The motors on three-motor cranes, and where driving single reversible machines direct, such as plate rolls, were series wound. The total rated horse-power of the motors in the engine works, brassfoundry, and pattern shop was 476, the total in the shipyard being 568. In the engine works, machine and boiler shops, except in the cases of the large machines, such as the big vertical planers,

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plate-edge planers, and boring-mill, etc., all the tools were driven off lines of shafting by a single motor. In the case of the large lathes for turning propeller shafts, the conversion of which took place before the author's arrival on the scene, this was probably a mistake. In the extensions of the engine works, now taking place, all the big lathes will be direct driven by separate motors with speed regulation. At the time of the installation of electric power, large use was made of drills and chipping tools driven by compressed air, and the author experimented with portable hand electric drills for the purpose of comparing them with the pneumatic in weight for power, cost, and efficiency. The conclusion he arrived at was that for holes up to about $\frac{3}{8}$in. to $\frac{1}{2}$in. in cast iron, the electric drill was superior to the pneumatic in first cost, cost of running, efficiency, and weight for power given. For holes above that size, the first cost of the electric drill gets much greater than that of the pneumatic, its efficiency is much higher, and its weight for power becomes prohibitive in a crowded shop or where the drill has to be moved about much. It may be interesting to give a few figures, from tests taken, as to the power absorbed by tools, etc. (see Tables A, B, and C).

TABLE A.—Turning Wrought-Iron Propeller Shaft.

Tool.	Lbs. of metal removed per hour.	Cutting speed, feet per minute.	Cut.	Traverse.	Net B.H.P.	Lbs. of metal per B.H.P. per hour.
No. 1	284	28	·5in.	$\frac{3}{32}$in.	8	35·5
No. 2	284	28	·5in.	$\frac{3}{32}$in.	9	31·6

TABLE B.—Planing Edge of Steel Boiler Plate 1¼in. + $\frac{3}{32}$in. thick.

Test.	Depth of cut.	Cutting speed, feet per minute.	Lbs. of metal removed per hour.	Total B.H.P	B.H.P in cutting.	Lbs. of metal per B.H.P. per hour.	Remarks.
A ...	—	13·5	—	6·75	—	—	Tool running
B ...	$\frac{1}{16}$in.	13·5	221·3	28	21·25	10·4	— light
C ...	$\frac{3}{32}$in.	13·5	331·7	34	27·25	12·15	—
D ...	$\frac{1}{8}$in.	13·5	110·7	18	11·25	9·85	—
E ...	$\frac{3}{16}$in.	13·5	165·8	25	18·25	9·01	—
F ...	$\frac{3}{32}$in.	13·5	—	45 about	—	—	Tool very blunt

These figures were taken on the ordinary work done by the planer. The tool was of ordinary tool steel, and it was worked with feed and speed at which it would remain fairly sharp for about an hour. It will be seen from the reading F what a very great difference a blunt tool will make, this tool being one that had been taken out for regrinding. As will be seen, it was useless for anything like a heavy cut, the motor fuses blowing at once. These figures are, perhaps, not of much value as far as the powers required for any individual machines are concerned, but they are useful to form a rough estimate of the power required for groups of tools, which is a different thing. The starting currents for Nos 12, 13, 14, were taken to show the heavy torque required to start the class of machinery with heavy moving parts, such as that used in a shipyard. The usual average of time taken to bring these machines from rest to full speed would be 20 to 30 seconds, and in all three cases it will be seen that the peak of the current taken at starting was considerably over the rated full-load current for the motors, although, looking at the other figures, one migth think that smaller motors could be safely used. As the speed of these machines need not be very constant, and to help at starting, it is better to have a few turns of series winding on the motor field coils. The author thinks it advisable, as machinery of this class is, as a rule, scattered, intermittently used, and generally started and stopped by any man who may want to punch a hole in a plate, and knows nothing about electricity or electric driving, to keep well on the liberal size when selecting sizes of motors, so that rough usage is less liable to cause breakdowns. Three or four hours' stoppage of a single punching machine at a busy time may cause more loss than the loss in a year due to the less efficient running of a motor larger than is absolutely necessary. Wherever several machines were grouped within a short distance of one another, the plan was adopted of placing the double-pole switches and starters for the motors of the group in a cabin at a point visible from all the machines, and putting a boy to do all the starting and stopping of the machines in the group at signals from men going to use the machines. In all cases of driving separate punching and shearing tools belt drives were employed in preference to spur or chain gear. When starting a heavy torque is required, and a belt allows of a certain amount of slip till the machine has got up speed, and relieves the motor of some of the strain it would have were it rigidly connected to the gear. Also, in the case of punching the motor has very little to do with the actual punching. It gives the moving parts their inertia, and this inertia carries the punch through. Even during the quarter second or so taken by the punch to travel through the metal, the speed of the machine is affected, and here again a belt drive is advantageous, for the belt will slip, and reduce the momentary load thrown on the motor, where rigid gear would give it a big shock, to say nothing of the risk of breaking teeth on gear wheels, a much more serious matter than a broken belt. The author has seen a heavy 4ft. cast-iron spur wheel, with teeth about 1½in. thick at the root, and 6in. wide, with very heavy arms, rim, and hub, smashed in four or five pieces on one of these machines in shearing an angle bar, while the belt, although without guides, did not even come off the motor pulley and flywheel. In the case of shearing machines, the working stroke—*i.e.*, the period when the blade is actually cutting through metal—lasts for a much longer proportion

TABLE C.—SCHEDULE OF WORK DONE BY MOTORS AND POWER ABSORBED BY THEM.

No.	Machinery driven by motor.	Max. starting current.	Min. B.H.P.	Max. B.H.P.	Normal working B.H.P.	B.H.P. absorbed in shafting.	Remarks.
1	1 24in. planer, 1 9in. planer, 1 24in. circular saw, and joiners' shop machinery driven off shafting	—	6·25	25	10 12	6·25	About 30 or 40 hands in shop.
2	1 30in. wood planer, 1 set grindstones for sharpening, driven off shaft	—	—	16	8·10	4·75	
3	1 large frame saw, 2 30in. circular saws, driven off countershaft 20ft. long	—	—	36	12·15	6·5	
4	1 30in. rotary planer, 1 set small grindstones, 1 24in. circular saw, 2 small lathes, 1 facing machine	—	—	17	8·10	4·75	
5	1 30in. band saw, 1 30in. circular saw, 1 24in. rotary planer, 1 6ft. grindstone, 40ft. of shafting	—	—	31	7·5·10	4	About 25 to 30 hands in shop.
6	1 6ft. grindstone, 1 slotting machine, 5 or 6 small lathes (metal)	—	—	25	14-16	—	
7	About 20 small lathes, etc., 140ft. of shafting, 3⅞in. diameter	—	8·25	20	13	7·25*	= ·0518 h.p. per running foot [to drive shaft. * No
8	1 3ft. planer, 1 drilling machine, about 10 lathes, screwing machines, etc.	—	7	18	10-12	6	[belts on main shaft.
9	1 pneumatic 10cwt. hammer, 1 blower for 24 fires.....	—	12	20	—	—	
10	1 blower in smiths' shop, feeding 1 7in. nozzle flanging fire, 2 4in. nozzle ditto, 20 hearths	—	6	10	8·5	—	
11	1 blower feeding 46 smiths' fires, 22 working.....	—	—	—	20	—	
12	4-sided punch, having 2 1¼in. punches and 2 8in. by 8in square punches.....	71 amps.	4	16	5·5	—	Motor rated at 15 h.p.
13	1½in. punch and shears	57 amps.	3	14	5	—	Motor rated at 15 h.p.
14	1in. double Cameron punch	48 amps.	3	8	6	—	Motor rated at 10 h.p.

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of the total stroke, but the conditions are very similar, and the belt drive gives elasticity which cannot be got by direct spur driving. The stroke of a shear blade is less of a blow and more gradual than in the case of a punch, and lasts long enough to appreciably overcome the inertia of the moving parts, the motor thus having a harder job than when punching.

(To be continued.)

SIMULTANEOUS TELEGRAPHY AND TELEPHONY.*

BY JOSEPH HOLLOS.

The question of simultaneous telegraphy and telephony is not of recent date. While, however, in some places good results have been obtained, in others the advantages reached by this combined using of telephonic circuits are hardly worth mentioning, and in view of the difficulties experienced in the service it was thought better to abandon the scheme.

If we look closer at the question, we can at once observe that wherever the telegraph and telephone services are under the supervision of one and the same interested person the results obtained are excellent. Where, however, the two systems are in different hands the result is unsatisfactory. Thus, in America, where the financial interest of the telephone companies is involved, because of the desire to increase income by leasing lines for simultaneous telegraph, and where, for this reason, these two operations are under the control of one technical staff, the result is excellent. The results are also fair in the European services, if the same technical officer supervises both telegraphy and telephony, and one service is co-ordinated with the other. The result is, on the contrary, very poor in all cases if the telegraph and the telephone services are in different hands.

This is evident if we consider how greatly the one system interferes with the other—that is, that careless handling of the one interferes at once with the proper functioning of the other—the two systems thus being brought into mutual opposition. For this reason the service must be arranged in such a manner that the two systems cannot interfere with each other, and in as far as troubles are unavoidable, they must be reduced to a minimum. If they should exceed, certain arrangements must be provided to hold out the less important service without delay.

In this direction the Hungarian telegraph and telephone service can show good results by comparison with similar installations, and, therefore, it will not be without interest to outline the principles which were followed in the formation of the system. Above all, the simultaneous installation must be the simplest possible, because only thus and with the fewest possible instruments may undisturbed working be obtained. For this reason the method of simultaneous working founded on the Wheatstone bridge principle, was made the basis of procedure.

The telephone circuit is closed through two inductive branches. At their point of intersection the battery branch is led off to the group of telegraph apparatus, while the telephone apparatus is placed in the so-called galvanometer branch. It is thus evident that the connecting-in of the telephone apparatus—namely, the leading of the telephone circuit through the switchboard—requires some care, because if there is a ground in the switchboard connections the telegraph working is disturbed. Even if one telephone circuit is directly connected to another, and there be simultaneous working on the latter, the two telegraph simultaneous systems are brought into contact, which again causes marked disturbance. This may also be caused by the operators ringing simultaneously on several circuits from the same common source of ringing current.

Even if only one of the circuits fed from the common ringing source is connected for simultaneous telegraphy, such working will still be slow, because in ringing on the simultaneous conductor we ring also on five or six other conductors. However well insulated these circuits may be individually, the insulation of the simultaneous telegraph circuit will be so far reduced by the connection that it will hardly be possible to maintain continuous telegraph working.

It is true that we can remove all these difficulties at one stroke by connecting the incoming telephone circuit, before leading it to the switchboard, to a repeating coil, and working then only on the other half of the repeating coil. But by this plan the difficulty is only transferred to the other side—the telephone side. Above all, we have a loss of energy in the repeating coil, to which are added losses inevitably occurring in the signalling apparatus, and it may happen that with such an arrangement the telephone subscriber does not get as much as 50 per cent. of the incoming speaking energy into his receiver. We must strive, therefore, that along with the undisturbed working of the telegraph, the telephone working be kept at the same relative level that would exist in the absence of simultaneous working. Moreover, the repeating coil not only weakens the speaking current but also the calling current, and we must, therefore, take precautions in this direction.

Under these conditions it is inadvisable to connect the circuit first to the repeating coil. As long as the circuit is on the calling apparatus there is no danger of disturbing the simultaneous working. The disturbance arises only at the moment of connecting. For this reason it would be sufficient to place the repeating coil in the connecting cord; but in the same path there is also the clearing-out signal, and a great loss of energy might thus be incurred. This we may, however, remedy if the repeating coil is constructed in such a manner as to serve at the same time as the clearing-out signal.

The clearing-out signal is, as a rule, connected in the bridge between the two branches of the circuit, and its duty is by its great self-induction to prevent the wasting of any considerable part of the speaking current. How far it is able to satisfy this demand might be readily ascertained by inserting a receiver in the shunt path. In spite of thus increasing the impedance of the bridge we still obtain intelligible speaking even with a clearing-out signal of 2,000 ohms resistance, if the latter is entirely embedded in iron. These currents do not so rigidly follow the rules which apply to strong currents, and therefore inferences drawn from such rules do not apply in this case, as may be shown by a simple experiment. With such a clearing-out indicator, 30 per cent. of the energy is lost on the average, and 70 per cent. only is available, as I have been able to ascertain myself.

With a well-constructed repeating coil, if arranged as a clearing-out signal, the loss is not greater. Consequently, if we insert such a repeating coil into the connecting cord, simultaneous working without affecting the telephone is secured. The repeating coil transformed into a clearing-out drop naturally possesses a closed iron circuit. In European practice this plan is avoided, and an open-circuit repeating coil is generally preferred. The question whether the repeating coil has an open or closed magnetic circuit does not affect the high frequency involved, and for weak currents this is of much less importance than the other losses that arise in an open-circuit repeating coil. For relatively strong signalling currents the closed iron circuit is of decided advantage, because, with open-circuit repeating coils, it is only exceptionally possible to ring through with alternating current, while it is always certain when there is a closed iron circuit.

From the point of view of simultaneous working it only remains to separate the ringing currents. This may be accomplished if alternators are used by branching the ringing current at each operator's position on a separate repeating coil. Where batteries are used, which are to-day exceptional, each operator's position must be given its separate battery.

In the simultaneous working apparatus itself the branching coil is of the highest importance. It is most important that the inductance on the two sides should be equal. This is more important than the exact equality of their ohmic resistance. This, however, determines not only the resistance of the coil, but also the size of copper wire to be used.

From the point of view of choking, it is desirable to use long coils; such coils, however, by reason of the phenomena of dispersion, prevent the complete neutralisation of the telegraph currents, and, therefore, it is necessary to select short coils. With such an arrangement the operation of

* A paper presented before Section G of the International Electrical Congress of St. Louis.

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the telegraph apparatus is not perceptible on well-balanced telephone circuits.

GLASGOW'S NEW TRAMWAY MANAGER.

The mantle of Mr. John Young has fallen upon Mr. James Dalrymple, who during the last three years has fulfilled the office of deputy manager. Mr. Dalrymple has served in various departments of the Corporation for 23 years, and has been associated with the tramways since 1894. As accountant he was entrusted with the management of the tramway finances, and, like Mr. Young, he entertains strong opinions on the subject of depreciation. He has devoted considerable attention to the subject of tramway economics, and was invited to present his views before the Royal Commission on Municipal Trading.

MR. JAMES DALRYMPLE.

In 1901 Mr. Dalrymple was appointed deputy manager, and the Convener of the Tramways Committee, in recommending him for the managership at the meeting of the Corporation last week, stated that the committee had no hesitation in selecting such a tried official for the important position hitherto held by Mr. Young.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

XI.—On Mixing with the Men.

My Dear Young 'Un,—I am sorry to hear that you went to Jack Blogson's benefit last week. Who Jack Blogson may be I have not the remotest idea. I am fully prepared to hear that he was a hard-working turner who got himself tied up in the back gear of his lathe and has been out of employment for 18 weeks; that he has six children and a small wife who takes in washing—this being their only means of subsistence. Yet, while offering every sympathy to the man (and if you had a direct subscription list I wouldn't mind putting my name down if the affair struck me as worth it), yet I would point out to you that this benefit was, as you admit, held in a low pub, that quantities of beer were drunk, that some of the songs were high—almost decomposed, in fact—and that you had a fearful time getting the foreman home. Now, who got the benefit of that orgy? *You* didn't, because you wasted an evening and got a fat head. Jack Blogson didn't, because he got blind drunk, and his small wife had to come and steer him home. The man who got the benefit was "the gent wot howns the 'otel!" And I may tell you this: you have lost caste with the men. They may call you a jolly good fellow, and hit you on the back, if that is any use to you, but down in their own minds they have lost that respect for you as a man who has sterner ambitions than their own. You have now got a couple of months' leeway to make up.

This question of mixing with the men is a most difficult one—particularly at your stage. Later on, when you have got some practical knowledge of your own to go on, the difficulty will vanish. But at present you have all your shop experience to learn, and the men who will teach you—or "take the twist" out of you, as the case may be—are the fitters and turners around you; you must therefore keep in touch with them. At the same time, if you clog yourself with their mire you will incapacitate yourself from rising. More than once I have seen a smart young fellow barred from a position of trust because he was too hail-fellow-well-met with the men for whom a foreman was wanted. You must hold yourself in reserve a little. Remember that the operatives about you have got on to the flat of their curve, while you are still on the upward slope. Although, judging by shop standards, your ordinate may at present be shorter than that of the fitter next to you, yet your maximum is going to be a lot bigger than this, and he won't forget it if you don't.

I am of opinion that this mixing with the men is the cause of the shoal of mediocre engineers we have about at present. It isn't the fault of the colleges or shop systems; it is the fault of the students. A man comes from college with a consciousness that he is in for an entirely new set of experiences. Young and not altogether self-reliant, he hastens to make friends-of-convenience of the men he is working with. This is usually done by "paying his footing," which consists in handing away sums of money to the nearest bar-keeper to lubricate the throats of comparative strangers. This species of blackmail is all the more galling because etiquette demands that it must be performed with an appearance of extreme gaiety and good-fellowship which is not really felt by either party, because at that stage neither knows the other.

The wheels of life having been thus lubricated, the workmen will now try to sell tools to the novice, disposing of their old and worn-out stock; and their further estimation of his character will depend upon the combination of acumen and affability which he displays. In any case he will probably be had, but the all-important object of making acquaintances will now have been achieved.

And when this is done, what is gained?

Why, the man next to him will mark his approval of the newcomer by saying he knows a chap who does a little book-making in a quiet way, and who has just given him a sure tip for the Doncaster. Would the newcomer like to put anything on it?

If the newcomer is a wise man he will give a decisive and ornamental *NO*, because that is just where he is going to spoil himself. Beer-guzzling and horse-racing are the two biggest vices of the British workman, and these vices won't run in parallel with study for a month. If you start these capers in order to please your workmates, you are just taking the short cut into the ditch. Better plod along on the main road of hard study and initial unpopularity. Your reward will come later.

In talking on this subject, however, I must let you see the other side. It is no good being a snob or a recluse. You are going to do yourself almost as much harm that way as the other. The man that I always wanted to grind up against the wall and push about the dirty floor, when I was in the shops, was a haw-de-haw youth who was always reminding everybody that his father was the principal shareholder, and that he himself was on his way to the assistant manager's chair *vid* the drawing office. Inexplicable accidents were always happening to that young man, and the number of times the fellows had to beg his pardon for inadvertently putting their gear wheels and other impediments where he was bound to trip over them was incredible. He came to a bad end. He committed the blazing indiscretion of bringing his best girl round the shops one day, and then the band played! While he was explaining what the belt was for on a lathe, and while he was describing the process of case-hardening, there was a gentle whistling chorus of "Here we come gathering nuts in May!" Nobody was doing it—everybody hard at work! But everyone was looking pleased except the foreman, who had been tipped. The girl couldn't stand it; she fled incontinently, and our young duke followed. There was an office enquiry of the largest dimensions, but as nobody had done it, nobody was nabbed. But the dukeling never came back.—Yours,

The Old 'Un.

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TO CORRESPONDENTS.

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THE METRIC SYSTEM.

The agitation in favour of the metric system, as might have been expected, has commenced directly the vacation was over. The Rugby Engineering Company has the matter under discussion. It will be seen from the report, given in another column, that opinions are somewhat divided. The result of the discussion, for or against, will be known at the adjourned meeting next week. It is fortunate that just at this juncture the opponents of the system have entered the field. As the late Sir Frederick Bramwell so aptly remarked, there is always a danger in this country of having an objectionable new departure more or less forced upon us because its advocates are sincere and active, while its opponents, being satisfied with what already exists, do not make their opinions and power felt. Such is the case with regard to the metric system. Its advocates are persistent in their efforts to force it upon an unwilling population; and as the opponents have hitherto not acted in combination, very little weight has been given to the opposition. We do not pretend for a moment to suggest that the advocates of the metric system are not sincere; they are, and it is owing to this intense sincerity that troubles may arise. The text of the advocates of the metric system is fairly summed up Mr. Briggs, the advocate of the system before the Rugby Engineering Society: "The most elementary question which naturally presents itself is, 'Why should we adopt the metric system?' Leaving aside the wider interpretation, the answer is, 'Because of the ever-increasing necessity for an international system of weights and measures.' Admitting of such necessity, the questioner next asks, 'Why should we change our system of weights and measures, instead of the Continental nations changing theirs?' to which we reply, 'Because the metric system of weights and measures is greatly superior to the Imperial system.' With the advocates of the metric system rests the *onus probandi*." We are not going to dwell on the advocacy side of the question—that can be read on another page. We are opponents, and welcome the formation of the British Weights and Measures Association, which has for its objects the defence, standardising, and simplifying of British weights and measures. The executive of this association consists absolutely of practical men, with not a single representative of academic learning amongst them. In this controversy it will not do to count heads. We have rather to estimate values, and, in our opinion, the views of such men as Denny, Kaye Gray, Musgrave, and Paxman outweigh the views of all the academies and schools in the kingdom. The gist of the small pamphlet just issued by the association may be summarised: "The persistent efforts of the advocates of the French metric system to get it enforced in the British Empire have brought into being the British Weights and Measures Association, whose primary object is to combat the metre. It also seeks to standardise and simplify British Imperial weights and measures, so as to make them in the greatest degree available for all purposes. There is a risk that the metric advocates will be successful if opposition is not organised, for the tendency is to let judgment go by default on account of the ignorance which prevails as to what the suggested reform really means to Britons. Believing that the enforcement of the metre in the British Empire would be a national calamity, we seek not only to organise those whose studies of the subject have enabled them to see the hollowness of the metric pretensions, but also to provide means of educating those who now directly support the metre by reason of their knowledge being limited to theoretical application, and of those by whose apathy the movement receives negative support, and who may possibly have never

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had occasion to give the subject a thought, but who will be sufferers by it should it be enforced." It is pointed out that the system known as the metric system is but a fragment of what was originally intended, and even this fragment is not universally accepted in the nation of its birth. All those that go down to the sea in ships refuse to have anything to do with the metric system It is to them an impossible system. And if it cannot be applied on sea, its advocates suggest that there should be one system applied on land and the other on the water. Then again, the textile industry even in France will not accept the system. In the manufacture of cotton, woollen, worsted, linen, jute, and hemp the English system is practically universal. It is based on yards, inches, pounds, ounces, drams, and grains. The drastic laws that have been made in France to compel the use of the metric system have been but partially successful. The French hatting trade threatened with the infliction of the metric measures strongly objects. The English measurements of draught, displacement, and tonnage are universal. The metre is just as much an artificial unit as is the yard. The metre is too large a unit for engineering work, and the millimetre is too large for the finer work. Far better, according to these practical men, is the mil of one-thousandth part of an inch. The fact of it is the glamour of the metric system, when analysed, has nothing to do with the metric system itself, but simply depends on the decimal system. Again referring to the late Sir Frederick Bramwell, he was always caustically sarcastic when dealing with pure decimalists, maintaining that in an equal number of cases familiarity with vulgar fractions was just as useful as familiarity with decimals. One of the arguments put forward by the advocates of the metric system is that it has been adopted by this, that, and the other nation. Well, that is like the nonsense talked about American progress in certain directions. America was an open field, hence there was room for anything. So with those nations as regards metric or any system, open to anything that came along, and took the first thing that politics pressed upon them. Let us see what the opposing association says on this point, and we trust we shall hear little more of that particular phase of the argument: "When the metric advocates are beaten on all other points, they invariably fall back on the sentimental idea of having one language for weights and measures throughout the world. They point out that thirty-six out of thirty-nine civilised nations have already adopted the metric system, and it is only common justice that the minority—British Empire, United States, and Russian Empire—should give way to the majority. That looks very plausible, but what of the relative importance of those countries. Taking those thirty-six nations in order of population, none of the first four have the population of Liverpool. Lancashire has more inhabitants than any of the first eighteen. The total of the first twenty-four is only equal to the population of the United States. There is a larger population within fifty miles of Manchester Town Hall than in any one of the first twenty-five of those nations. The Russian Empire has a population equal to the first twenty-eight, and the British Empire alone has four million more people than the first thirty-four added together. Counting the three against the thirty-six we have 567 millions against 445,296,000, and the measures of those 567 millions are all based on the English inch. Looking at the question from the point of view of trade and commerce, the Anglo-Saxon race alone has the pre-eminence, which makes the vaunted position of metre users ridiculous." There is another point noticeable in many of these agitations: the advocates are either men of merely academic training or men directly engaged in competition with this country, hence desire to foist their own system—worse or better—thinking that any change plays into their hands.

THE TRUTH v. "THE JOURNAL OF GAS LIGHTING."

Our contemporary has evidently taken to heart our strictures of last week, and has done its best in reply. It makes certain that we shall see the reply, and so kindly sends a copy of its issue to this office. Many thanks for so doing, but as we have subscribed to the *Journal* for many years, the duplicate copy is wasted. We are glad of the further opportunity the *Journal* has given us to express our opinion as to its tactics. We have no word to say in its favour, no word to withdraw from what it terms our vulgar abuse; rather to add to what we have said, and in still stronger language to show the contemptible manner in which the *Journal* treats things electrical. It now admits that its usual method of dealing with electrical matters is to take second-hand statements, because "the original financial statements of electrical undertakings do not with great frequency get addressed to the office of the *Journal of Gas Lighting*." Our contemporary makes merry over slackness editorially, but does not see the gulf into which it has itself sunk. Here is a paper which every week for years past has sown broadcast statements culled from other papers without any editorial attempt to get information at first hand. We should have thought a paper taking up the position the *Journal* has taken would have made certain of its facts from original documents—which, by the way, it can as easily get as we can, at a small cost or a little trouble. Now, what is the policy of the *Journal* as regards electrical work? There is no doubt but it has for years set itself to damage the electrical industry, and to do this provides its readers weekly with electrical memoranda. These memoranda are consistently of the truthful character, but usually only half the tale is told, and to combat a half-truth satisfactorily is the most difficult operation. The selection of items, again, in this weekly trash is very peculiar. They are always of a character to lead the reader to decry electrical work, and never by any possible chance record much that is of a satisfactory nature. If this is not delving in dirty ditches, what is it? Our sapient contemporary is wise enough to try and twist our words to a meaning they do not bear. Our electrical contemporaries are *not* the dirty ditches. They record good, bad, and indifferent matters. They do not always agree with us. We do not expect it, and should not respect them if they did. But the *Journal* picks and chooses from this second-hand stuff, and picks only that which seems damaging. It makes its own dirty ditches, and does not find them already made. Take the *résumé* of the current number. It deals with the muddle at Dublin, a gentle rap over the knuckles at Southampton, Dartford and the Local Government Board, ourselves, and Wrexham. There is no redeeming feature, there is no good in anything electrical, so far as the *Journal* is concerned. To us it borders on the infamous that any so-called respectable journal should always flaunt in its columns what is thought damaging and never admit aught that is encouraging to an industry. It pretends that it did not see in the sentence we inserted—involved as it is acknowledged to be—that there must be an error. There could not be two deficits differing in amount. The fact is, our contemporary was only too eager to pounce upon figures that seemed to favour its methods of discussion, and did not expect to have to acknowledge its second-hand method of getting information. It is the champion of gas. Let it remain so, but if it presumes to give electrical information, let it be honest and

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say it only gives the most damaging it can find in all the other papers, and carefully refrains from checking from original sources.

OBITUARY.

The late Desmond G. FitzGerald.

It is with exceedingly deep regret that we have to record the death of Desmond G. FitzGerald, who passed away at his residence at Clare, Suffolk, on Sunday last in his seventy-first year. In our estimation the late Mr. Desmond G. FitzGerald has never obtained the general recognition his ability and devoted work in the service of electrical science deserved. The son of the editor of the *Morning Post* in its palmiest days, he was in his youth familiar with the talent and the beauty of the early Victorian period; partly educated in France, he witnessed the scenes of '48, and undoubtedly his whole life was tinged with the teachings prevalent in the France of that period. He entered the War Office, but monotony and the routine of official life did not appeal to him, whose delight was scientific investigation, and especially in the domains of chemistry, electro-chemistry, and electricity, and his object was in the commercial application rather

THE LATE DESMOND G. FITZGERALD.

than the mere accumulation of facts. That he appreciated work in other directions will be agreed if we mention that he was one of the earliest inventors who endeavoured to perfect the breech-loading rifle. We believe it was in 1861 he resigned his position at the War Office in order to devote his whole attention to the production of a weekly paper devoted to electrical subjects, and thus the *Electrician* started. The task he undertook was Herculean, and although the paper was conducted with the greatest ability and energy, the time was not ripe for so big a venture, and after a few years it ceased to exist. Later on he assisted and for a time edited the *Electric Telegraph and Railway Review*, which also, after a short precarious existence, ceased to be published. A careful examination of these early papers cannot fail to prove to the most sceptical that it was from no lack of energy or ability or material that they failed, but that the public interested was not sufficiently large to guarantee success. Mr. FitzGerald also contributed largely to the *Engineer*, to the *English Mechanic*, and to other technical papers. To turn to another side of his labours, during the whole of his career Mr. FitzGerald was an assiduous experimentalist, and, if we dare venture to say so, failed but by a hair's breadth to become one of the greatest of British inventors. If the records of the Patent Office are searched, there will be found specifications relating to electro-chemical products, to telegraphic apparatus, and to secondary batteries, any of which, falling into the right commercial hands, might have created an industry. We in this brief notice can but indicate the inexhaustible energy of the man. During the greater part of these years he was not only writing, experimenting, and inventing, but he was teaching, and, indeed, was the principal teacher in the school of telegraphy which was opened in the sixties, and carried on during many years by Mr. Lundy, subsequently by his widow and Mr. Jones. A great majority of the men who entered the cable service in the sixties and seventies received a training under him. Turn we now from the work to the man. He was an original thinker and a capable teacher, while his command of the English language as a writer and a speaker was unique. This might not usually be gathered from casual observation, because of a hesitancy in his speech, but careful observation would show the listener or reader the elegancy of his diction—no word misplaced, no word misused, no word too many, and none too few.

> Then when the clay-cold form shall bid adieu,
> Hid in its parent's bosom, kindred earth,
> Let not the errors e'er appear in view,
> But turn from them and only speak his worth.

Nearly 30 years of intimate friendly intercourse with the late Mr. FitzGerald compel us to accentuate the view that his ability and attainments were of the highest order. His ideals were high, his hatred of anything mean intense; and if he failed to ingratiate himself with those with whom he was brought into contact, it was because his instincts were higher, nobler, truer, and finer than those of men who are buffeted about in the strenuous strife of the world He lived in a world of his own, which few understood, and fewer still cared to examine. Those of us who knew him well loved him for his merits, and our heartfelt sympathy goes out to his widow and daughter in this the time when their great loss is so vividly felt. At the last his cry was rest.

> And rest more sweet and still
> Than ever nightfall gave
> Our longing hearts shall fill
> In the world beyond the grave.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICITY FROM WATER POWER.

SIR,—I regret to find that in my British Association paper on the above subject, published on p. 294 of your issue of Aug. 26, I erroneously attributed the list I gave of plants recently installed to the Stanley Electric Manufacturing Company, of Pittsfield, Massachusetts, instead of to the General Electric Company of America, as should have been the case.

I make this correction at the request of Mr. C. C. Chesney, the chief engineer of the Stanley Electric Manufacturing Company, from whom I originally obtained the particulars, and would explain that the mistake occurred through my interpreting the words "our later installations," used by Mr. Chesney in his communication to me, as meaning installations put up by his company, whereas I now hear from him that the word "our" in this connection referred merely to American installations as distinguished from those of other countries.—Yours, etc.,

A. A. CAMPBELL SWINTON.

TESTING BOILER FEED.

SIR,—I have read with interest the replies to Question No. 691, but rather fancy the propounder of question is not altogether satisfied with the replies, although they strictly answer his question. I would venture to state that what No. 691 wants to know is when he has got the right proportion of reagents in his boiler feed water, rather than to know the degrees of hardness. I have experienced considerable trouble myself with the same subject, and, with all due respect to the assistance given by many chemical friends, had never managed to get really satisfactory results until I adopted the method mentioned later on.

One of the main reasons, I think, for the failure of any chemical tests of the water to produce satisfactory results from an engineer's point of view, is that they fail to take into consideration that the evaporating of water in a

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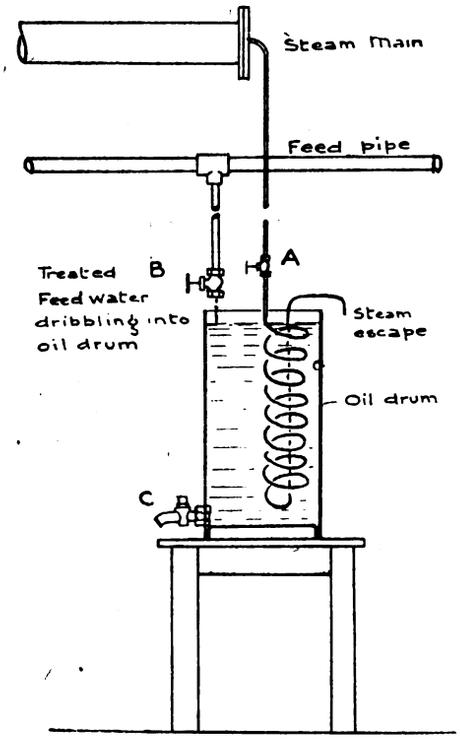
boiler is really a concentrating process. A very small increase or decrease in the exact chemical quantities of the lime or soda over that theoretically required will give trouble. In the first case it accumulates in the boiler when the water will become too alkaline and attack the iron, owing to electrolysis between it and the gunmetal fittings, or in the second case the excess of "untreated hardness," if I may use the term, accumulates and produces a hard scale on the boiler. Further, as a result of many tests made, and of some few years' experience, the degree of hardness of the water is in most cases nearly always changing, due to the action of rain diluting the stream from which the water is drawn, and from other obvious causes. So that the reagents required to properly soften the water during one week may be quite wrong during the next, and an engineer cannot always afford the time to constantly test the feed water for hardness, even if he could obtain satisfactory results by so doing.

Ultimately I schemed out the following plan, and may since its introduction have practically had no more trouble. The sketch will nearly explain itself. An ordinary 10-gallon oil-drum is placed upon a stand. Inside is a coil of ½in. iron steam-pipe, supplied from the nearest steam-main



through a cock, A. A branch from the feed-water delivery (say a 1in. pipe to prevent choking) with a valve, B, in it is led to the top of the drum, and the feed is allowed to dribble out into the drum. The action is as follows: the drum being filled with feed water, the steam is just turned on to the coil sufficiently to keep the water just boiling and the feed supply regulated to just make up the evaporation. Now, whatever is going to take place in the boiler itself will take place on the steam coil. If the water is not sufficiently softened a hard scale will form on the coil, or if there is too much alkalinity in the feed, the iron around the brass drain cock, C, will show black, or may be this blackness will not be noticed unless the scale (found, say, previously) be knocked off, for it is not uncommon, when too much soda is used, for the interior of a boiler to look scaled while really underneath the scale the iron is being pitted by electrolytic action.

A week or two of experimenting with the above apparatus will enable any engineer with a few brains to properly proportion the reagents required; and what is more, to instantly correct any tendency to scaling or corrosion. I have found the most satisfactory results in the boiler to obtain when the steam coil showed just a soft thin covering of whitey-brown mud that could easily be dislodged from the coil by a piece of pinewood. As to the action the different reagents have upon the boiler feed water, these are given fully by the replies from your correspondent, so that by reading them carefully and by using a little thought and care to see the reagents properly weighed and added, anyone should be able to get good results when using the apparatus described. I may add, in conclusion, that the lime used should be dried in an old copper or other pot, as, owing to the amount of moisture usually in air-slaked lime, there is considerable difficulty in getting accurate weights.—Yours, etc., A. W. TOURNAY-HINDE.

Sulphoid Corporation, Limited, Cockle Creek Works, New South Wales.

[N.B.—We are always pleased to publish letters such as the above from engineers in the Colonies.—ED., *E. E.*]

MOTOR STARTERS.

SIR,—With reference to an article appearing in your issue of Oct. 7, under the heading of "Notes on Motor-Starting Switches," we notice the writer finds fault with asbestos mandrils for supporting resistance coils. We cannot agree with his remarks, as our experience points to quite the reverse. Many makers have found porcelain supports unreliable on account of their friability, and this has led to our placing on the market a special form of "Arkite" tubing, which has been successfully used by many of our leading electrical manufacturing companies for supporting resistance coils for fuse carriers, for large currents, and generally for electrical purposes where great heat or arcing occurs.

We may mention that "Arkite" tubing has none of the defects usually found with resistance-coil supports, and we have pleasure in sending you a sample, which will amply bear out our statements.—Yours, etc.,

THE CAPE ASBESTOS COMPANY, LIMITED,

London, Oct. 12, 1904.

'E DON'T KNOW WHERE 'E ARE!—OR RAMPANT NEPOTISM.

DEAR SIR,—Is it so rare in the Metropolis to find one, whether among Southwark aldermen or not, who at every pause find it necessary to cast disparagement on the man of brains who works and is an engineer?

Why, we in the country towns find plenty of the same kidney, not only among aldermen and councillors (who, by the way, generally have a poor relation to provide for when they talk so), but among municipal managers who have themselves been "pitchforked" into their position through political influence, and have to a great extent to rely upon engineers to pull them safely through; yet these same men have the audacity to tell their subordinates—engineers who have been all through the works—to their face that "an engineer is a mere cipher, that they are nowhere." In the same breath the pitchforked man orders the subordinate to prepare a report or series of notes (commonly called "particulars") on such-and-such a thing, for the said "I am" to use as his own material and ideas in a paper or lecture before some association. One very prominent individual of this tribe, who calls himself an engineer and manager should—if he had his due—be working out a term (learning engineering) in a quarry of one of H.M. penal settlements.

No, sirree, what you find in London is not new in the country, not by any means. But are not the engineers themselves to blame? What is the use of an association if it is not run also on the lines of combination and fellowship? And where does that come in when persons who are *not* engineers at all can get into the said circle?—THE GHOST.

THE METRIC SYSTEM IN MECHANICAL AND ELECTRICAL ENGINEERING.*

Introductory Statement for the Metric System.

BY ERNEST R. BRIGGS.

1. It has been wisely decided that the discussion on the metric system by this society should be as strictly confined

* Paper read before the Rugby Engineering Society, Oct. 6.

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to the mechanical and electrical branches of engineering as the ruling of the chairman can make it; nor need this be considered a restriction that is in any way irksome, since in the application of the metric system to the mechanical workshops of to-day there are more controversial points than could possibly be exhausted in a much longer time than that which the council have arranged for this debate.

2. An opening statement may either skim lightly over numerous points, being a general survey of the whole question, or attention may be drawn in greater detail to portions of the subject, leaving many phases of the subject untouched. No doubt it is rather in the province of the opener of a debate to direct attention to the various strategical points of the debate; nevertheless, the present writer is of opinion that it would be better to refer more fully to one or two details which become prominent in the actual application of the metric system to mechanical workshops, leaving other speakers to bring forward further points, as, doubtless, they will be anxious to do.

3. The most elementary question which naturally presents itself is, "Why should we adopt the metric system?" Leaving aside the wider interpretation, the answer is, "Because of the ever-increasing necessity for an international system of weights and measures." Admitting such necessity, the questioner next asks, "Why should we change our system of weights and measures, instead of the Continental nations changing theirs?" to which we reply, "Because the metric system of weights and measures is greatly superior to the Imperial system." With the advocates of the metric system rests the *onus probandi*.

4. The superiority of the metric system shows itself more in its application to the industries under discussion than in almost any other connection, and it is the engineer, above all, who recognises the imperative importance of an international system. Moreover, the fact must not be lost sight of that the engineer in the past had to use such units as were at hand, and it is, therefore, hardly to be expected that the inch and foot would be the best units that could be adopted for his purpose.

5. As it is pertinent to the engineer that an international system of weights and measures should be adopted, it may be advisable to add a word or two as to the reason why this is so. An example will serve to illustrate the point. Some 60 or 70 years ago every mechanical engineer of note had his own standard of screw threads, under the mistaken impression that he was protecting his business. The result was, however, a failure, and out of the chaos order was brought about through the Whitworth threads predominating by the masterful genius of the great mechanic. So in all branches of engineering can be traced the growth of local trade into national trade, in only too many cases against the blind opposition of many men of the day. History repeats itself. Here, at the opening of the twentieth century, the same state of affairs is present. National trade is making rapid strides into international trade. Trade standards, tariffs, wars, cannot stop it. Better to take a leaf out of the past and help it. In the case of the screw threads referred to above, there exists at the present day the principal standards of screw threads in use for ordinary fastenings—viz., the Whitworth, the Sellers, and the S.I.—examples of which may be found in any country or any town of a manufacturing people. The number of Sellers and S I. threads in use in this country is rapidly increasing, due to the growing importation of American machine tools and German and Swiss electrical machinery. The same state exists in Germany, and even in America. This fact, typical of the whole question, may be left to speak for itself.

6. In the meantime it is necessary to examine somewhat the respective values of the inch and millimetre as units of measurement for the mechanical and electrical engineer. A unit of length within the limits of this debate may be defined as the medium by which the size of a piece of machinery is conveyed from the mind of the designer to the hand of the constructor. It, therefore, follows that the most suitable unit for the purpose is that which will enable a dimension to be written with as few symbols as possible, but at the same time will also allow a fine limit in which to express the size required. For example, a large unit would call for few symbols provided the distance to be measured was exactly equal to some multiple of the unit employed. But the larger the unit the smaller the chances of the distance being an exact multiple. On the other hand, the smaller the unit the more symbols required, and the greater the chances of the distance being an exact multiple. It is obvious that there is an average convenient unit of length. What is it?

7. The most casual examination of working drawings brings out the fact that although the inch is nominally the smallest Imperial unit of length, yet the designer has been compelled to construct a new one by continual subdividing until he has obtained a $\frac{1}{16}$in., which is really his unit of length. As there is no recognised name for this virtual unit, it is written as a vulgar fraction in terms of the inch. Hence, in order to express a dimension up to 1in. it may be necessary to employ as many as four figures (not to speak of dashes and ticks); up to a foot, six figures.

8. On the other hand, the metric system supplies a unit of length, the millimetre, exactly suited to the requirements of the engineer. By its means any dimension up to about 4in. can be expressed in two figures, while up to about 40in. requires only three figures. The millimetre being a smaller unit than the $\frac{1}{16}$in., also permits of finer limits being used. Such a system thus permits of fewer figures being used on drawings, allow a finer expression of the required size, and by means of a simpler notation greatly reduces the chances of error on the part of the workmen reading the drawings.

9. By far the most controversial point in the application of the metric system is that of screw threads. As to the absolute value of the three systems, there can be no doubt in the superiority of the S.I. threads. The table in the appendix gives the sizes of Whitworth threads most usually employed, with the diameter increment; also a selection of S.I. threads which would meet ordinary requirements.

10. A large amount of misconception arises when dealing with the screw thread question by the supposition that a change from the Imperial to the metric units must be accomplished in a short space of time. This need not be the case at all, even supposing that the present Imperial system of weights and measures be made illegal, so long, of course, as the illegal weights and measures were not made a medium in the sale of the manufactured article. With a new firm starting business it is just as convenient to adopt the metric system in full—that is, to go the "whole hog" with S.I. threads—as it is to adopt the Imperial system. On the other haad, with a firm who have been in business for some years, and who have sunk a large amount of capital in small tools and gauges, the matter is different. In such a case it is better to wait until an opening occurs, such as the introduction of a new speciality, or the complete revision of the existing one, before attempting the introduction of the metric system. If the conditions are not favourable for the adopting of the S I. threads, the Whitworth may still be used without great inconvenience, until a better opportunity presents itself.

11. The above remarks are intended to refer only to the use of screw threads for ordinary fastenings, such as bolts, studs, etc.; in work of a special nature requiring screw threads—for instance, the square threads used so much in machine tools, etc.—metric pitches should at once be adopted. This does not present any difficulties with regard to lead screws for lathes, since by means of a 127-tooth wheel, metric pitches can be cut with an error which is considerably less than the ordinary manufacturing limit. The reason for this being that 127mm. is equivalent to 5·000004·351 inches, thus giving an error of less than five-ten-thousands (0·0005) of an inch in a length of 40ft.

12. Another important point in which there should be no delay when once a start has been made is in the adopting of metric pitches for gear wheels. Metric cutters of standard sizes can be obtained from any dealer, either from stock or to order. For bevel gears there is even less

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trouble, as they can be cut on the usual machines as well as gears called for in Imperial measures.

13. Although the adoption of metric weights and measures of capacity is relatively a small matter by comparison with that of linear measurement, yet, looked upon from an absolute basis, they are of great importance. The amount of time saved by getting rid of the necessity of converting the long string of tons, hundredweights, quarters, pounds, into pounds and *vice versâ* cannot be overestimated. There is no juggling with figures; the engineer uses only two units, the kilogramme (kg) and millier, or metric ton. He is not worried when stresses are expressed in both pounds per square inch and tons per square inch. When he is told that the head of a column of water is 100m., he has only to move a decimal point to know that the pressure on the base is 10 kg. per square centimetre. Should he be informed that the contents of a tank of water is 10 cubic metres, he knows at once that the weight is 10 metric tons, or 10,000 kg., and that its capacity is 10,000 litres. If a liquid is flowing through a pipe at a velocity of 10m. per second, and the section of the pipe is 400 square centimetres, it does not take him long to find out that the discharge is 100 decimetres × 4 square decimetres = 400 litres per second. Let him try with a speed of 100ft. per second, sectional area of pipe 400 square inches, to find the discharge in gallons, and he will say that the slide rule is the salvation of the Imperial system. The engineer using the metric system never has to reduce feet into inches, or fractions of an inch into decimals of a foot. In fact, he uses the same units for calculation as he does for measuring, which is distinctly more than the average British or American engineer does.

14. It must not be thought that the introduction of the metric system, with all its advantages of simplicity and freedom from error, can be introduced into a workshop merely by telling the draughtsman to figure his drawings in millimetres, and by giving the workman a metric scale. Far from it; the frailty of human nature has been the subject of many homilies, and it may be taken for granted that at the end of 10 years, nay, 100 years, would still see the existence of the Imperial system.

15 To introduce the metric system into a manufacturing concern, and to really gain by it, it is necessary first to get the chief draughtsman and the works manager enthusiastic on the question, and then to banish all feet, inches, pounds, and gallons from calculations, drawings, limits. The speeds and feeds of the machines must be expressed in metres per second or per minute, and in millimetres; all weighing apparatus must scale in kilogrammes, and kilogrammes only. The introduction must be thorough; of that there must be no question. There are men who, by application to the values of the units, have been able, in the short space of 12 months, or even less, to think not only in millimetres and kilogrammes, but also in compound units, such as kg./sq. cm., m./sec, etc.; while men who, although in daily contact with the system, have hardly taken the trouble to think even in millimetres in as much as five years. That is the key to successful adoption: get the men keen on it, and the transition period will be short and hardly felt.

APPENDIX.

Common Sizes of Screw Threads.

WHITWORTH (inches).

Dia.	Ths. per inch.	D.a. Incmt.	Dia.	Ths. per inch	Dia. Incmt.
¼	20		1¼	7	
		⅛			¼
⅜	16		1½	6	
		⅛			¼
½	12		1¾	5	
		⅛			¼
⅝	11		2	4½	
		⅛			¼
¾	10		2¼	4	
		⅛			½
⅞	9		2½	4	
		⅛			½
1	8		2¾	3½	
		⅛			¼
1¼	7		3	3½	
		⅛			

16 sizes.

S.I. (mm.).

Dia.	Pitch.	Dia. Incmt	Dia	Pitch.	Dia. Incmt.
6	1		26	4	
		2			6
8	1·25		42	4·5	
		2			6
10	1·5		48	5	
		2			8
12	1·75		56	5 5	
		4			8
16	2		64	6	
		4			8
20	2·5		72	6·5	
		4			8
24	3		80	7	
		6			
30	3·5				
		6			

15 sizes.

Reply to the Introductory Statement.

BY R. C. JACKSON.

16. In moving an amendment to the resolution, it is to be noted that a restriction has been placed on the subject matter of this debate. It is not proposed to make any objection to this ruling, except to state that, in the writer's opinion, a correct judgment of the respective merits of the metric and Imperial systems of weights and measures as applied to mechanical and electrical branches of engineering, cannot be arrived at without taking a much wider survey of the principles and matters involved than can be debated within the limits laid down by the mover of the resolution and the time allowed for the purpose by the council.

17. In paragraph 2 a preference is stated for supporting the affirmative argument by some detail illustrations of the application of the metric system to mechanical workshops, etc. A reply to this is that until one is able to show that the fundamental units of the metric system are better in themselves, it is premature to discuss the detail applications of the units in question.

18. In paragraph 3 of the opening statement the metric system is stated to be greatly superior to the Imperial system.

19. The argument in support of the greater scientific accuracy of the Imperial system may be put shortly as follows: The Imperial system of weights and measures is found to be based upon a *straight* line of finite length—*i.e.*, the *axis* of the earth—as compared with the metric system, which is based upon a *curved* line—*i.e.*, a fraction of the *quadrant* of the earth's surface.

20. The answer to paragraph 6 is the one-thousandth part of an inch or the mil, a unit of length which appears to satisfy all the conditions claimed for the millimetre, but in a still better degree. For fine work fewer fractional readings are required. Examples will occur to anyone in connection with wire gauging and sheet metal work.

21. On the respective merits of the various screw threads now in use referred to, the writer puts forward no definite opinion, and prefers to let other speakers deal with this aspect of the case who have a closer practical knowledge of it. The very fact of the extensive use and successful competition of the Whitworth and Sellers standard threads alongside of the S.I. standard, shows there is little or no trouble experienced in the matter.

22. Since the metric system is, and has been, permissive for some time, it will, no doubt, become finally adopted by the country at large when it has shown its great superiority to the existing system of things.

23. MEASURES OF WEIGHT AND CAPACITY.—The late Sir John Herschel, in an address delivered before the Leeds Astronomical Society on Oct. 27, 1863, shows how a decimal relation may be established between the Imperial system of linear measurements and those of capacity and weight, similar to that existing in the metric system. He points out the fact of the length of the polar axis having been determined from the combined results of all the scientific measurements of arcs of the meridian to be equal to 500,482,296in. of our Imperial yard, and that if one five-hundred-millionth part of the polar axis were adopted as a new standard unit, to be called the "geometrical inch," it would differ from the Imperial inch less than one-thousandth part of an inch—a difference so small as not to be measured by any ordinary method, and only by the aid of the nicest scientific instruments. For all ordinary practical purposes the geometrical inch would be identical with the Imperial inch. The present legal weight of a cubic foot of distilled water at 62deg. F. is 997·145oz., being short by 2·855oz. of 1,000oz. If the linear foot were increased by the one one-thousandth part, the present deficiency of 3oz. approximately would be made up. Since the Imperial half-pint is the measure of 10oz. of distilled water, or the hundredth part of the capacity of the cubic foot, the ratios of these units of length, weight, and capacity would be thus brought within such practical limits of precision as would meet every possible commercial requirement The address concludes: "Thus the change would place our

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system of linear measure on a perfectly faultless basis, it would at the same time rescue our measures and weights from their present utter confusion, and secure that other advantage of connecting them decimally with that system on a regular, intelligible, and easily remembered principle, and that by an alteration practically imperceptible in both cases, and interfering with no one of our usages or denominations."

24. It is urged that the address quoted from should be carefully read by all those who are interested in the study of the important subject of metrology.

25. An important matter which has not been referred to in the opening of this debate is this: Assume for granted the metric system to be all its advocates claim for it, how and by whom is the cost of alteration to be paid? Sir Samuel Montague, president of the Decimal Association, in advocating the use of the decimal system, has always assumed the Government would pay. Mr. M'Farlane, of the Westinghouse Company's Pittsburg factory, is reported to put the cost of changing in these works to the metric system at the large sum of 650,000dol. Colonel Tannet-Walker, of Messrs. Tannet-Walker and Co., Leeds, has put the cost of changing in their works at £7 to £10 per man employed. On a low estimate, Mr. Towne, of the Yale and Towne Company, states that one million dollars would not cover the cost to the engineering trades alone in the States.

26. Mr. Coleman Sellers, speaking in 1879, estimates the cost of the change in the machine shops of his company at £40 per man employed.

27. The following figures were all given by the respective firms and companies to a committee of the National Association of American Manufacturers, who, on Dec. 23, 1903, sent out a circular letter of enquiry. The replies were published in *American Industries* for April 15, 1904: The Long Arm System Company, Cleveland, O.; ship fittings; cost of 200,000dol. The introduction of the metre would be confiscation without compensation. Carnegie Steel Company, Pittsburg; armour plates; use of two standards in the same factory would entail endless confusion. The Miller Dubrul and Peters Manufacturing Company, Cincinnati; cigarette machinery; cost, 60,000dol. to 75,000dol. The Niles Tool Works Company, Hamilton, O.; machine tools; cost, 50,000dol. to 75,000dol. The Cincinnati Milling Machine Company; machine tools; cost not less than 100,000dol. E. C. Atkins and Co., Indianopolis; saws; cost, 50,000dol. to 75,000dol. North Bros. Manufacturing Company, Philadelphia; hardware specialities; cost, 50,000dol. Lane and Bodley Company, Cincinnati; foundry and machine works; cost, 200,000dol. to 500,000dol. Lidgerwood Manufacturing Company, New York City; hoisting engines; cost, 500,000dol.

28. The cost of conversion in the engineering workshops alone of the United Kingdom has been put at 100 million pounds.

29. Now, whatever the figure may be, the cost to those countries concerned would be enormous, and an additional drag on industries which are already sufficiently handicapped.

Resolution to be moved by Mr. E. R. Briggs: "That, in the opinion of this society, the advantages to be derived from the application of the metric system of weights and measures to mechanical and electrical engineering are so great as to outweigh the temporary inconvenience caused by the transition period; and that the hon. corresponding secretary be instructed to forward a copy of this resolution to the local engineering societies of this country, asking them to grant facilities for the discussion of the metric system by their members, in order to bring about its universal adoption as the international system of weights and measures."

Amendment to the above resolution, to be moved by Mr. K. C. Jackson: "That in the opinion of this society the alleged advantages of the metric system are insufficient to justify their adoption by this country, and that what is required is to simplify and standardise our present Imperial system."

GRAPHICAL DETERMINATION OF THE WEAR OF TROLLEY WIRES.

The *Elektrotechnische Zeitschrift* describes an instrument recently put on the market by Messrs. Dreyer, Rosenkranz, and Droop, of Hanover, for the purpose of obtaining a record in a simple and quick way of the amount of wear on overhead trolley wires.

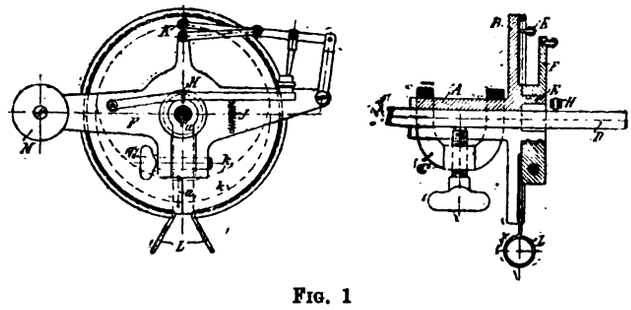

FIG. 1

It consists of a boss, A (Fig. 1), fitted with a wide flange, B, and arranged for clamping to the trolley wire, D, by means of the clutch, C. Both boss and flange are split so that they can be passed over the trolley wire in position. A species of crank, F, is attached to a projection, E, on the boss, and is arranged to be rotated about the latter. This crank also is split, and is held together by the screw, G. The motion of a scriber, H, pressed against the trolley wire by the spring, J, and moving round the wire as F is turned, is transmitted by means of levers giving a 10 : 1 magnification to the pencil, K. An annular sheet of paper is held against the flange, B, by means of the spring, L.

When the crank, F, is turned round by means of the knob, M, the pencil records the shape of the cross-section of the wire on the paper. Whilst the trolley wire is new and circular a circle k having an area 100 times that of the wire will be recorded. If, on the other hand, the wire were worn at one point to the extent a, the curve k' would be obtained, showing the wear a' enlarged 10 times. Fig. 2 shows a full-sized curve (dotted) obtained with this instrument on a trolley wire that had been considerably worn at one side by the collecting bow.

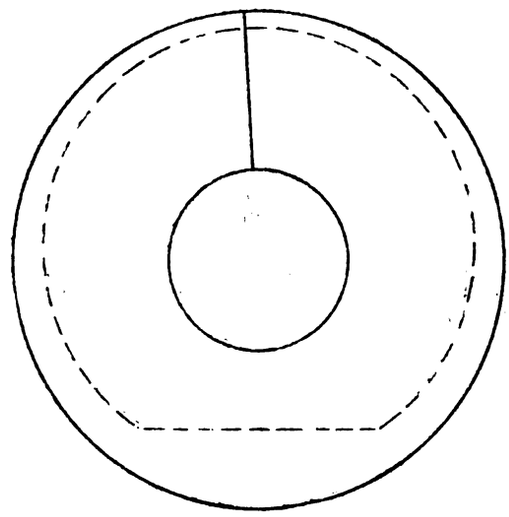

FIG. 2.

The apparatus should prove of considerable use on large tramway schemes, as, besides allowing the ordinary wear on straight lines to be recorded, it offers a simple method of deciding the satisfactory nature or otherwise of the trolley suspension arrangements at curves and crossings. By taking profiles of the wire at such points at regular intervals the gradual increase in wear could be followed, and any noticeable increase in wear could be counteracted by altering the suspension or tension arrangements. In this way it should be possible to reduce the number of wire breakages, with their accompanying inconvenience and expense, considerably.

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FORTHCOMING EVENTS.

FRIDAY, OCT. 14.

Electro-Harmonic Society.—At 8 p.m., smoking concert.

SATURDAY, OCT. 15.

Glasgow Technical College.—At 7.30 p.m., presidential address to Scientific Society by Mr. R. W. Munro.

TUESDAY, OCT. 18.

London Chamber of Commerce.—At noon, meeting of the Postal, Telegraph, and Telephone Committee.

THURSDAY, OCT. 20.

Society of Arts.—At 8 p.m., "Automatic Regenerative Control of Electric Traction," by Mr. J. L. Hall.

FRIDAY, OCT. 21.

Institution of Mechanical Engineers.—At 8 p.m., "A Scientific Investigation into the Possibilities of Gas Turbines," by Mr. R. M. Neilson.

ECONOMICAL TELEPHONE CONSTRUCTION AT SWANSEA.

MR. A. R. BENNETT SHOWS THAT TELEPHONE LINES COST LESS THAN £16 EACH.

On Oct. 5 Mr. Tulloch, on behalf of the Local Government Board, held an enquiry at the Swansea Guildhall on an application of the Corporation to borrow a further £2,000 for the extension of their telephone system. The application was opposed by Mr. W. D. Benson, barrister, of London. He said he appeared on behalf of the Prince of Wales Dry Dock Company, the Ocean Dry Dock Company, and three other ratepayers.

Mr. A. R. Bennett, consulting telephone engineer, gave evidence on behalf of the Corporation, and explained that the original scheme was for 750 completed lines, together with ducts and poles for another 750, but without any spare cables or wires. This was estimated to cost £18,000. Subsequently, and as a matter quite apart from the telephone construction proper, the Corporation decided to erect a special building for the telephone offices and switch-room, for which the Local Government Board granted an additional £2,300. It had been found possible to greatly improve on the estimates; so much so that, instead of connecting 750 lines and instruments for £18,000, 1,003 lines and instruments had been completed for the sum of £15,769. 3s. 7d., or only £15. 14s. 6d. each. In addition, a large number of spare cable lines had been provided in excess of the estimates. It was true that several of the junction lines to branch exchanges within the area had not been completed, but there was sufficient money in hand to finish these out of the original grant, and, in point of fact, several were well on the road to completion. The £2,000 now asked for was required to lay new ducts in certain directions and draw in new cables, so as to render the spare wires, which had already been laid, available for connecting the new subscribers who daily applied for Corporation telephones. There were 176 unexecuted orders on hand, and it was found difficult to reduce the number, as new applications were received as soon as old ones were wiped out. A portion of the £2,000 would be devoted to completing the multiple switchboard at the central exchange to take 960 subscribers' lines.

Mr. Benson did not call any evidence against the Corporation, but spoke for about an hour, arguing that the borough rates were already so high as to render it inadvisable to increase the ratepayers' liability, and also calling into question the accuracy of the accounts prepared by the borough accountant, which showed that the undertaking was being worked at a profit. The town clerk replied in a few words, and there is every expectation that permission to borrow the money will be granted at an early date. During the enquiry eulogistic remarks were made as to the very great efficiency of the Corporation telephone service as compared with anything that had ever previously been known in Swansea.

We take the following report from the *South Wales Daily Post* of Oct. 5.

The TOWN CLERK explained, with regard to the telephone matters in respect of which Mr. Benson opposed, that in November, 1902, the Local Government Board sanctioned the borrowing by the Corporation of £20,300 for the establishment of a municipal telephone exchange, and in April, 1904, a further sum of £306 was sanctioned, making a total for telephone matters of £20,606. Of that amount the Corporation had expended £19,158 19s. 4d., leaving a balance at the present time of £1,447. 0s. 8d. in respect of works not yet carried out. At the present time there were 1,003 subscribers' instruments and lines on the municipal system, and the rental from them amounted to £3,823. 10s. 5d. There were, however, 176 further applications for connections, and it was as regarded those applications that it was now desired to raise the sum of £2,000 to enable the Corporation to join up those subscribers. The balance in hand—£1,447. 0s. 8d.—could not be devoted to the purpose, as the original sanction was in respect of specific works other than that now contemplated. The details of the £2,000 were £460 for filling present multiple switchboard at central exchange to its maximum capacity, £30 for increasing capacity of switchboards at branch exchanges, £30 for extending test frames and adding test jackets and guards, £447. 11s. for new ducts and cable, £100. 1s. 4d. on another section, £150 for small cable for branches, £231. 5s. for additional subscribers' instruments, and £521. 2s. 8d. for joining up subscribers.

The CONSULTING ENGINEER gave evidence, and said he was consulting adviser on telephones to several other corporations—Glasgow, Portsmouth, Brighton, Hull, etc. He explained that the scheme sanctioned in 1902 was to provide for 725 subscribers, including the necessary junction lines, and 25 public telephones—in all 750 completed lines. Of these 700 were to be connected in Swansea, and 50 in other places within the telephone area. The scheme also provided for the provision of spare ducts and spare accommodation on distributing poles to the extent of another 750 lines, but did not include any spare cables or other spare wiring. Subsequently it was decided to erect a special exchange and office premises at a cost of £2,300, which amount was included in the loan sanctioned, and later on permission was asked to spend a further sum of £306 on the provision of a junction cable to the National Telephone Company's exchange for the purposes of intercommunication, which was granted. The lines of ducts within the borough had been substantially carried out with slight deviations in the duct routes, as were shown to be expedient by the grouping of new subscribers. The total length of the excavations carried out was 6 miles 775 yards, a slight excess being caused by the number of distributing points being increased from 57 to 60, and to the use of underground cables at two places on the Morriston route, and one place on the Mumbles route. Spare ducts of a total length of a mile and 303 yards had been laid in excess of the original estimate, and a considerable number of spare cable wires which would come in useful hereafter, and reduce the cost of future work. Until the success of the system had been demonstrated locally, the Telephones Committee were unwilling to proceed with the proposed junction lines from Swansea to the Mumbles, Swansea to Morriston, Swansea to Skewen, Swansea to Gowerton, Loughor, Gorseinon, and Pontardulais, Morriston to Skewen, and Morriston to Clydach and Pontardawe, representing 31¾ miles of pole route. Consequently those junction lines had not all been finished. Those completed were to Mumbles, Morriston, and Manselton, while others partially completed were Swansea to Skewen, Morriston to Skewen, Swansea to Loughor, and Morriston to Clydach. The total length of junction poles erected was 13¼ miles, leaving 18½ miles still to do, the estimated cost of which was £1,009. Against that they had £2,230. 16s. 5d. of the grants still unexpended. Owing to a number of the subscribers in Swansea being within a short distance of the exchange, it had been found possible to connect many more instruments than it was at first thought prudent to reckon upon without exceeding the loan sanctioned, but instead of the 750 completed lines contemplated, there were 1,005 now working. Deducting the capital still unexpended, and the value of the material in hand, it would appear that those 1,005 lines had cost £15,769. 3s. 7d., or only £15. 14s. 6d. each. Including the cost of the building of the exchange premises, which was not in the original estimate, the cost per line would be £18. 0s. 2d. For the purpose of joining up the new subscribers who daily made applications for telephones, it was imperatively necessary to provide additional ducts, cables, instruments, and switchboard accommodation, and the proposed new works would provide for at least 100 additional subscribers.

Mr. Bennett was cross-examined by Mr. BENSON at length. Counsel sought to show that only the telephone works within the borough, with the exception of the Mumbles exchange, had been completed; but the consulting engineer explained that on almost all the outside sections overhead work, such as the erection of poles, was well in hand, while the necessary underground work within the borough in connection therewith was completed. By far the most expensive part of the work, in other words, was completed on those partially-finished portions. The wiring was a comparatively small matter. It was more economical to erect the poles first and then do the wiring as one job.

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By the Inspector: He certainly expected to complete all the works in the original estimate for the £2,230 still unexpended, because they had been working very much cheaper than the estimates all through.

Mr. Benson: You have already spent £19,000 in doing what portion has been done in the borough without one extension outside?

Mr. Bennett: No, there is Morriston.

Mr. Benson: Morriston is in the borough.

Mr. Bennett: But it costs money.

Mr. Benson: Of course it does. But I say you have already spent £19,000 in the borough and Morriston and practically not gone outside? The amount is £19,158.

Mr. Bennett repeated that all the real expense was in putting up poles, and the expenditure on wiring was comparatively cheap.

The Inspector: Your question is whether these outside lines can be completed for the balance of £1,447?

Mr. Benson: That is what it comes to.

The Inspector: And Mr. Bennett says emphatically yes.

Mr. Bennett: Without any doubt.

Further cross-examined, Mr. Bennett said that the cost of wiring a metallic circuit was about £12 per mile, using the Post Office specification of 100lb. of wire to the mile. Taking the erection of the poles, the cost would be £50 per mile. He would not admit that when it was decided to proceed with 750 lines, or half the number originally estimated, that this number should have included the junction lines, but did admit that when the junction lines were completed, individual subscribers would have to be joined up and extra money would be required for that. At the same time the revenue would be increasing. Regarding spare accommodation, the consulting engineer pointed out that at several points there were spares that could only be utilised by the expenditure now desired in order to lay in new cables and splice them up with the spare accommodation. In other places the size of the cable ducts had been increased to admit of additional cables. He would not agree that what was known as outside extensions simply meant extra wiring, as very often a new cable had to be taken in and out of the building. The reason that a cheaper tariff was made was because there was less work in the operating-room than with direct lines. Nothing had been allowed for depreciation, as it was a burning question with auditors as to whether it was necessary to provide for that, seeing that the life of the undertaking was as long as the loan by which time the money would have been repaid. In the case of the Swansea system, however, everything was kept at such a high state of efficiency—new material being used for all repairs—that no depreciation account was necessary. The sum of £200 per annum was set apart for repairs, and he estimated this to be quite sufficient, together with an amount for depreciation, although the capital outlay was over £20,000.

Re-examined: No portion of the £2,000 would be expended in providing the junction lines. Those would be completed by the £1,447, plus £783, the value of material in stock.

Mr. Benson put it to Mr. Bennett that subscribers had only consented to come on to the system on intercommunication being promised.

The Town Clerk said that was a question between the Corporation and the National Telephone Company that would have to be decided in the law courts.

The Borough Accountant gave evidence. In reply to Mr. Benson, he said the rates amounted to 8s. 4d. in the £.

Mr. Benson: That is pretty high—an increase of 6d. since 1903.

Mr. Benson then addressed the inspector, stating that he represented clients whose assessable rateable value was £4,400, and they objected to the application because experience in other towns, and now with Swansea, was that there was no limit to municipal trading concerning telephones. He did not believe for one moment that if the accounts of Glasgow, Portsmouth, and other places where paper balances were shown in connection with their telephone systems, were properly audited and depreciation allowed, any profit would be shown at all. Glasgow three years ago began with a capital liability of £100,000. Since then it had increased to £331,000—a tremendous liability to the ratepayers. In Swansea the Corporation were pledged up to £20,600, and notwithstanding that the scheme was not carried to the outlying parts, they were now asking for money. There was no limit to it. He contended that the junction lines should have been provided at the outset, and suggested that the Corporation had not acted *bona fide* in the matter.

The Inspector said he was not clear that under the Local Government Board sanction the Corporation were bound to carry out those works. At any rate, the money had not all been spent. Had the outlying districts been connected, would Mr. Benson's clients have then been satisfied?

Mr. Benson said intercommunication would then have been brought about probably and the *bonâ fides* of the Corporation shown. Learned counsel proceeded to comment on the loss sustained by the Corporation waterworks, and adversely criticised the working of the electric lighting station, which in 1903 showed a profit of £1,810 without any provision being made for sinking fund or depreciation.

The Town Clerk said the 1904 report showed a substantial profit after providing for sinking fund and depreciation to date.

Mr. Benson said it was childish to say that £200 would cover repairs and allow for depreciation on an undertaking costing over £20,000. His clients were already very heavily rated, and very soon the liability of the telephone system would be £40,000, or even more. As soon as new subscribers came on fresh capital would be necessary, and, therefore, in the interest of the ratepayers, the present application ought not to be sanctioned.

The Town Clerk hinted that the National Company were behind the opposition, and urged that the telephone scheme must now go on. There was no intention on the part of the Corporation to abandon any part of the original scheme, and if the undertaking proved to be the success that was hoped for it, more moneys, of course, would be necessary, and the Corporation would look forward to making more calls.

Mr. Benson: For how much, Mr. Thomas?

The Town Clerk: That depends entirely upon the success of the scheme. Mr. Thomas added that there was nothing before the Corporation that led them to believe the concern was going to be a failure.

This concluded this part of the enquiry, and the inspector then heard evidence concerning the need of the sanitary accommodation above referred to.

TRADE NOTICES AND NOVELTIES.

The "Wirt" Dynamo Brush.

Messrs. J. Defries and Sons, Limited, of 146 and 147, Houndsditch, E.C., are putting on the English market the "Wirt" dynamo brush, which is worthy of the attention of electrical engineers as a whole. This brush, which we illustrate in Figs. 1 and 2, is of the metallic type, and is designed to enable dynamos to run without sparking at the commutators. The means by which this is effected will be clear from the illustrations, which show that the brush is a composite one. The inner

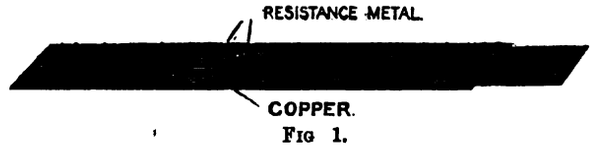

Fig 1.

laminations are of copper, and the outer laminations of high-resistance material. As regards sparking, the result is that while there is not a high resistance in the path of the current, there is a considerable resistance between the heel and toe of the brush. It is this function in the carbon brush which greatly assists in securing sparkless collection, and the construction of the "Wirt" brush produces this good quality without necessitating the larger commutator needed for the carbon brushes.

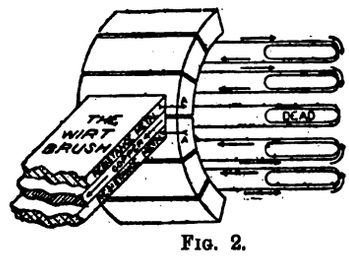

Fig. 2.

We understand that the large manufacturing firms in the United States have adopted the "Wirt" brush extensively, and it will enable engineers in this country to readily reduce the sparking on machines designed rather too close to the sparking limit. The brushes are made in a great variety of thicknesses and breadths, so that there should be little difficulty in changing over from a copper brush to one of the "Wirt" type.

Berliner's Telephones.

The telephone instruments illustrated herewith are of a special type introduced by the Berliner Telephone Manufacturing Company, 200, Upper Thames-street, London, E.C., to meet the requirements of what is now known as the "Reply and call" system, which, in certain circumstances, has advantages over ordinary intercommunication systems. With the latter, any department can speak to the other at will direct, without requiring a central station. It is, however, sometimes advisable that only the principal should be able to communicate to the various departments, and, *vice versâ*, the departments not to speak to one another except through the principal. In these circumstances the "Reply and call" system will be found

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useful. The central-station instrument (Fig. 1) is fitted with the firm's patent automatic replacement levers, and the principal, if he desires to speak to any department, has only to take the hand combination off the hooks, pull down the lever of the number required, ring, and then speak; replacing the hand combination automatically restores the lever. This telephone is also provided with a pair of through-connection plugs, enabling the principal to place any two departments in direct communication with each other, and he can, if he wishes, call up and speak to several departments at the same time by simultaneously pulling down the levers of the numbers required.

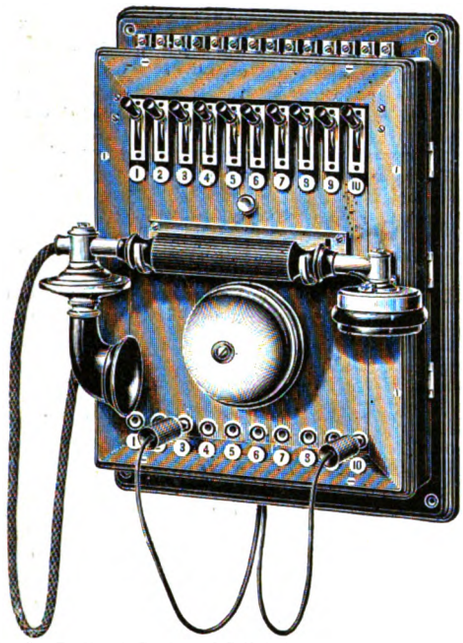

FIG. 1.—Berliner's Reply and Call Automatic Wall Telephone for Central Point.

The automatic side station (Fig. 2), designed for use with the "Reply and call" system, dispenses with the two-way switch hitherto necessary, thus doing away with the trouble and confusion caused by leaving the switch in the wrong position. The act of calling the central station automatically changes over the call line, whether the receiver is on or off the hook. Directly the receiver is replaced the connection is automatically restored to the reply line, leaving the instrument ready to receive a call. Several patterns of these instruments are made, which, together with a large variety of the firm's "Twencen" domestic and

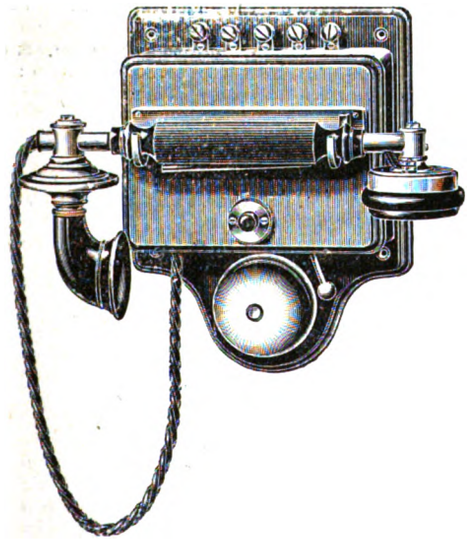

FIG. 2.—Berliner's Reply and Call Automatic Side Station Wall Telephone.

other telephones, are dealt with in a list just published from 200, Upper Thames-street.

Electric Radiators.

We illustrate herewith several electric radiators of new design manufactured by the General Electric Company, Limited. The "Dolphin" pattern (Fig. 1) is of very ornamental appearance, and suitable for dining and drawing rooms, state cabins, etc. It has a hammered iron base, and is fitted, as shown, with three lamps and two switches. Fig. 2 illustrates a radiator of the ornamental "Diaper" type, mounted in a handsome lacquered and polished cast-brass framework, and suitable for dining or drawing rooms. This is one of several patterns of the same type supplied, being wired on the enamel system, and, therefore, non-luminous. The "Car" radiator (Fig. 3) is very strongly constructed, and so arranged that the connections may be taken direct through the floor of tram or railway car. There are no loose coils to cause short-circuits. Other types

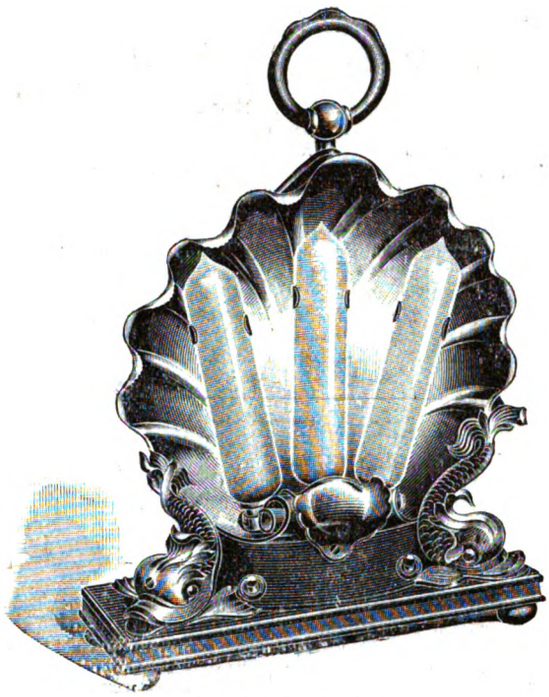

FIG. 1.—G.E.C. Dolphin Radiator.

and patterns of these radiators are illustrated and described in a neat little pamphlet just issued by the firm in question. It may be added that the "Luminous" or "Glow" pattern radiators are each fitted with a polished aluminium reflector, which only requires the most occasional rubbing with a dry cloth to keep it in perfect condition. The

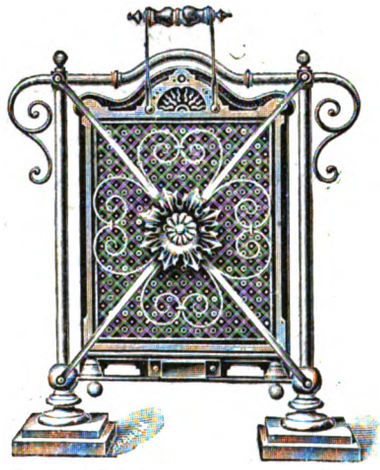

FIG. 2.—G.E.C. Ornamental Diaper Radiator.

heating lamps can be instantly fixed in the event of renewals. Special care, we are told, has been given to the design of these lamps, which have now been brought to a high stage of perfection. Their life is extremely long, and the heating effect well maintained throughout. All the radiators are provided

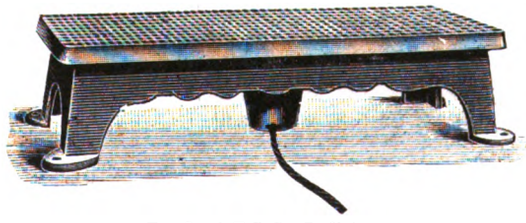

FIG. 3.—G.E.C. Car Radiator.

with an improved form of holder, which ensures a perfect connection. Included in the pamphlet mentioned are also some particulars of a useful form of heating pad designed to supersede hot-water bottles and poultices, from whose objectionable features it is free, besides being more effective and ready for use at a moment's notice.

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LEGAL INTELLIGENCE.

DEFECTIVE TELEPHONES.

A case of importance to telephone subscribers was tried in the Mayor's Court, before Sir Forrest Fulton, K.C., and a jury.

The National Telephone Company sued Mr. A. C. M. Jenkins, of Leadenhall-street, to recover £18. 5s., a year's subscription for the use of a telephone. The defendant had refused to pay a year's subscription due in advance on the ground that between Sept. 28 and Dec. 9, 1903, the company had not kept the line in good working order. It was stated that between Sept. 28 and Nov. 30 the defendant could neither send nor receive a message, and he was constantly having trouble with the instrument. The plaintiffs admitted that they had received complaints during the time mentioned, but that the defects were immediately set right. One of the clauses to the agreement provided that in the event of the line not being in good working order the company should repair it with all possible haste, but were not to be held liable for any delay provided reasonable endeavour was made to restore communication as speedily as possible. That, it was urged on behalf of the company, had been done.

In the end the jury found that the line was not in working order, and judgment was entered for the defendant on the claim, and also on a counter-claim which he had raised for the agreement to be delivered up and cancelled.

TRAMCAR OBSTRUCTION.

At Leigh (Lancashire) Police Court, on Monday, Mr. George Shaw, managing director of the Leigh Brewery Company, and four of his carters, were again charged with wilfully obstructing a South Lancashire Tramway Company's tramcar, between Leigh and Lowton, on March 11 of last year. The case, which was chronicled in this journal at the time, had been remitted to the Leigh magistrates, who in the first instance had refused to convict, by the King's Bench Division, with a direction from the Lord Chief Justice that there was no absolute right on the part of a vehicle to keep the left-hand side of a road, but on a tramcar and a vehicle meeting they should act reasonably towards each other. The facts were that the car and the defendant's van encountered each other in a narrow part of the road, and as the driver of the van refused to cross over to the other side, where there was more room, the car was detained for over three-quarters of an hour, when it backed to a loop.

After a long hearing, the **Chairman** said the Bench were equally divided on the matter, and as he would not give a casting vote, no decision could be given. The tramways company could, if they liked, bring the case up again before another bench, or let it drop.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The report and accounts for the year ending June 30, 1904, show that the sum of £42,603. 17s. 9d. has been brought forward from profit and loss account. Interest on debenture stock has absorbed £18,760. 18s. 4d.; £11,000 has been set aside as depreciation on freehold and leasehold property, plant, machinery, and tools; £1,442. 13s. 11d. has been applied in writing down values of stocks; and the sum of £1,508. 8s. has been reserved on account of bad and doubtful debts. A further sum of £1,000 has been added to the reserve for future stock depreciation. After providing for the foregoing, the result as shown in the net revenue account is a credit balance of £8 891. 17s. 6d. At meetings of shareholders held on May 12 and 30, 1904, a resolution was passed reducing the capital of the Company by £2. 10s. per share on each of the 23,564 B shares of the Company. This resolution was duly confirmed by the court on July 26. Effect has been given to it in the account as now presented. As a result of this writing down of capital a debit balance of £3,589. 14s. 7d. remained, and deducting this from the balance of £8,891. 17s. 6d. as mentioned above, leaves a credit balance of £5,302. 2s. 11d. to be carried forward. Cost of establishing the business, goodwill, etc., £443,451. 8s. 1d., has been brought forward at the figures standing in the last balance-sheet. A sum of £1,029. 7s. has been expended on capital during the year. The shares of the Altrincham Electric Supply, Limited, have been taken at par, as in previous years. The indebtedness of this company has been reduced during the year by £1,466. 10s. 1d.

CUBA SUBMARINE TELEGRAPH.

The report for the half-year ended June 30 last, to be presented at the meeting on the 19th inst., states that the total receipts of the six months were £18,716, while expenses (including the cost of the attempted repair of the Cienfuegos-Santiago 1875 cable) amounted to £14,039, leaving a balance of £4,676, to which has to be added £6,971 brought forward, giving a total of £11,647 to be dealt with. The dividend on the preference shares will absorb £3,000, and leave £8,647, out of which the directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares; the balance, £4,647, being carried forward. Payments to June 30 on account of the Cienfuegos-Santiago new cable have been charged to the reserve fund, which now stands at £144,932. The directors regret to report that the Cape Cruz-Santiago section of the Manzanillo-Santiago cable became interrupted on June 14. The cable is being repaired. This interruption accounts for the falling off in the receipts during June, as shown in the statement. The applications to the United States Government for payment of the claim for the cost of repairing the damage done to the cables during the Spanish-American war, and to the Cuban Government for payment of the subsidy for the coast cables, are still unsettled.

NORWICH ELECTRIC TRAMWAYS.

The report for the year ended June 30 last states that the earnings show an increase over those of the previous year, traffic receipts having amounted to £34,720, against £33,516 in 1903. The result of the year's working is a gross profit of £10,768, to which has to be added £201 interest received and £1,213 brought forward. Deducting from this £2,640, being 4 per cent. interest to June 30, 1904, on the outstanding mortgage debentures, and £1,012 which the directors have placed to reserve account, there remains a profit of £8,529. The directors recommend that a dividend of 3 per cent. be paid on the shares for the year, leaving £609 to be carried forward. The reserve will then stand at £3,197. The operating expenses for the year show an increase of £85. The number of passengers carried was 7,461,718, and the number of car miles run was 1,088,951.

SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER.

An extraordinary general meeting of this Company was held at Liverpool on Friday, at which a resolution for the voluntary liquidation of the Company was passed. Mr. Arthur Stanley, M.P., explained at the ordinary meeting (which preceded the extraordinary meeting) that voluntary liquidation would facilitate the reconstruction of the Company, and ensure the interests of the creditors and shareholders being looked after.

NEW COMPANIES REGISTERED.

City of Buenos Ayres Tramways Company (1904), Limited (82,214).—Capital, £1,240,000. Objects: to acquire certain of the assets of the City of Buenos Ayres Tramways Company, Limited (now in voluntary liquidation); to acquire, or construct, maintain, work, and control any tramways, railways, roads, ways, canals, telegraphs, telephones, gas and electric lighting or power works, etc. Registered office: 1, Great Winchester-street, E.C.

Marks and Hodgkinson, Limited (82,265).—Capital, £5,000. Objects: to acquire the business of electricians and electrical engineers carried on by J. Marks and H. Clarkson, to adopt an agreement with J. Marks and W. B. Hodgkinson, and to carry on the business and that of manufacturers of and dealers in electric lighting plant, apparatus, and fittings, etc.

Rectophone Company, Limited (82,178).—Capital, £20,000. Objects: to adopt an agreement with H. G. A. I. Wieder and H. Knudsen, and to carry on the business of mechanical engineers, makers of and dealers in phonographs, sound producing and transmitting appliances, etc.

Liens Registered.

Electrolytic Alkali Company, Limited, Middlewich.—Lien registered Oct. 1, for £10,350 4½ per cent. first mortgage debentures, part of £50,000 authorised; trustee: Liverpool Mortgage Insurance Company, Limited; charged on the undertaking and all the property for the time being, including the uncalled capital.

Mexico Electric Tramways, Limited, London, E.C.—Trust deed registered Oct. 5, for £500,000 second debenture; trustees: L. Breitmeyer and C. Rube, 1, London-wall-buildings, E.C.; charged on certain ordinary shares and second mortgage debentures of the Compania de los Ferro Carriles del Destrito Federal de Mexico, subject to £400,000 first debentures, and on all other assets.

Motor Traction Co., Limited, London, S.E.—Lien registered Oct. 5, for £500 6 per cent. debentures; no trustees; charged on the stock-in-trade, loose machinery, and tools.

South Metropolitan Electric Light and Power Co., Limited, Blackheath.—Lien registered Oct. 3, for £53,292 4½ per cent. debentures, part of a series not to exceed the amount of the issued and paid up share capital; amount previously issued, £120,000; charged on the undertaking and all the property, present and future, including the uncalled capital.

PERSONAL.

Mr. Saunders, tramways manager of Lowestoft, has been granted an increase of £20 per annum.

We are informed that Mr. Fred. C. Gibbon, M.I.E.E., has again returned to Messrs. Browett, Lindley, and Co., Limited, under agreement for a long period, as sole managing director. Mr. Gibbons was formerly one of the company's joint managing directors, but severed his connection 12 months ago to take up the position of representative in England of Messrs. James Howden and Co. As our readers are aware, the company have devoted their attention to the production of vertical steam-engines for driving electric generators from the earliest days of this industry. We learn that for the future all these engines will be fitted with efficient shaft-throttle governors, simple and reliable, and equal in economy to automatic governors, which have been such a source of loss and trouble to the company in the past.

The borough electrical engineer of Poplar has tendered his resignation, which has not yet been accepted.

The Swindon Town Council have resolved that Mr. F. E. Jordan, switchboard attendant at the electricity works, be appointed shift engineer at the works at a salary of £84 per annum. It is also pro-

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posed that the salary of the electrical engineer, Mr. J. G. Griffin, be raised from £250 to £300 per annum, and that of the assistant electrical engineer, Mr. R. W. Grubb, from £100 to £130 per annum.

Many will miss in Mr. John Hollingshead, whose death we regret to note took place on Monday, not only another link with the past, but one of the best-liked men of their acquaintances. Best known as founder of the Gaiety and the Alhambra, he was a man of no inconsiderable literary attainment. He was on the staff of *Household Words* under Charles Dickens, of the *Cornhill Magazine* under Thackeray, and on *Good Words* under Dr. Norman MacLeod. His monograph of Leicester-square is well known. What we are especially concerned in is that he introduced the electric light to England in 1876.

Mr. Blair, of Woolwich, has been appointed resident electrical engineer at Acton.

APPOINTMENTS VACANT.

Assistant Electrical Engineer, Erith Urban District Council. See advertisement.

Assistant to Canvasser, Woolwich, £2. 2s. per week, Oct. 22. See advertisement.

Canvassing Engineer, Wolverhampton, Oct. 31. See advertisement.

Pupil, corporation lighting and power station. See advertisement.

Improver, Mansfield. See advertisement.

Resident Agent or Manager for Singapore electric tramways.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Swansea.—Tenders are required for altering an engine, rewinding dynamo, etc.

Brighton.—Tenders are required for installing electric light in the diphtheria pavilion at the sanatorium.

Barrow-in-Furness.—The Corporation invite tenders for arc lamps and accessories. Tenders by 18th inst.

Melbourne.—The Federal Postmaster-General requires tenders for 6,000 yards of telegraph cable. Tenders by Nov. 15.

Crejour (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Middleton.—The Corporation invite tenders for dust destructor, boilers, etc., at the electricity station. Tenders by 25th inst.

Porto Alegro (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Ipswich.—The Corporation invite tenders for the supply of continuous-current meters for the ensuing 12 months. Tenders by 24th inst. See advertisement.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Wandsworth.—The Borough Council require tenders for electric lighting and ventilation of Council House. Tenders by Oct. 18. Full particulars in advertisement columns.

Richmond (Surrey).—The Guardians invite tenders for the installation of electric telephones at the workhouse, Grove-road. Tenders to the Guardians by 4 p.m. on 27th inst.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

Rugby.—The Urban District Council invite tenders for the supply of about 440 yards of ·15 three-core low-tension paper-insulated and lead-covered cable. Tenders by 25th inst. See advertisement.

Fulham.—The Council invite tenders for the supply and erection of a 3,000-volt main generator switchboard at their generating station, Townmead-road, Fulham. Tenders by 19th inst. See advertisement.

Great Western Railway.—The Directors of this Company are prepared to receive tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1905. Tenders by Oct. 17. See advertisement in last issue.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Cumberland and Westmoreland Lunatic Asylum, Carlisle.—Tenders are required for plant. Copies of tender may be inspected at the office of the Consulting Engineer, Electricity Works, Northallerton, Yorks. Tenders to the Clerk to the Committee of Visitors by Nov. 1.

Mexico.—A consular report states that there is at present a demand for the undermentioned classes of manufactures: electrical accessories for street railways, including traction, rolling-stock, rails, posts, cables, etc., electric conduits, electric motors and other accessories for motive power, irrigating machinery, steam and electric.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Darlington.—The Darlington Co-operative and Industrial Society, Limited, invite tenders for installing the electric light in their offices in Priestgate, and their premises now in course of alteration in Corporation-road.

Sunderland.—The Corporation invite tenders for the supply of two 300-kw. three-phase generators, 5,500 volts, to be coupled to existing Belliss engines, and two 300 kw. synchronous three-phase motors, 5 000 volts, to be coupled to existing multipolar Silvertown dynamos. Tenders by 28th inst. See advertisement.

Liria (Spain).—The Alcalde requires tenders for the public lighting by electricity of the town, in accordance with conditions which can be seen at the office of the Secretary of the Municipality. The total amount of candle-power required will be 2,000, and the basis of the contract will be an annual payment of 6,000 pesetas (about £175).

Philippopolis (Roumelia).—The Municipality requires tenders for a concession to construct and work electric lighting and tramways for 50 years. A guarantee of £6,000 is required. Tenders by Oct. 15. On the next day a second adjudication will take place in case there is an offer of £5 per cent. less per kilowatt-hour than the minimum.

Craiva (Roumania).—The *Moniteur des Intérêts Matériels* (Brussels) announces that the adjudication will take place at 4 p.m. on Oct. 25 (Nov. 7) at the Mayoralty of Craïova, of the concession for construction and working of a line of tramways (mechanical traction) in the town of Craïova. The duration of the concession is fixed at 50 years. A provisional deposit of £200 is required.

Aberdeen.—The City Parish Council invite tenders for the following works in connection with the new poorhouse at Oldmill: (1) electric light plant—engines, dynamos, etc.; (2) steam-boilers; (3) steam distribution and heating; (4) non-conducting covering for boilers, etc. Tenders to be lodged with Mr. C. B. Williams, inspector. Aberdeen City Parish Council, 20, Union-terrace, Aberdeen, by 12 noon on Oct. 19.

Antwerp.—The Municipality of Ghent invite tenders for the construction of 10 electric cranes at that port in accordance with the specification, a copy of which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall street, E.C. An initial deposit of 2,000fr. (£80) is required to qualify each tender, and for the tender accepted a further deposit of 18,000fr. (£720). Tenders, in registered envelopes, addressed "Au Collège Echevinal de la Ville de Gand," must be posted not later than Oct. 17. The adjudication will take place on Oct. 19.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 25ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegragh Office Yard, Thursday Island of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Airdrie.—The School Board have accepted the tender of Mr. Grant, South Bridge-street, for fitting up four electric clocks at £18 each.

Lifts.—Messrs. Wm. Aug's Gibson, Limited, 28, Fleet-street, E.C., have obtained the contract for the lifts for the new Shipping Exchange buildings in Cockspur-street.

Exeter.—The tender of Mr. W. Blake, Plymouth, at £4,265, for the superstructure for the tramway car shed has been recommended for acceptance.

Aston.—The Electricity Committee have accepted the tender of the General Electric Company, Limited, for the supply of a steam generator and plant at the price of £1,529.

Battersea.—The Borough Council have accepted the offer of the British Thomson-Houston Company, Limited, for 70 improved prepayment electricity meters for the Latchmere Estate at the rate of £5 each.

Greenwich.—The London County Council have received the following tenders for the transforming plant required for the temporary provision of electric current for power purposes to the electricity generating station:

Electric Construction Company, Limited, London and Wolverhampton*	£860
Johnson and Phillips, London	860
British Electric Plant Company, Limited, Alloa, N.B.	940
Lancashire Dynamo and Motor Company, Limited, Manchester	1,034
British Westinghouse Electric and Manufacturing Company, Limited, London	1,083

* Recommended for acceptance.

Newcastle.—The Union Electric Company, Limited, 151, Queen Victoria-street, E.C., have received the order for the supply of all the arc lamps required for the illumination of the industrial exhibition.

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The Excello intense flame arc lamp has been adopted, as being the most suitable for this class of work.

Watford.—The Urban District Council have accepted the tender of Messrs. Clifford and Gough, at £3,745 for additions to the electricity works. The committee have also placed an order with the Brush Electric Company, Limited, for a new engine at a cost of £130.

BUSINESS NOTES.

TRACTION.

Maidstone.—Tramway extensions have been decided upon.

Warrington.—The Town Council decline to institute ½d. fares.

Colchester.—The Corporation has rejected the proposed extensions as premature.

Southend-Colchester.—The Board of Trade have sanctioned a light railway between these places.

Birmingham.—It is reported that the Harborne route is to be abandoned on account of the objections of the residents.

Wigan.—Owing to the Hindley Council insisting upon terms which the Corporation consider unreasonable, that route has been omitted from the tramway scheme.

Falkland.—The residents are considering the question of introducing a light railway. The county surveyor has been requested to prepare plans and estimate.

Coventry.—The residents of Earlsdon having requested the company to vary the proposed routes, the company have promised early consideration of the matter.

Pudsey.—In reference to the proposed tramway service, the Corporation have retained the services of Mr. E. J. Silcock, M.I.C.E., F.S.I., of Leeds, to prepare plans and advise them generally on the question of tramways.

Accrington.—The Clayton District Council have resolved that the Corporation be asked to include certain additions and alterations in their Bill respecting tramways, and also a clause giving the Council power to supply energy for traction within their district.

Northampton.—At the meeting of the Town Council the chairman of the Tramways Committee made an encouraging speech as to the income of the undertaking since the electrification of the system, and added that if the committee could reasonably do anything in the way of workmen's tickets they would.

South Shields.—After a three-night debate the Council have decided upon municipalisation in regard to the tramways. A considerable section of the Council favoured a proposal that after constructing the lines the authorities should invite tenders for a lease, but ultimately the above decision was arrived at.

Pontypridd.—The portion of the tramway from Hafod to Porth has been purchased by the Rhondda District Council, and the Pontypridd Council decided to ask that authority to appoint a committee to meet representatives of the Council with a view to making arrangements for the working of the tramways as far as Porth.

Bournemouth.—It is anticipated that the work of constructing the new tramway from Bournemouth to Christchurch will be put in hand at an early date. The Corporation, with this object in view, have purchased the Tuckton Bridge, which has for several years been used for vehicular and pedestrian traffic over the Stour, at £15,000.

Liverpool.—The City Council have approved the recommendation of the Tramways Committee that application be made for powers to construct two tramway routes in Bootle. The Local Government Board will hold an enquiry on the 20th inst. into the application of the Corporation for a loan of £400,000 in connection with the extension scheme.

Dumbarton.—Two companies are suitors for the privilege of providing tramways for the district, but the Council are considering the question of undertaking a service themselves. Something may depend upon whether the Electric Supply Corporation can obtain the consent of the adjoining authorities. If they can, it is probable that the Council will come to an arrangement with them.

Notts and Derby Tramways Co.—The company having asked the Mansfield Woodhouse Urban District Council for approval of the proposed position of the rails and poles, the Council have suggested that where the widening of the road is necessary to obtain 22ft. of metalled roadway, in accordance with the Board of Trade regulations, the company should increase the width to 36ft., including footpath.

Baker-street and Waterloo Railway.—The subway from the eastern side of the booking hall at Charing Cross Station to the footway in front of the Strand post office is being proceeded with. The hoarding has been removed to centre of roadway in order that the work in the new section can be carried on. The work on the proposed subways leading to Northumberland-avenue and Charing Cross is not being proceeded with pending the negotiations for an alternative subway at Cockspur-street.

Rowley.—The work of constructing the new tramway from Oldhill to Blackheath, which was undertaken by the District Council at a cost of £28,000, has now been completed, and the line has been connected up with Dudley and Cradley Heath. Power will be supplied by the British Electric Traction Company, which has secured the lease of the tramway. The inspection by the Board of Trade will probably take place in the course of the next few days.

Derby.—The Corporation have approved the proposal of the Tramways Committee to establish an insurance fund against third-party risks. The sum of £1,000 from the proceeds of the accumulated revenue of the tramways is to be placed to the credit of a reserve fund, to which will be contributed £10 in respect of each car per annum. On the question of extensions, a councillor suggested that before further extensions were considered the committee should give their attention to the question of motor 'buses, which would obviate expenditure upon the permanent way.

Chatham Light Railway.—There has been some discussion between the company and the Gillingham Town Council with reference to the refusal of the company to run all cars to the terminus at Gillingham Green. The Council appealed to the Board of Trade, who requested the Council to state what they would consider an adequate service. Particulars of the service desired by the Council have been forwarded to the Board. As the Board cannot approve By-laws 8 and 9, it is proposed to hold a conference with the Chatham Corporation so that a form of by-law for preventing overcrowding may be agreed upon.

Swansea.—At a meeting of the Tramways Committee, the surveyor reported in regard to the work of extension that out of 10¼ miles rather less than 3¼ remained to be completed. The committee deputed the chairman, vice-chairman, and engineer to meet the Education Committee with a view of creating a scholarship scheme, and giving boys who had won a scholarship at the technical college an opportunity of becoming pupils at the electric station. The tramways company state that they cannot see their way to expend £427 extra on wood paving at St. Thomas. The directors, however, agree to use wood paving outside the two chapels for 40 and 32 yards respectively. It has been decided to ask the company whether they will take over and work the tramway sections as they are completed.

Bury.—At the meeting of the Town Council the Chairman of the Tramways Committee stated that the tramway system had been completed within the borough, and cars were running before the date fixed for the completion. He quoted figures showing that the Council in undertaking the construction themselves had accomplished the work of permanent way, electrical equipment, and street improvements at a cost of £144,000, compared with an estimate of £204,000. He paid a high tribute to the borough electrical engineer (Mr. A. W. Bradley) and to the working staff for the admirable manner in which the work had been conducted. In regard to workmen's fares, it has been decided that the system of issuing books of tickets should be abolished, and that from the first car in the morning until eight o'clock tickets for the return journey will be issued at single fares.

Glasgow.—The Corporation have adopted a proposition that the general manager be instructed to make up a statement showing separately each week, for the next two or three weeks, the revenue and earnings per car mile run of the routes outside the city. A report by Mr. Young showed that by taking the earnings for the 12 months to Aug. 20 last on those routes which have one or both termini outside the city boundaries, it is found that the average revenue works out at 10·74d. per car mile, and by taking the earnings on those routes which may be termed city routes the average revenue for the year works out at 10·51d per car mile. "The above result," observes the report, "shows that the outside routes from end to end give an average of about ¼d. per car mile more revenue than the inside routes." The scheme of extensions was approved, except in regard to the Riddrie to Hogganfield route.

London County Council.—It is reported that the City Corporation are now disposed to view the Council's scheme for a tramway along the Embankment more favourably, though no official communication has yet taken place. The Council have replied to a letter from the St. Pancras Borough Council, in which the latter require the conduit system to be used throughout their district. The Council state that they have endeavoured to arrange for the conduit system in the more central districts, overhead traction being as far as possible confined to the outlying areas. It is added that the estimated additional outlay which would be involved by the substitution of the conduit system on those routes for which it is suggested that the overhead system should be employed would amount to something like £500,000. A special committee of the St. Pancras Council recommend the latter to adhere to their resolution requiring adoption of the conduit system throughout.

Perth.—The Town Council had under consideration on Saturday a resolution of the Tramway Committee not to proceed at present with the electrification of the tramways. The Lord Provost opposed the electrification proposal, and thought that more horses and cars would meet the requirements of the town. The Dean of Guild moved that the offers for electrification be accepted. These amounted to £32 862. 14s. 2d., besides which provision must be made for engineers' fees and the wages of the clerk of works. Adding the purchase price, the capital expenditure would amount to £68,292, or, say, £70,070. He reminded the Council that the borrowing powers under the Tramways Act and under the order obtained last year were £77,000. The present time was favourable to the economical execution of the work. One councillor moved that the tramways be leased to a company, and another that a *plébiscite* should be taken. Eventually the subject was deferred until the next meeting.

Rochdale, Bury, and Oldham.—Mr. James More, the valuer for the local authorities in connection with the tramways arbitration, has withdrawn his first allocation of the purchase price of the company's undertaking, and has sent another apportionment. It appears that the original allocation did not comply with Clause 2 of the agreement between the local authorities. The revised award, which differs but slightly from the original one, is as follows: Rochdale and Wardle, £70,790. 6s.; Littleborough, £6,979. 18s; Royton, £15,421. 14s.; Heywood, £20,239. 7s. 2d.; Bury, £38,394. 15s. 9d.; Tottington, £4 134. 18s. 2d.; Unsworth, £3,016. 12s. 4d.; and Whitefield, £3,697. 8s. 7d. In connection with the completion of the purchase, fixed for yesterday, a curious position is reported to have arisen. The agreement provides that in the event of the transfer not being carried out by the appointed date, the authorities shall pay interest at the rate of 5 per cent. The authorities were ready with the purchase-money, and were willing to give an undertaking to pay the company's

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costs after taxation; but it is stated that the company were not disposed to accept an undertaking. Seeing that the authorities are only liable for the taxed costs, it is not easy to see how they can pay same before the bill has been before the taxing master, unless the company expect them to hand over an ample sum for same on completion, leaving the final settlement until the bill has undergone taxation.

Belfast.—A joint meeting of the Finance and Tramways Committees was held on Monday, when a long discussion was held in regard to the financial aspect of the Belfast Street Tramways undertaking, and finally it was decided that a sub-committee, consisting of the Lord Mayor, the chairman of the Finance Committee, the chairman of the Tramways Committee, and the chairman of the Law Committee, should take this matter into consideration, have an interview with the bankers, and, if necessary, visit London, and subsequently submit a report to an adjourned meeting of the two committees. Subsequently, at a meeting of the Tramways Committee, it was reported that the consulting engineers, Messrs. Lacey, Sillar, and Leigh, are to forthwith make a careful inspection of the whole system and prepare a report, and it is expected that they will meet the Tramway Committee to-day. A long report was submitted by the general manager bearing upon the amalgamation of the tramways and electric lighting undertakings. Mr. R. Brown, of the Kingsland mechanical surface-contact system, wrote to the effect that he was prepared to instal that system for several miles in any part of the city the committee chose for the purposes of a free trial, and if at the end of the trial the committee were not satisfied with it he would remove it and replace that portion of the line with the overhead traction. A reply was sent to Mr. Brown to the effect that the committee were still considering the matter. It is proposed to retain Mr. Balfour Browne, K.C., and the Irish Solicitor-General for the arbitration with the company.

Heywood.—The Tramway Committee held a meeting last week to consider the replies from Bury and Rochdale to the suggestion of Heywood on the question of payment for working the cars within Heywood borough. At the joint conference the representatives of Bury and Rochdale suggested that 5d. per car mile should be paid. Heywood's representative did not agree with this suggestion, and subsequently, by the direction of the committee, the town clerk of Heywood wrote to both the neighbouring corporations offering to pay 4½d. per car mile, and giving reasons why it was considered that this was sufficient. It was further suggested that if Bury and Rochdale could not accept this offer, the matter should be submitted to the arbitration of some practical tramway manager to fix the sum to be paid. Both the corporations replied to the same effect that they had carefully considered the matter, and could not agree to depart from the 5d. per car mile suggested. They offered, however, to make the agreement retrospective at the end of 12 months, and if the working expenses proved to be less than 5d. per mile, then Heywood would be given the benefit, and the price to be paid for the next five years would be fixed at the amount agreed upon as the working expenses for the 12 months. After considering the question, the committee decided that they would agree to pay the actual working expenses as found by each year's working. At a meeting of the Finance and General Purposes Committee resolutions were adopted authorising the borrowing of the money from the bank for the payment of Heywood's portion of the award for the buying out of the company. The amount due from Heywood is £20,239. 7s. 2d.

LIGHTING AND GENERAL.

New Cable Works.—New cable works are about to be established at Ammendorf, near Halle.

Derby.—The Corporation have reduced the maximum price for current from 5d. per unit to 4¾d.

Neath.—An enquiry has been held into the proposed borrowing of £20,000 for electric lighting purposes.

Wolverhampton.—Sanction has been received to the borrowing of £10,000 for the purpose of electric lighting.

Doncaster.—The Town Council have agreed that places of worship be charged at the uniform rate of 3½d. per unit.

Dudley.—In the last eight weeks 234,043 units were generated, of which the trams took 148,839, public lighting 10,348, and private lights 52,671.

Holloway.—In order, it is stated, to obviate the possibilities of suicide by gas, the electric light has been installed in 400 cells in Holloway Goal.

Blackburn.—It is proposed that when a successor to Mr. Giles has been appointed he should combine the offices of electrical engineer and tramways manager.

Indo-European Telegraph Co.—The directors have declared an interim dividend for the half-year ended June 30 last at the rate of 5 per cent. per annum.

Sunderland.—An enquiry will be held on the 18th inst. into the application of the Corporation for sanction to borrow £25,000 for electric lighting purposes.

Buralem.—The Town Council have appointed a deputation to confer with the Tunstall Council with regard to the supply of electricity in bulk to the latter authority.

Tonbridge.—A largely signed memorial, asking, amongst other things, for more light, has been referred to the Highways Committee of the Urban District Council.

Crewe.—The Town Council have recommended the acceptance of several tenders, amounting to some £4,000, for additional machinery and equipment at the electricity works.

Sligo.—The General Post Office authorities are at present considering a scheme whereby intermediate towns on the route between Dublin and Sligo may be provided with telephone facilities.

Walsall.—The electrical engineer has been instructed to report the estimated cost of extending the mains in Lysways-street and Pershore-street, and the probable consumption and income.

Paisley.—The Town Council have accepted the suggestion of the electrical engineer, Mr. Parkinson, to approach Johnstone and Renfrew Corporations with a view to the supply of electricity to these towns.

Telephones over the Thames.—The Thames Conservancy have granted permission to the National Telephone Company, Limited, to stretch two additional wires across the river below Staines railway bridge.

Portsmouth.—Application is to be made for sanction to borrow £635 for telephone extension. There are now 1,935 lines fixed, and at the next meeting it will be proposed to extend the proposed loan to £1,200.

Removals.—The Civil and Mechanical Engineers' Society has changed its offices to 25, Victoria-street, Westminster. The Linolite Company have moved into larger offices at 25, Victoria-street, Westminster.

Sale of Plant, etc.—Particulars of a sale of a complete electric lighting plant by W. P. Adams, 28, Victoria-street, Westminster, S.W., appear in another column, also of a lease of an equipped warehouse at Chelsea.

Aston.—The hours of "peak charge" have been altered to between 6 p.m. and 8 p.m., and consumers are now given the option of an alternative flat rate of 4d. per unit, with a discount of 5 per cent. if accounts are paid within one month.

Kensington.—The following notices of intention to lay mains have been agreed to: Notting Hill Electric Lighting Company in Ladbroke-grove, Clydesdale-road, and Westbourne-grove; Brompton and Kensington Electricity Supply Company in Warwick-street.

Whitwell.—The Derby County Council have sanctioned the application of the Parish Council to raise a loan of £2,000 for the purpose of lighting the parish by electricity, preparatory to the matter coming before the Local Government Board in the ordinary way.

Darlington.—Current is now supplied for tramway purposes at the following charges: for the first 1,000 units, 4½d. per unit; for the next 2,000 units, 4¼d. per unit; and for over 3,000 units, 4d. per unit. This is a reduction of ½d. per unit all round, which is equal to 10 per cent.

Anglo-American Telegraph Co.—The directors have resolved, after placing £5,000 to credit of the renewal fund, to declare an interim dividend for the quarter ended Sept. 30, 1904, of 12s. 6d. per cent. on the ordinary stock and £1. 5s. per cent. on the preferred stock.

London County Council.—On Tuesday the Council agreed to sanction a loan of £23,960 to the Stepney Borough Council for electric light installation and meters. A number of applications to lay mains under Electric Lighting Acts and Orders in the Metropolis were agreed to.

Stretford.—The total units generated during August was 78,007, of which 49,520 were used for power and 14,460 for lighting. The revenue for the past month was as follows: traction, £309. 10s.; public lighting, £132. 16s. 11d.; private lighting, £60—total, £502. 6s 11d.

Carlisle.—Sanction has been received to the borrowing of £5,000 for the purposes of main extensions, meters, services, etc., the whole to be repaid in 25 years. The agreement with the North British Railway Company for the electric lighting of the canal goods yard by electricity has been completed.

Westminster.—The St. James and Pall Mall Electricity Company have now changed the arc lamp globes in their district from muranese to opalescent, with a very decided improvement to the lighting of the streets. This alteration, previously approved by the Works Committee, will not entail any increased cost to the Council.

St. Pancras.—The Borough Council support the proposed application of the London County Council to Parliament for powers to enable the local authorities who are or who may hereafter become electric lighting and power undertakers to wire and fit consumers' premises for the use of electrical energy, and to obtain loans for this purpose.

Easedon.—The Urban District Council have accepted an offer of the Backworth Coal Company to supply current for 100 lamps in the principal roads and streets of the Easedon and Backworth Wards. The cost will be slightly higher than they were paying in the Holywell Ward, but there is a possibility of a reduction after the project is completed.

Upton and Prenton.—Sanction has been obtained to the borrowing of £6,500 for the purpose of supplying electricity in Prenton and Upton. The town clerk is about to give the necessary statutory notices in respect of the laying of electrical cable from the borough into the township of Prenton. Current will be supplied in Upton about Nov. 15.

Finchley.—The estimates of the Electric Lighting Committee for the coming half-year show that a sum of £2,719 will be required, with receipts at £2,715. There would be an estimated deficit of £4. The committee does not anticipate that it will be necessary to make any call on the rate for the coming half-year. Up to date 14,100 8-c.p. lamps have been applied for.

New Barnet.—On Tuesday the Urban District Council were asked to receive a deputation of ratepayers on the subject of electric lighting. It was decided to inform the deputation that arrangements in connection with the scheme were not sufficiently advanced to admit of immediate settlement, and that consequently there would be ample time for holding a public meeting or meetings for the purpose of considering the Council's scheme.

St. Marylebone.—The Council last night received a report on the financial side of the proposed loan for the electric light recommending

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that the town clerk be authorised to take all necessary steps in connection with the completion of the loan, and to affix the common seal to any necessary authority for the County Council to pay the sum of £1,415,000 to the Council's treasurer.

Gillingham.—The engineer in his last report states that the eqtivalent of 236 8-c.p. lamps had been connected with the mains since the last meeting, making a total of 11,815 8-c.p. lamps with 139 consumers connected. A number of three-light ½-ampere Lunar Nernst lamps are to be erected, also a 260-c.p. single-light fitting, and a main is to be extended. It is proposed to reduce the meter rents from 2s. 6d. to 1s. 6d. per quarter.

Pontypridd.—The General Post Office authorities have not found enough telephone subscribers at Llantwit Vardre to justify the expenditure involved in the establishment and maintenance of an exchange there. The District Council are now enquiring whether they would establish and maintain an exchange there if the Council contributed, in addition to the ordinary rate, a sum that would justify the necessary expenditure.

Transfer of Business.—Messrs. Robson and Coleman (late Robert Robson), electrical engineers, 5, St. Mary's-place, Barras-bridge, Newcastle-on-Tyne, have taken over the business of Mr. Thompson Gradon, jun., electrical engineer, 131, Barras-bridge, Newcastle-on-Tyne. We are informed that up to date over 2,000 electric light and power installations have been completed by that firm. They undertake all kinds of work, and a special repair department is one of their features.

Swindon.—The electrical engineer's last monthly report showed 234 consumers connected, as compared with 93 in the corresponding month of last year, and 152 street lamps, as against 65 a year ago. The extensions required to the generating station, in order to meet the demand for current for lighting and power purposes, have been approved. Plans will be prepared and application made for sanction to borrow £20,000. A number of electric mains are also to be extended.

Battersea.—The Lighting Committee have granted permission to the Association of Engineers-in-Charge to visit the central electric generating station on a Saturday afternoon to be arranged. An expenditure of £125 has been agreed to for fitting up the meter-testing room at the central electric generating station and the provision of cables, tools, and apparatus for the purpose of testing meters and carrying out the necessary works of repair which at the present time are being carried out by the meter-makers.

Hebden Bridge.—The Urban District Council's electricity works, costing £10 260, were opened on the evening of the 6th inst. by Mr. Abraham Webster, chairman of the Council. The scheme has been carried out under the advice of Mr. Walter Emmott, consulting electrical engineer, Hebden Bridge. The works consist of engine-room, storage-battery room, offices, and stores. Various commercial applications of electricity, with special references to its uses for motive power, were exhibited in the building.

Ilkeston.—An exhibition of electrical plant, inaugurated by the Tramways and Electricity Committee of the Corporation, was formally declared open on Monday by the Mayor (Alderman C. Maltby) in the presence of a numerous assembly, including Alderman Robinson (chairman of the Tramways and Electricity Committee), Councillors F. Woolley, W. Richards, and W. Shakspeare (members of the committee), Aldermen F. Beardsley and R. Hunt, Messrs. Hamilton (Nottingham), A. C. Gilbert (tramways manager), etc.

Ealing.—The financial result of the June quarter's trading of the electric lighting department is an increased income of 11 per cent. over the corresponding quarter of last year, but on account of a large increase in coal costs and extra interest, etc., the net result was more unfavourable than last year. During the vacation 2,342 lamps were applied for, making a total of 20,905. There are now 2,125 consumers on the books. The pressure at West Ealing requiring strengthening, a transformer station was recently built at West Ealing.

Tunbridge Wells.—The Lighting Committee have received a letter from the Southborough Urban District Council stating that their Highways Committee are of opinion that the Tunbridge Wells Corporation should bear the whole cost of the lighting of Powder Mill-lane. The committee consider that the arrangement made in 1897 is an equitable one, and should be continued. The further consideration of questions relating to transformers at private houses has been deferred, also consideration of a report by the electrical engineer upon the system of charging for current.

Carnarvon.—The draft free wiring agreement (already referred to by us) has been sealed. The following alterations have been made: (1) the Council to exercise their right of refusing applications for free wiring within six days instead of three days; (2) a clause to be inserted providing that a statement showing the prime cost of each installation be submitted to the Council quarterly; (3) the clause prohibiting the local authority from contracting with any other firm for the wiring of consumers' premises not to apply when the local authority are themselves the consumers.

Dumbarton.—Negotiations are still proceeding with the Caledonian Water Power Electricity Company, who have asked for wayleaves under the county roads for a period of 50 years. The Road Board, however, are only disposed to grant a wayleave during pleasure, as in the case of wayleaves for other purposes. There are also other minor difficulties, such as that of entering into an agreement, especially for a period of years, with an unincorporated company. On the other hand, the Board are anxious, if possible, not to interpose difficulties in the way of what might prove a public advantage.

London Gazette.—A general meeting of the members of the Stewart Electrical Syndicate, Limited, will be held at 140, Leadenhall-street, E.C., on Nov. 17 at 12 o'clock noon, to receive the liquidator's report showing how the winding-up of the company has been conducted and its property disposed of. A general meeting of the shareholders of the Electrical Indicator Syndicate, Limited, will be held at 4, Pembroke-street, London, N., on Nov. 15 at 11 o'clock p.m., to receive the liquidator's report showing how the winding-up of the company has been conducted and its property disposed of.

Yarmouth.—The half-yearly estimate of the Electric Light Committee anticipates a clear profit of £1 018. Another cable under the harbour has been broken. There were originally 20 cables, of which 16 have been broken, and of the four remaining two are in a very bad state. It has now been decided to lay six cables across the harbour in a steel tube, as was done for the tramways, at a cost of about £1,200 inclusive. There are now connected to the mains 546 consumers, representing 27,348 8-c.p. lamps. During September ten new consumers were connected, representing 339 8-c.p. lamps.

Wellingborough.—At the last Council meeting the Clerk read petitions from owners and agents of property in the immediate neighbourhood of the electric lighting works complaining of the vibration and noise caused by the working of the machinery at the works. It stated that several tenants had left the houses owing to the nuisance, and the owners were suffering pecuniary loss. A petition was also read from occupiers complaining of the humming noise, and alleging that the smoke nuisance had not been abated. Subsequently the Council sat *in camera* to meet the representatives of the electric company.

Erith.—The committee have accepted the resignation of Mr. P. M. Hunt, assistant engineer, and applications for the appointment are invited. The concrete foundation for a further boiler is to be put down before the present extensions to the generating station are completed. Messrs. Friday and Ling, the contractors, are to carry out this work at their schedule price (£60). Messrs. Callender's intend to use a part of the further supply of current demanded by them for the lighting of arc lamps at their works, and the Council have informed them that they cannot agree to supply current for arc lighting at the power rate of 1½d. per unit, but would be prepared to supply such current through a separate meter at the ordinary lighting rates.

Hastings.—At the last Council meeting a report was received from the Electric Lighting Committee with regard to the proposed loan of £3,416 for electric lighting purposes. It appears that the Local Government Board have drawn the attention of the Corporation to the fact that the deficits on the working of the undertaking during 1900 and 1903 have only partly been provided for. The Board wanted to know what steps the Council were going to take to wipe out the balance and to prevent a recurrence of these losses. The committee recommended that, in addition to the £1,500 provided for the purpose in the present estimates, a similar sum be set aside yearly until the deficit has been wiped out, unless in the meantime increased profits might render such provision unnecessary.

Manchester.—The Electricity Committee on Wednesday discussed the report of the chief engineer (Mr. Pearce) on the results of the experiments which have been made in lighting certain parts of the city with electricity. The details of the report were not disclosed, but the *Manchester Guardian* understands that the committee are satisfied with the results which have been obtained. All the old types of lamp have been exchanged for the Gilbert enclosed type. This new and better type of lamp will burn for 120 hours—some say for 150 hours—without needing retrimming or any attention whatever. The new lamps give a light equal to between 1,300 and 2,000 candles, whilst the illuminating power of the discarded lamps did not exceed in any case 1,000 candles. The lamps also required retrimming after every 20 or 30 hours of burning. At the close of their meeting in the town hall the committee went out to see the effect of the electric lighting in Piccadilly, Albert-square, and St. Ann's-square. The new lamps are certainly a marked improvement on the old ones.

Swansea.—An enquiry has been held into the Corporation's application to borrow £2,000 for extensions of the Corporation's telephone system. The Town Clerk said that £20,606 had been already sanctioned for the municipal telephone exchange, out of which £19,158 had been expended. At present there were 1,005 subscribers' instruments and lines, and the rentals were £3,823. 10s. 5d. The present application was to enable the Corporation to join up 176 further subscribers who had applied. Mr. Bennett stated that the total length of junction poles erected was 13¼ miles, leaving 18½ miles still to do. Capital remained unexpended sufficient for this purpose. The 1,005 lines in existence had cost £15,769, or only £15. 14s. 6d. each. At the last Council meeting the engineer reported that applications were being continually received with regard to the taking on of pupils at the electricity works, and the engineer reminded the committee of a former minute to the effect that the question "might be considered in the light of scholarships in connection with the scheme to be prepared under the Education Act, 1902." If it was the wish of the committee that pupils should be taken on, the engineer suggested that not more than three should be appointed, that the term should extend for two years, subject to a satisfactory scheme being drawn up jointly by the Education Committee and the Electric Lighting Committee. It was decided to appoint a small committee to confer with the Education Committee and ask them to carry out the suggestion, which had previously been carried. Mr. Pruemann reported that he had again been asked to extend the electric mains should be extended to the Sketty district, and it was decided to lay pipes when the cable work is done. The engine and dynamo to be removed from the Strand station to the destructor works in order to be suitable for tramway purposes, will require certain necessary alterations. Messrs. McLaren, of Leeds, made the engine, and they required £608 for the work, including dismantling and re-erecting. The rewinding of the dynamo would cost a further £152. It was decided to have specifications drawn up, and to invite tenders. The engineer has been requested to report upon the advisability of charging a flat rate.

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Scottish Central Electric Power Co.—A start has now been made with the work connected with the erection of an extensive station by the Scottish Central Electric Power Company, who some time ago were granted a provisional order for lighting and motor purposes. About five acres of ground have been staked off at Carmuirs, between Bonnybridge and Larbert, and it is expected that the company's radius of supply will extend to about 12 miles. The engineers for the generating apparatus are Messrs. Bramwell and Harris, London, and the builders are Messrs. J. J. and P. McLachlan, Larbert.

Barrow.—An enquiry has been held into the borrowing of £35,000 for the purpose of electric lighting. The Town Clerk (Mr. C. F. Preston) said the electric lighting borrowing powers up to March had been £78 575, and the whole of that had been expended. The outstanding debt was £67,496. The borough rate for the year amounted to 4s. 3d. and the poor rate 1s. in the £, making a total of 5s. 3d. in the £ for the year. The proposed expenditure of £35,000 was made up as follows: buildings, £4,000; engine-room plant, £5,750; boiler-house plant, £6,750; clerk of works and contingencies, £1,500. This made the cost of the present extensions £18 000, and for additional services for the future they had put another £5 000. The borrowing powers applied for, but not obtained, amounted to £12,097, which made a total of £35 097.

Heston and Isleworth.—The Council are advertising that they will supply electric current for light and power at the following charges: lighting. 5d. per unit for any quantity, subject to the following discounts if accounts are paid at Council's office within one month from demand: winter quarters, consumption exceeding 200 units, summer quarters 150 units, 5 per cent. discount; 300 and 200, 7½; 400 and 300, 10; 600 and 350, 15; 700 and 400, 20. Meters from 1s. per quarter. Power: consumption not exceeding 750 units per quarter, 3d. per unit; consumption exceeding 750 units per quarter, 2d. per unit. Meters from 2s. per quarter. Premises will be wired and fitted on receipt of approved applications free of all initial cost to the consumer. In these cases current will be supplied at 5½d. per unit. The consumer will have the right of purchasing the installation outright at any time.

Ripon.—The Gas and Electricity Committee have been considering a letter from Mr. G. F. Metzger, of Manchester, to Mr. G. Simpson, South Lodge, respecting electricity for the city of Ripon, and also a report by Mr. Warden Stevens, of London, on a scheme to supply Ilkley with electricity. The Mayor, in thanking Mr. Simpson for his kindness in sending the letter for the perusal of the committee, stated that they were not prepared to go fully into the matter at present. A deputation of the Corporation has been received by Mr. Pelham, one of the secretaries of the Board of Trade, with reference to the electric lighting order of the city, and Mr. Pelham informed them that nothing would be done with respect to the order before next March, and that the Corporation should have an opportunity of laying their case before the Commissioners, when the Power and Traction Company applied, and suggested that the Corporation should make terms, if possible, with the company.

Middlesbrough.—The engineer (Mr. H. M. Taylor) in his last report states that during the month of September 58,798 units were sold, against 37,773 units in September last year, making an increase of 56 per cent. This result is largely due to the increased motor load. The revenue for the month amounted to £817, compared with £645 last year, and the cost of generation was £274, against £214. or 1·12d. per unit, against 1·36d. The total cost of production was £420, against £370, or 1·71d. per unit, compared with 2·35d. in September last year. This gives an estimated profit for the month of £396, exclusive of interest and redemption. The lamps connected during the month numbered 2,234, bringing the total lamps connected and applied for to 51,250, of which 45·4 per cent. had been burning at one time, the maximum load being 698 kw., compared with 619 in September last year. The extensions at present in progress will entail an expenditure estimated at £7,997, but a contract has been let at £7,772. At the conclusion of the last Council meeting, Councillor Hornung complimented Mr. Taylor upon the manner in which the electric light had been installed in the town hall.

Fareham.—From the accounts of the electricity works for the year ended March 31 we note that the loans amounted to £12,251, of which £3,345 has been repaid. The total capital expenditure to March 31, of which £558 was spent last year, totals £12,287, of which £5,577 is accounted for under "lands, including law charges incidental to acquisition," and including the purchase of the undertaking, £258 for buildings, and £2,533 for machinery. The total receipts to March 31 on the capital account are given as £12,304. The expenditure out of revenue amounted to £1,062, and the receipts to £2,036, made up as follows: sale of current per meter at 7d. per Board of Trade unit, £1,328; public lighting, £655; rental of meters and other apparatus on consumers' premises, £43; charging accumulators, £10—leaving a balance to be carried to the net revenue account of £974. Of that amount £784 has been absorbed by interest on mortgage debt and instalments of principal of money borrowed, leaving a balance on the net revenue account of £190, which, together with the balance of £128 from the last account, brings the reserve fund account up to £318. The quantity generated was 98,619 units, of which 34,654 were sold for public lamps, and 45,213 to private consumers by meter—making a total of 79,867. The quantity used on the works was 4,688, making a total quantity accounted for of 84,555, and the quantity not accounted for 14,064. The number of public lamps is 27 arcs and 109 incandescents. The total maximum supply demanded is 72 kw.

Colliery Plant.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, report a number of contracts, amongst them being a complete plant for the Dunston, Swalwell, and Garesfield Collieries, Limited, the power for which will be supplied by the Newcastle-on-Tyne Electric Supply Company, and the installation will consist of the complete equipment both for the surface and underground. On the surface there will be an electric winding gear fitted with three-phase motor capable of winding from a depth of 200ft., the motor being fitted with a special controller so that the speed of the winding can be varied and also run at a very low speed if necessary for the examination of the shaft, etc. In addition to the winding gear, the fan and also an endless rope haulage gear, which are placed at bank, are also electrically driven. The current is taken down the shaft by armoured cables, and at the shaft bottom a main shaft pump of Scott and Mountain's well-known three-throw type is to be fixed, this pump to deliver 1,200 gallons of water per minute against a head of 220ft. In the five-quarter seam another electrically-driven pump will be placed, this pump delivering 200 gallons per minute at a distance of 1,000 yards in-by. In the Brockwell seam two further sets of Scott and Mountain's pumps will be placed, each of these sets being designed to deliver 300 gallons each against a head of 105ft. This is probably one of the first instances in the United Kingdom where the whole equipment of the colliery will be electrically driven and steam entirely dispensed with, and the owners of the colliery are to be congratulated on their enterprise. Other contracts include engines, etc., for Messrs. Jas. Ross and Co., of the Phillipstown Oil Works, Linlithgow; Messrs. Bell Bros., Limited, Port Clarence: the Wigan Coal and Iron Company, Limited; considerable extensions to the electrical plant for the Tredegar Coal and Iron Company, Limited, which they put down about three years ago; and also coal-cutting machinery for Consett Iron Company, Backworth Colliery, Hamsterley Colliery, Thorncliffe Colliery, etc.

Dundee.—When electric light was installed in Dundee current was conveyed to the central area, first served through copper stripe laid in an underground porcelain trough. The extensions in the first instance consisted of insulated cables laid in iron piping. Last year the work of reconverting and relaying street mains was begun, and completed about six months ago. The cables in the iron pipes were withdrawn, and for them insulated cables laid in porcelain ducts and encased in bitumen became the carriers of the electric current. The copper strips—the oldest part of the system—were then used as feeders to convey the current to various distributing centres in the area of supply. Recently it was ascertained that the porcelain supports were decomposing by electric action, and the Corporation have resolved to do away with the copper strips, and in their place to substitute modern cables. This work will necessitate an expenditure of about £3,000. Against this has to be placed the sum which is derivable from the copper, estimated at £950. The ducts required are in stock. The *Dundee Advertiser* says the engineer, writing under date Oct. 4, states "that the lead sheathing of the cables which were laid in pitch in wooden trenches in the outlying areas of Dundee in the year 1900 has never been earthed—that is, the lead sheathing at carefully calculated intervals should be connected to the earth by water-mains or otherwise. This has been carefully and thoroughly done during the laying of the cables on the new system, and I anticipate that much damage will probably have been done to your outlying system through the work of earthing the lead sheathing of these mains having been omitted." The engineer, in explanation, added that the leakage currents which may have been allowed to leave their proper path of returning to the generating station will travel along water-mains and gas-pipes, doing damage to the same. This same damage in a worse way may happen to the lead sheathing of the cables, although by equalising the pressure at different points of the system—that is, by connecting the lead sheathing to water-mains at these points—it is possible to eliminate any trouble from this source. He further stated that he would take immediate steps to communicate with the original contractors, with the view of having the work done at once. Should any damage to the lead sheathing of the cables be discovered, especially as the tramways have been running during that period, it was quite possible that the stray currents from them (which at one time were high) had travelled along the lead sheathing of these mains to its detriment. It was impossible, Mr. Richardson said, to find out whether damage had been done or not at the present date.

PROVISIONAL PATENTS, 1904.

Oct. 3.

22440a/1903. Improvements in telephone switchboards. Wallace Cranston Fairweather, 65, Chancery-lane, London. (The Kellogg Switchboard and Supply Company, United States.) (Date applied for under Patents Rule 9, Oct. 17, 1903.) (Complete specification.)

21157. Improvements in electrical switches. Harry William Cox, Temple-buildings, Albert-street, Nottingham.

21170. Automatic trolley-pole adjuster for electric tramways. Walter Cecil Mantby Pettingill, 13, Mount Preston, Leeds.

21211. Method of regenerating negative accumulator plates of diminished capacity, or for avoiding the diminution in capacity of new plates. Richard Kieseritzky, 18, Southampton-buildings, Chancery-lane, London.

21217. Improvements relating to automatic telegraphic apparatus. Antoine Damaskinos, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21222. Improvements in sockets or holders for incandescent electric lamps. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Oct. 4.

21242. Improvements in and connected with electric arc lamps. Otto Gross, 5, John Dalton-street, Manchester.

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21243. An automatic contact make and break for electric ignitions for gas and other engines. Harry Frank Rogers and Sidney Edmonds, 29A, Longmore-street, Birmingham.

21247. Electric automatic alarm letter-box opening. David Portman Corbet and William Mapp Hughes, 54, New-road, Kidderminster.

21259. Improvements in electric switches. Harry William Cox, Albert-street, Nottingham.

21264. Improvements in electric arc lamps. August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

21276. Improvements in means for supplying and collecting electric current for driving electric trains and other vehicles. Paul Trangott Julius Estler, 52, Chancery-lane, London.

21307. A new or improved electricity meter. Emile Julien Javaux, 18, Buckingham-street, Strand, London.

21310. Improvements in smelting furnaces and electric stoves. Walker Moseley, 23, Trossachs-road, East Dulwich, London.

21314. Improvements in electric phase indicators. Kenelm Edgcumbe and Edgar Isaac Everett, 151, Great Saffron-hill, London.

21315. Improvements in ground detectors and electric cut-outs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

21322. Improved process for the etching of metal plates by the aid of electrolysis. Otto C. Strecker and Hans Strecker, 322, High Holborn, London. (Complete specification.)

OCT. 5.

21329. Improvements in electric trolleys. Thomas Cowburn, Rundle House, Hucclecote, Gloucester.

21332. An improved method for attachment for receivers of telephones and the like. Darcy Thornicroft, 32, Fernbank-road, Undercliffe, Bradford.

21334. Improvements in seats for use on electric and other cars, vehicles, ships, and outdoor purposes generally. Frederick Leese, 27, Waller-street, Byker, Newcastle-on-Tyne.

21340. Improved means for producing electric light. Charles Frederick Adams and Leonard Rowland Whitfield, 10, St. George's-crescent, Liverpool.

21382. A new or improved method of operating telephonic exchange systems, and apparatus therefor. Arthur Thomas Milnor Thomson and the Thomson-Davis Telephone System, Limited, Norfolk House, Norfolk-street, Strand, London.

21388. Improvements in electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

21400. Improvements in and relating to electric traction systems. Alfred Cecil Eborall, 13, Southampton-buildings, Chancery-lane, London.

21401. Improved method of effecting communication between telephone exchanges, and apparatus therefor. Arthur Thomas Milnor Thomson, 22, Southampton-buildings, Chancery-lane, London.

21402. Improvements in electrodes for electric accumulators with invariable electrolyte. Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 7, 1903, being date of application in Sweden.) (Complete specification.)

21403. A method for increasing the activity in electrode masses of badly conductive metallic oxides or hydrates in accumulators with invariable electrolyte. Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 31, 1903, being date of application in Sweden.) (Complete specification.)

21405. Improvements in means for suspending overhead electrical conducting wires or cables. Anton Kuchinka, 18, Buckingham-street, Strand, London.

OCT. 6.

21409. A new or improved appliance for use in indicating the presence of electricity. George Charles Shankster, 26, Lee-street, Holderness-road, Hull.

21415. Improvements in the construction of electric tramways. Samuel Green Bennett, Clyde House, Heath Town, Wolverhampton.

21422. Improvements in electrical switches. Harry Nunns, South-parade, Halifax.

21423. Improvements in or relating to electric lamp bulbs. John Charles Barker and Frederic Claude Rylands, 100, Wellington-street, Glasgow.

21435. A device for covering and protecting the conductor or "live" rail of electric railways, and a current-collector arm to be used with the same. Oscar Sayle Gill, Lake House, Allerton-road, Woolton, Liverpool.

21447. Improvements in connection with electric railways. William Percy Nesbitt, 55, Chancery-lane, London.

21455. Electric time alarms. Samuel Sidney Bromhead, 33, Cannon-street, London. (The American Bank Protection Company, United States.) (Complete specification.)

OCT. 7.

21513. Improvements in the construction of electric accumulators. Jacques Marie de la Croix and Henry Francis Joel, sen., 74, Windsor-road, Forest Gate, London.

21519. Improvements in starting apparatus for electromotors. Charles Turnbull, jun., 34, Castle-street, Liverpool.

21523. Improvements in arc lamp mechanism. George Owen Donovan, 126, Chester-road, Erdington, Birmingham.

21532. Improvements in and relating to electric signs and illuminated devices. Francis Bertram Felloes, 60, Queen Victoria-street, London.

21543. Improvements in or relating to electric light fittings. William Winstanley Strode, 111, Hatton-garden, London.

21553. Improvements in galvanic dry cells or batteries. William Strickland, 21, Finsbury-pavement, London.

21562. Electrolytic method and apparatus for the production of white lead. Elias Bernard Koopman, 18, Southampton-buildings, Chancery-lane, London. (Clinton Paul Townsend, United States.)

21564. Improvements in pillar brackets for the control gear of electrical or other mechanism. Edward Neville Bray, Frederick Rice Markham, Ferdinand Edward Reiss, and Markham and Reiss, Limited, 18, Southampton-buildings, Chancery-lane, London.

21566. Improvements in the electro-deposition of copper and other metals. Sherard Osborn Cowper-Coles and the Metals Corporation, Limited, 4, South-street, Finsbury, London.

21567. Improvements in removing metallic cylinders from mandrels on which they are electro-deposited. Sherard Osborn Cowper-Coles and the Metals Corporation, Limited, 4, South-street, Finsbury, London.

21579. Improvements in electric meters and demand indicators. George Markham Hayton, 23, Coleman-street, London.

21580. Improvements in or relating to contact devices for electric clocks. Bernard Gustafson and Ragnar Carlstedt, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Oct. 8, 1903, being date of application in Sweden.) (Complete specification.)

OCT. 8.

21601. Improvements in trolley sheaves for engaging electric power wires, applicable also to sheaves and guide pulleys used with wire ropes, cables, and the like. Silas Williams, Phœnix Foundry, Bute Docks, Cardiff.

21622. Improvements in electric ignition for internal-combustion engines and in apparatus therefor. Rankin Kennedy, Bute, Shettleston, N.B.

21625. Submarine cable groyne. Rowland George Allanson Allanson-Winn, 22, South Frederick-street, Dublin.

21629. Shade-frame for electric lamps, especially pear lamps. Gustav Adolph Lehmann, Seestrasse 5, Dresden, Germany.

21639. Improvements in electrical condensers. Marconi's Wireless Telegraph Company, Limited, Edgar Berry, and Harry Alexander Elrick Ewen, 24, Southampton-buildings, Chancery-lane, London.

21640. Improvements in apparatus for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, Edgar Berry, and Harry Alexander Elrick Ewen, 24, Southampton-buildings, Chancery-lane, London.

21641. Improvements in safety devices in connection with radio-telegraphic transmission circuits. Marconi's Wireless Telegraph Company, Limited, Edgar Berry, and Harry Alexander Elrick Ewen, 24, Southampton-buildings, Chancery-lane, London.

21642. An electrical apparatus for adjusting tramrail points. Joseph Edward Macaulay, 7, Eldon-terrace, South Circular-road, Dublin. (Complete specification.)

21648. Improvements in trolley heads employed in electrical traction. Horace James and Arthur West, 15, St. James's-row, Sheffield. (Complete specification.)

21672. Improvements relating to electric batteries. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (La Société Anonyme le Carbone, France.)

21676. Improvements in electrodes, specially applicable to electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

21677. Improvements in electrodes specially applicable to electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

21678. Improvements in and relating to the construction of rotary members for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 27, 1904.

1903.

21008. Mounting a number of electrical fittings or instruments upon a common base or panel. Hofstede-Orull.

21173. Electro-mechanical arrangement for changing speed and for reversing. Gasnier.

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21318. Electric switch-holders or key switches. Davies.

21504. Electric meters. Soc. Anon. des Ateliers de Mécanique de Précision de Derritet. (Date applied for under International Convention, Oct. 15, 1902.)

21939. Signalling through submarine and like cables. Lodge and Muirhead.

21939a. Signalling through submarine and like cables. Lodge and Muirhead. (Date applied for under Patents Rule 9, Oct. 12, 1903.)

22216. Laying electric conductors. Tanner and Claremont.

22443. Apparatus for winding inductive and non-inductive coils. Wilson.

22551. Electric motors and controlling devices for use in the electrical propulsion of vehicles or trains of vehicles. Raworth.

24305. Means for the production of continuous high-potential electrical discharges, applicable for the deposition of dust, fume, smoke, fog, and mist for the production of rain, and for other purposes. Lodge.

24469. Suspending chain for electric lamps and the like. James Hinks and Son, Limited, and Wright.

24472. Electric furnaces. Ruhstrat and Grimmer.

24793. Fluid pressure regulators. British Thomson-Houston Company, Limited. (General Electric Company.)

24796. Moter controllers and emergency brakes for railway and tramway vehicles or trains. British Thomson-Houston Company, Limited. (General Electric Company.)

25006. Electric ignition apparatus for internal-combustion motors and the like. Lewis and Daimler Motor Company, Limited.

25387. Controllers for regulating the speed of electric motors. Scott.

26267. Electric measuring and recording devices. Atkinson.

26268. Electrolytic meters. Atkinson.

26456. Insulated electric conductors. British Thomson-Houston Company, Limited. (General Electric Company.)

26457. Insulated coils for electrical apparatus and process of making the same. British Thomson-Houston Company, Limited. (General Electric Company.)

26460. Electric rheostats. British Thomson-Houston Company, Limited. (General Electric Company.)

26462. Electric arc lamps. British Thomson-Houston Company, Limited. (General Electric Company.)

26577. Field magnets for dynamo-electric machines. Finzi.

27189. Means for controlling the voltage from an electric generator. Deutsch.

27283. Counters for electric current meters, gasmeters, water-meters, and the like. Biermann.

1904.

1374. Method of and means for regulating electric motors. Lang.

6110. Electric arc lamps. Foster, Grote, and Ely.

6411. Brush-holders for electric motors or generators. Cooch.

7249. Electrical fuse boxes, junction boxes, and the like. Lee.

8745. Trolley pulleys of electric tramcars. Binns.

12766. Apparatus for gripping or holding and cutting submarine cables. Sazérat.

14059. Apparatus for electro-galvanising. Potthoff.

14060. Conductor and collector devices for electric railways and tramways. Bolzano.

16395. Combined electric switch and lamp-holder. Hunter.

16578. Morse telegraph transmitters or instruments for transmitting telegrams by means of Morse signals. Wolters.

17051. Electrical switches, known as tumbler switches. Sperryn and Wood.

17181. Contact devices for apparatus for electrically lighting and extinguishing gas. Testor.

17364. Means for preventing the breaking of an electric circuit containing arc gaps or the like. Bousfield and Ozonized Oxygen Company, Limited.

18141. Electric block systems for railways. Robinson. (Date applied for under International Convention, Aug. 22, 1903.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	5½-6
—— 6 per cent. Cum. Pref., 1-100,000	5	5½-6
—— 4½ per cent. Mortgage Debentures	100	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	2¾-3¼
—— 4 per cent. Mortgage Debenture Stock	100	87-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	½-¾
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	94-97
—— 4½ per cent. 2nd Debenture Stock	100	70-75
Callender's Cable, Debentures	100	101-105
—— Ordinary	5	9½-10½
—— 5 per cent. Pref.	5	5-5½
Crompton and Co.	3	1½-2
—— 5 per cent. Debentures	100	90-95
Edison and Swan United, "A" Shares, 1-99,261	3	½-¾
—— "A" Shares, 01-017,139	5	1-2
—— 5 per cent. Debentures	100	79-83
—— 4 per cent. Deb. Stock, Red.	100	77-82
Electric Construction, Limited, Nos. 1 to 112,100	2	1-1¼
—— 7 per cent. Cumulative Pref.	2	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9-9½
—— 4 per cent. 1st Mort. Deb. Stock	100	91-96
W. T. Henley's Telegraph Works, Ordinary	5	10½-11½
—— 4½ per cent. Preference	5	5-5½
—— 4½ per cent. Debentures	100	108-111
India Rubber, Gutta Percha, and Telegraph Works	10	19-20
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	10-10½
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	101-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10	11½-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	9½-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	10½-11½
—— 4½ per cent. Debenture Stock. Red.	100	103-106
Bromley (Kent) Electric Light and Power Co.	5	5½-5¾
—— 4½ per cent. 1st Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	10½-11
—— 7 per cent. Preference	5	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	7½-8
—— Nos. 20,001-30,000	5	7-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	12½-13½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	107-110
Charing Cross and Strand, Nos. 1-70,000	5	8½-9
—— 70,001-80,000	5	8-8½
—— 4½ per cent. Cum. Pref.	5	5¼-5½
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4½-5
—— 40,001-80,000	5	4½-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-106
Chelsea Electricity Supply	5	6½-7
—— 4½ per cent. Debentures	100	108-111
City of London, Ordinary	10	10½-10¾
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London Electric Supply, Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	11½-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	102-105
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	6½-6¾
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	1½-2½
—— 5 per cent. Debenture Stock, Red.	100	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5½-6
—— 4½ per cent. First Deb. Stock, Red.	100	101-104
Havana Electricity, Limited, 1-15,000	10	9½-10½
Hove Electric Lighting, Limited, Ord. 1-13,000	5	7½-8½
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	101-105
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	100-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	1½-2½
—— 6 per cent. Pref.	5	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	97-100
Metropolitan Ordinary	10	15¾-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	112-117
—— 4½ per cent. Cum. Pref.	5	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	96-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.	100	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	14½-15½
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-86 and [illegible]-14,310	5	5¾-6½
—— 4 per cent. Debenture Stock	100	99-102
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	93-101
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2¾-3½
—— 4 per cent. Debenture Stock	100	83-87
South London, Ordinary		4½-4¾
South Metropolitan Electric Light and Power Co., Ord.	1	¾-1
—— 7 per cent. Cum. Pref.	1	1¼-1½
—— 4½ per cent. 1st Mort. Deb.	100	104-108
—— Ditto, June, 1904	—	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	4½-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	4½-5
Westminster, Ordinary	5	12½-13½
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½
Electric Tramways.—		
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	5⅜-5⅝
—— Ord.	5	6⅜-6⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	139-142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	102-104
Barcelona Tramways, Limited, Ord., 1-20,000	10	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	9-10
—— 5 per cent. Deb., Red., 1-600	100	98-101
—— 4½ per cent. Red. Deb. Stock	100	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	⅝-⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	⅞-1
Belfast Street Tramways, Ord., 1-26,600	10	10-11
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	1½-2½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	3¾-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96-101
British Columbia Electric Railway Co., Ord. Def.	100	99-102
—— Ord Pref.	100	100-103
—— Non.Cum. 5 per cent. Pref.	10	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	104-106 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	9¾-10½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	10¾-11¼
—— 5 per cent. Perpetual Debenture Stock	100	115-118
—— 4½ per cent. 2nd Deb. Stock	100	94-97

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5		3⅞-4⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
—— Prov. Cert., all paid	100	—	102 105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7 -7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways, Nos. 1-480,000	1	—	1⅜ 1⅞
City of Birmingham Tramways, 5 per cent. Cum. Pref. ..	5	—	4½-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) ...	100	—	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	—	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	—	9½-10
—— 5 per cent. Cum. Pref.	10	—	11-12
—— 4 per cent. Debentures	100	—	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	94-97
Imperial Tramways Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	3½-4
—— 4 per cent. Debenture Stock	100	—	88-91
Kidderminster and District Lighting and Traction, Pref.	5	—	8 8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	10½-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	105-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	3/16 5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¾-1
—— 4½ per cent. Deb. Stock, Red.	100	..	99-101
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	5	—	½
—— 6 per cent. Cum. Pref.	5	—	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100	—	88-93

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	12-12½
—— 5 per cent. Cum. Pref.	10	—	9¾ 9⅞
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk.	100	—	102-105
Potteries Electric Traction, Ordinary 20,001-40,000	10	—	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	—	8½-9½
—— 4½ per cent. Debenture Stock	100	—	101-104
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,132 6 per cent. Preference	1		
—— £528,093 4½ per cent. Debenture Stock	10	..	—

Electric Railways.—

Name.	Amount paid.		Last price
Central London, Ordinary	100	—	87 90
—— 4 per cent. Pref.	100	—	100 102
—— " " deferred	100	—	79 81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100	—	107-110
City and South London, Consolidated Ordinary	100	—	47-49
—— 4 per cent. Debenture Stock	100	—	105-108
—— 5 per cent. Pref. Stock '91	100	—	122-125
—— " " " '96	100	—	117-120
—— " " " '01	100	—	113-117
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
—— Ordinary, 1-50,000	10	—	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700..	—	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	—	98-98½
Waterloo and City, Ordinary	100	—	86-89

Telephones.—

Name.	Amount paid.		Last price
National Telephone, Preferred	100	—	104-106
—— Deferred Stock	100	—	92-94
—— 6 per cent. Cum. First Pref.	10	—	12-14
—— 6 per cent. Cum. Second Pref.	10	—	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	—	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	—	97 99
—— 4 per cent. Deb. Stock, Red.	100	—	104 106
—— 4 per cent. Prov. Cert.	—	..	67-69
Orleans(?) [illegible] and Electric Company	1	..	15 16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1⅛-1¼

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week: Ending	1904.	1903.	Increase or decrease: Week.	Current year.	Miles of single track open: 1904.	1903.	Accounts for past year: Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 8	1,320	1,140	+ 179	+30,453h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	—	—	—	—	—	8	8	,, 15	14,160	3,201,586	316,049	1·03	10·11	1,770	5 04
Barking Corporation	,, 8	45	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 9	1,0 2	1,034	− 52	—	23·53	23½	March 31	56,0 3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Tramways	,, 8	5,526	5,313	+ 213	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 7	957	797	+ 160	+ 2,817	24	23	,, 25	43,374	7,742,692	951,484	—	10 94	—	4·59
Blackpool Corporation	,, 6	879	670	+ 209	+ 5,513	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	Sep. 5	1,463	1,368	+ 95	− 40	16½	16½	Dec. 31	32,021	2,253 984	600,757	3·34	12·75	2,001	7 05
Bolton Corporation	Oct. 9	1,825	1,768	+ 55	+ 505	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 5	1,060	973	+ 87	—	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 1	4,888	3,945	+ 943	+22,586	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 9	968	857	+ 111	— h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 7	5,180	5,013	+ 167	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 8	1,140	826	+ 3.4	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 9	368	416	− 47	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 8	1,924	2,015	− 90	+ 1,771	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 8	196	211	− 15	—	—	—	Dec. 31g	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 8	6,751	6,504	+ 247	— h	6	6	,, 31	362,471	44,933,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 9	2,768	2,749	+ 19	− 1,112h	6¼	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	Sep. 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Oct. 6	504	559	− 51	− 2 462	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 7	234	227	+ 7	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 8	207	224	− 17	—	4½	4½	,, 31	11,255	2,871,332	280,901	0 94	9 63	2,503	—
Dublin & Lucan Electric Ry.	,, 7	129	144	− 15	— h	7	6¾	Dec. 31g	6,234	688,905	107,164	3·88	14·09	932	7·39
Dublin U. T., electric cars	,, 7	3,980	4,043	− 63	} —	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 7	930	934	− 4	}										
Dundee City Tramways	,, 5	874	922	− 48	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 10	665	657	− 2	+ 1,414	10·77	10·75	March 31	34,312	12,950,259	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 8	14,736	14,030	+ 646	— h	145	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	Sep. 21	342	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	Oct. 5	2,830	2, 95	+ 34	+ 3,4 6	33	30¼	March 31	68,283	16,322,054	1,387,885	1·00	11·79	2,0 9	8·77
Huddersfield Corporation	,, 6	1,249	1,252	− 3	+ 2,691	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 8	2,091	2,217	− 125	+ 7,509	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 8	389	417	− 28	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 5	135	172	− 37	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 5	243	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 8	5,741	5,423	+ 318	+10,0 5	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	Sep. 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 1	10,669	10,784	− 115	+12 039	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 9	1,504	1,562	− 58	— h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 8	13,047	10,5 6	+2,491	+72 931	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 8	174	206	− 34	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 6	143	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 8	12 364	11,715	+ 619	—	131¼	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 7	1,803	1,314	+ 489	+ 6,745h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 8	120	98	+ 22	+ 1,103	2¼	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 8	3,594	3,740	− 146	—	45	38½	,, 25	185,027	39,715,120	4,059,907	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	,, 8	498	455	+ 42	—	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	29	,, 31	91,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 6	457	5 3	− 46	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 8	119	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 9	4,621	4,392	+ 229	+ 2,939	34¼	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 6	982	1,061	− 74	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 5	315	296	+ 19	+ 1,240	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	Sep. 23	625	411	+ 214	+ 6 481	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	Oct. 2	1,216	1,218	− 2	+ 390	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10 46	—	6·08
Swindon Corporation	,, 1	312	—	—	—	3¾	—	—	—	—	—	—	—	—	—
Wallasey U D.C	,, 8	726	676	+ 50	—	10·5	10·5	,, 31	35,864	6,554,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 6	1,088	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 5	728	474	+ 254	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·006	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram(?) d Including depreciation f Including one section of horse traction. g 1903. h Half-year's figures.
j Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Street-Lighting.—The engineer to the city of Westminster has recently had an opportunity of seeing the street-lighting of Berlin, of which he speaks very highly; but apart from a portion of the Freidrichstrasse, which is very effectively but expensively lighted by incandescent gas of high power on ornamental columns 30ft. high, 25 to 30 yards apart, on each side of the street, he is of opinion that the lighting of the city of Westminster holds a premier place. It is interesting to note that even in Berlin, with a highly centralised controlling authority, it has been found useful to employ not only high-power incandescent gas, but also small incandescent lamps of the Victoria-street type and high-power electric arc lamps.

New Publications.—"Magnetism and Electricity (First Stage)," by R. H. Jude. (London: W. B. Clive and Co. 2s.) The revised edition of this volume includes a number of new features.—"Higher Text-Book of Magnetism and Electricity," by R. W. Stewart. (London: W. B. Clive. 6s. 6d.) This work has also been extensively revised, and a quantity of new matter introduced.—*Proceedings* of the Royal Society of Edinburgh, vol. xxv. (Edinburgh: Robt. Grant and Son. London: Williams and Norgate. 4s.)—"The Electric Tramcar Handbook," by W. A. Agnew. (London: Alabaster, Gatehouse, and Co. 2s. 6d.) This handbook contains a lot of instructive information for the motorman, inspector, and depôt worker. It should enable motormen who drive cars merely automatically to take an intelligent interest in their work.

Motor Tests.—Mr. Arthur Williams, of the New York Edison Company, reported some interesting motor tests at the recent Edison convention. In 12 large buildings in New York the average daily use of each installed lamp in a recent year was 3·22 hours, ranging from 14 per cent. below the average to 58·7 per cent. above. Of five large New York clubs the annual use averaged 4·75 hours, the range being from 22 per cent. below to 16 per cent. above the average. For motors in smelting works the average use was ·48 hours for each horse-power of the rated capacity; instrument makers, three hours; machine shops, 2·1 hours; general machinery, 4 56 hours, etc. The average for 50 motors was 2·26 hours per day for each rated horse-power. Tests show that the cost of operating ceiling fans on the basis of 5d. per kilowatt-hour is ·79d. For driving sewing machines the cost is ·175d. for belt-driven machines and ·1d. for direct-connected machines.

North-East Coast Institution of Engineers and Shipbuilders.—The twenty-first session of this institution will be opened at Newcastle to-night, when the new president, Lord Armstrong, will deliver his inaugural address. The dates fixed for general meetings, all of which will be held at Newcastle, are as follows: Nov. 18, Dec. 16, Jan. 20, Feb. 17, March 17, April 14, and May 19. The Graduate Section have fixed the programme for their sixteenth session. We notice in the report of the Council of last session that the papers read included "Technical Education in Germany," by Mr. Max Wurl; "Notes on the Construction of Stability Cross-Curves from Balanced Paper Sections," by Mr. J. H. Heek; and "Technical Education, with Special Reference to the Admiralty System," by Mr. B. C. Laws. Some of the papers were noticed in this journal at the time. Several papers were read and places visited by the Graduate Section. The members of all grades now total 1,131.

The Army and Wireless Telegraphy.—The wireless telegraphy experiments which a detachment of the Telegraph Battalion of the Royal Engineers have been conducting in Carnarvonshire have just been concluded. The system used was that devised by Sir Oliver Lodge and Dr. Alexander Muirhead, and the object was to test the practicability of communicating by this system between fairly distant points in spite of intervening mountain masses broken by passes and containing metallic minerals. Stations were accordingly established at Llanrwst, in the Vale of Conway, and within the grounds of Sir William Preece at Penrhos, near Carnarvon. The stations were thus about 20 miles apart, and separated by the lofty and rugged Carnarvonshire range. That the waves passed from station to station was soon ascertained, and the chief problem to be solved was the proper adjustment of the instruments. It is stated that the results have been successful, and that a good deal of important information has been gained.

Mining in China.—The Pekin Syndicate are making excellent progress with the sinking of shafts in their mining concessions situated in the Chinese interior province of Hunan. There is an installation of Babcock and Wilcox boilers, and these, fed by the native semi-anthracite coal, yield splendid results. The Chinese are evincing much interest in electricity, which is employed to illuminate the mines both on the surface and underground. Ready adaptability in the use of foreign appliances characterises the natives, who are adepts in the management of steam-engines. This trait is of considerable advantage to the syndicate, as the villagers are extensively engaged, with the full approval of the authorities, in the work of shaft-sinking. A quantity of additional plant has been requisitioned for the collieries belonging to the syndicate, and it is estimated that the output will total 2,000 tons per day. The coal is of good combustible quality, and is an excellent semi-anthracite, so that it is likely to be in demand for naval purposes. It is expected that the syndicate will be in a position to commence producing coal by the end of the year.

The College of Applied Science.—The scheme for establishing a college on the Charlottenburg principle, in connection with which Lord Rosebery announced, nearly a year and a half ago, that certain public-spirited citizens were prepared to present £300,000, has not so far taken a definite form, and the delay gave rise to rumours that this munificent offer had been withdrawn. As the result of enquiries, however, the *Daily News* states that such reports are groundless, the delay being attributable to the difficulty in securing a suitable site. A Government Departmental Committee, including representatives from London University and the London County Council, has the matter in hand, and is considering whether a free site can be provided at South Kensington. The committee are also considering how far certain existing institutions, such as the Royal College of Science, with its splendid laboratory equipment, might be incorporated in the scheme, so as to form the nucleus of the proposed institution. This plan may meet with some objection on the score that the location should be more central, but it has to be remembered that if the Government presents the site contemplated it will be equal to a gift of something like £100,000.

Electrolysis of Alkali Chlorides.—Messrs. A. Tardy and P. A. Guye contribute further notes on this subject to the *Journal de la Chimie Physikale.* The present paper treats of the function of the diaphragm during electrolysis. The diaphragm is the seat of four principal phenomena: (1) physical diffusion of the alkali from the cathode to the anode liquid; (2) migration of hydroxyl ions; (3) electrical endosmosis by which the anode liquid traverses the diaphragm; (4) flow of liquid from cathode to anode consequent on alteration of level due to (3). These effects are separately considered; the last is com-

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pletely eliminated when the cathode solution is continually replenished and kept at a constant level. Characteristic constants for the different effects may be calculated from knowledge of the porosity and permeability of the diaphragm, and results of measurements with different diaphragms are given. In order to obtain the maximum yield of alkali, it is necessary to keep the levels of anode and cathode liquids equal, and to employ a current density of sufficient magnitude to cause the endosmotic current to nullify that in the opposite sense due to diffusion. The latter may be done by altering the current for a given diaphragm, or by choosing the latter with a permeability suited to the current employed.

The Sheffield Compensation-Limit.—It will be remembered that Councillor A. Muir Wilson, a member of the Sheffield Corporation, refused to accept a ticket when travelling on the tramways, his object being to test the validity of a notice given by the Corporation limiting their liability for accidents to £25. The Sheffield magistrate convicted Mr. Wilson of a breach of the by-law, holding that the acceptance of a ticket is not a voluntary proceeding, but is obligatory under the by-law. A statement of the case has just been remitted to the King's Bench for their opinion on the points of law involved. If the higher tribunal hold that the by-law in regard to the acceptance of tickets is itself tenable, the conviction will presumably stand, but there will remain the question of whether the notice limiting liability is not *ultra vires*. At the time of issuing this notice the Corporation had instituted reductions of fares, and the question arises whether this constitutes such a contract as would relieve the tramway undertakers from the full responsibilities imposed by the Carriers' Act. The view entertained by the majority of the municipalities, as expressed by them when a conference was held upon the Newcastle inter-running question, is that it does not. Apparently, however, it will be necessary to wait for a ruling on this point until it is raised in a specific form by an injured passenger.

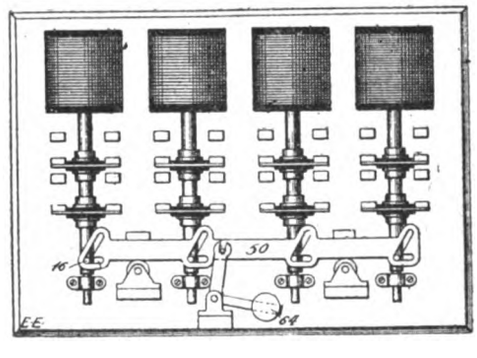
Tramcar Obstruction.—A section of the amateur magistracy at Leigh, Lancs., apparently considers itself more capable of interpreting the law than the Lord Chief Justice. Some time back one of the cars of the South Lancashire Tramway Company encountered a van at a point where the width of the road would not permit of the vehicles passing each other unless the van crossed over to the other side, where there was a greater margin. The driver of the van refused to do this, stating that if he crossed over he would be on the wrong side of the road, and would render himself liable to prosecution. Eventually, after waiting nearly an hour, the motorman backed to a loop. The Leigh magistrates adopted the view of the driver of the van, and refused to convict. This set up a somewhat extraordinary position, seeing that unless every tram, on finding itself confronted with such a difficulty as the above, resorted to the highly inconvenient expedient of backing to a loop the vehicles might remain facing each other until doomsday. Equity and common-sense surely dictate that under such circumstances a vehicle might safely commit the trifling irregularity, if such it be, of crossing to the other side of the road, and when, on the top of this, a Divisional Court presided over by the Lord Chief Justice holds that a vehicle has not an immutable right to remain on the customary side, one would think the Leigh justices would not have found much difficulty in returning a conviction. However on the case, reported in our last week's issue, again coming before them, a sapient moiety still considered that there was no case against the defendant, and as the chairman refused to give a casting vote the charge was dismissed. It is to be hoped that before long it will be authoritatively decided that the right side of the road is not invariably the left!

Steam and Electricity.—A correspondent contributes to the *Times* some highly interesting and encouraging figures upon the relative cost of steam and electric traction for railways. The returns issued by the Manhattan Elevated Railway, which a little over a year ago completed the electrification of its system, extending over some 40 miles, have foreshadowed favourable results, but hitherto comparisons between the two systems have been only approximate, as mixed traction has been in use. The *Times* correspondent now gives the result of the first year's working entirely by electricity, as compared with the last year when steam held sway—1901. The operating costs per car mile work out thus:

	Electricity.		Steam.
Maintenance of way and structures	·5325d.	...	·4635d.
Maintenance of equipment and power plant..	·6625d.	...	·652d.
Power supply and connecting transportation.	3·2505d.	...	4·673d.
General expenses	·2975d.	...	·35d.
Total	4·7340d.	...	5·9885d.

There appears to be a little discrepancy in the steam costs, which total rather over 6d. if the figures are correctly stated, but this only shows the results of the electrical working in a more favourable light. On the aggregates given, however, it will be seen that the operating costs show a reduction of about 1·25d. per car mile. During this period the operating percentage has declined from 44 73 in 1903 to 41·2 in 1904. In the same period the passengers carried on the same track mileage have advanced to 286,634,195—an increase of 40,047,173 in 12 months. The gross earnings went up to over £2,837,550, an increase of about £400,000, while the increase of net earnings totals some £318,820. These figures will be gratifying to the London underground railways, even if they do not stimulate the electrification of the suburban sections of trunk lines.

Interlocking Electromagnets.—A device has been patented in the United States for restraining the remaining magnets of a group from operation, accidental or otherwise, until the one that has been actuated is restored to its dormant condition. Some particulars of the invention, with the accompanying diagram, appear in the *American*



Electrician. A favourite means of accomplishing the object in view is to cause the magnet first operated to open the exciting circuits of the others. Mr. Wm. Baxter, jun., the present patentee, prefers to prevent the action of the remaining magnets mechanically, as indicated in the diagram. The arrangement consists of a locking bar, 50, capable of sliding horizontally, and held normally at the right-hand limit of its travel by a weight, 64, and bell-crank lever. The solenoid extensions each carry a pin, 16, which projects into an L-shaped slot in the locking bar. Should one of the solenoids be excited, the rising of its plunger will force the bar over to the left by the action of the pin in the slanting part of the slot, thus locking the other plungers,

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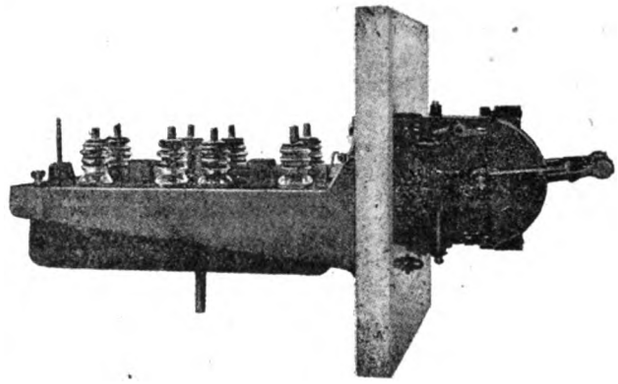
their pins being then in the horizontal part of the slots. The inventor does not allude to the circumstance that, in order to operate a locking mechanism of this kind, each solenoid must be very much longer than would be necessary merely to lift the circuit-closing contacts—probably three or four times as long.

Electricity in South Africa.—The *British and South African Export Gazette* announces that the difference of opinion on the part of Mr. R. Pape, borough electrical engineer at Port Elizabeth, and the consulting engineers, Messrs. Robert Hammond and Son, in regard to the character of the electric lighting supply for that town has been settled. Mr. Pape recommended direct current on the low-tension system, while Messrs. Hammond and Son, misled by the out-of-date map forwarded to them, urged a high-tension system, on the ground that the site of the generating station was not sufficiently central for the successful working of a low-tension system. The site is on the northern confines of the town, but it appears that rapid development is taking place still more northward, so that the site will become practically the centre of the district. On this being explained, Messrs. Hammond and Son quite agreed with Mr. Pape's proposal, and the borough and consulting engineers are engaged upon the preparation of specifications preliminary to calling for tenders. An expenditure on plant of £90,000 is at present authorised, and it is understood that the first orders will be for three sets of 400-kw. steam-turbine generators and the necessary cables, lamps, standards, switchboards, meters, fuse boxes, etc. Arc lamps will be used in the main streets and Nernst lamps in the lesser thoroughfares. In this connection our contemporary states that there is a wide and somewhat neglected field for electric lamp manufacturers in South Africa, and that Port Elizabeth offers a basis for building up a large business. As the local price of gas is 8s. 9d. per 1,000 cubic feet, it is expected that electricity will quickly step into favour for industrial and domestic purposes, thus creating a considerable demand for electrical fittings. From the same source we learn that the Kimberley Corporation and the De Beers Consolidated Mines Company have now agreed upon terms by which the latter will supply current for lighting the town. There are indications of activity among several other of the South African municipalities in the matter of undertaking electric lighting services.

Liege International Exhibition.—An influential committee has been formed under the auspices of the Associated Chambers of Commerce, the London Chamber, and the Anglo-Belgian Chamber of Commerce in London to organise a section representative of this country in connection with the international exhibition to be opened at Liège on April 22 next. As the exhibition, which will be under the direct patronage of H.M. the King of the Belgians, is to be held at such an important industrial centre the committee emphasise the desirability of Britain being worthily represented, and with this end in view they invite subscriptions to enable them to close arrangements with the exhibition authorities. It is estimated that the expenses will total about £5,000, towards which several substantial sums have already been promised, and as the time available is short it is essential that a decision should be arrived at without delay on the question of British participation. The site selected is a specially favourable one, a large area in the valley of the Meuse, including the beautiful Parc de Cointe, having been reserved. The general features of the exhibition will be those which usually characterise international undertakings of this character, and there will also be special attractions for visitors, and a Colonial section of great interest and importance. The contents of the various buildings will be classified in 21 groups, comprising all branches of industry, art, and sciences. A large portion of the exhibition is to be devoted to mechanical appliances, and it is intended to show machines in actual work. A feature of the exhibition to which much attention will be paid, and from which important results are expected, is a series of congresses and conferences, which will be held at intervals in the six months during which the exhibition will remain open. The Associated Chambers of Commerce of Great Britain will hold their autumnal meeting in Liège, and it is proposed that other of our prominent public bodies shall also hold meetings. The importance of this country making an adequate display is accentuated by the fact that our great rivals, including the United States, Germany, and France, have already reserved large spaces.

A New Oil Switch.—A new form of oil switch of the horizontal break type has been brought out by the Hanley Electric Manufacturing Company. A description of the apparatus, with the accompanying diagram, appears in the *American Electrician*. The breaking distance in the lower voltages corresponds to the standard practice, but in the



higher voltages it is increased by multiplying the number of breaks. Both the fixed and the moving contacts are disc-shaped with round edges, and are interchangeable. When the switch is opened, the arcing is stated to take place between portions of these rounded edges rather than over the flat portions which form the contact surfaces. From the bank of each disc a threaded projection extends, which in the case of the fixed contacts screws directly into the end of a hollow stud. In the moving contacts, however, two nuts secure each to a connection strip. This construction facilitates removal, and the expense of replacing the discs is trifling. Portions of the rounded edges after long use become damaged by the arc, and new portions can easily be brought into play by giving the discs a partial turn. This prolongs the life of the switch materially. The fixed contact discs are held against the lower ends of the insulators by hollow studs, into which they screw, and the lead wires are soldered into the top of these studs. By means of ball joints the moving contact discs are mounted upon the carriers, which are rigidly attached to the driving rod. The discs are said to be self-aligning in regard to the fixed discs, against which, when the switch is closed, they are pressed by strong coil springs. All parts requiring renewal can be removed and replaced with an ordinary wrench and screwdriver. The switches may be used in connection with the overload time limit or reverse-current relays. They are built for 2,500 and 6,600 volts in two, three, and four pole, single or double throw, with or without enclosed fuses and holders or overload attachment.

Cheltenham Electricity Undertaking. — An enquiry is proceeding at Cheltenham into the working of the electricity undertaking, as the result of the criticism of

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a section of the ratepayers. The electrical engineer, Mr. Kilgour, requested an enquiry by an independent expert, and the Corporation, who some time since passed a resolution of confidence in the Electricity Committee and the engineer, requested the Institution of Civil Engineers to nominate the expert. Mr. James Swinburne was appointed, and the case for the aggrieved ratepayers was presented to him the other day by a representative of the ratepayers' association. The substance of the complaint is that the Electricity Committee have not acquired a thorough grasp of the business; that they have acted without the authority of the Corporation; that loans have been anticipated before the Local Government Board enquiry has been held; and that matters have been left too much in the hands of the chairman of the committee (Alderman Norman) and the electrical engineer (Mr. Kilgour). Specific charges against the management comprise the expenditure of sums of from £200 to £400 upon extensions of mains to private houses, the annual receipts for which fall short of the capital charge on the extensions; the absence of depreciation accounts, and, until the last two years, of trading and profit and loss accounts; excessive public lighting; inadequate rates for energy supplied to the light railway company and for private lighting; and the accumulation of annual deficits. The sums expended upon extensions of mains were in several cases less than the amounts sanctioned, and Mr. Kilgour pointed out that the extensions have been available for other customers, while in regard to the accumulated deficiency of £17,000 it was stated that fresh legislation would be needed if this were to be paid off by the ratepayers. Mr. Swinburne observed that the locality of the extensions had to be taken into account before the Corporation could be convicted of bad judgment. For the ratepayers it was argued that in more than half the cases of extensions beyond the compulsory area losses had been incurred. It will be remembered that the Electric Committee recommended last spring that the rates for energy should be revised all round so as to yield a larger revenue. The gross profit for the last financial year, which showed a considerable increase over that of the preceding twelvemonth, represented about 5 per cent. on the capital outlay. The ratepayers' association state that their criticism is directed not against any individual, but against the policy, or, as they term it, the lack of policy of the committee. The matter, however, is still *sub judice*, as Mr. Swinburne has yet to hear the other side of the case.

Electricity on Railroads.—The address delivered by Mr. B. J. Arnold, president of the American Institute of Electrical Engineers, at the International Electrical Congress, dealt with the application of electricity to steam railroads. He noted that the first important use of electric power for heavy electric railroading is credited to the Chicago World's Fair, although the City and South London Underground and the Liverpool Elevated were started about the same time. Mr. Arnold believes that electricity will be generally used on all the main railroad terminals and ultimately on the main through lines for passenger and freight service, though he does not anticipate that it will always be adopted on the grounds of economy in operation, nor that it will come rapidly or through the voluntary acts of the owners of steam railroads, except in special instances. At first the terminals will be equipped for special reasons, due either to the voluntary act on the part of the terminal companies to effect economy in operation or to public pressure brought to bear upon the owners through an increased demand on the part of the public for better service, on the ground that the use of the steam locomotive is objectionable in our great cities. Roads which run through populous countries will either build new roads or acquire for their own protection those electric railroads already built and operating in competition with them and utilise them as feeders to their through-line steam trains. Thus the steam railroad companies will gradually become interested in electric railways and eventually become the real owners of them. With these roads operating as feeders to the main-line system and with the terminals thus equipped and the public educated to the advantages of riding in electrically equipped cars, the next step will logically be the electrical equipment of the trunk lines between the cities already having electrical terminals. Consequently, a favourably located trunk line having a sufficient density of population will feel warranted in equipping electrically, and when this is once done the other roads running between the same competing points must sooner or later follow in order to hold their passenger traffic. With the terminals and main lines equipped electrically and the desire on the part of the public for more prompt and efficient freight service resembling that which is given by the steam roads in England and on the Continent, due to the great density of population, there will be developed a great high-class freight service conducted in light, swiftly moving electric trains, which can be quickly divided and distributed over all surface tracks of smaller American cities or through underground systems similar to that which is now being built in Chicago. This class of freight service would soon prove so large a part of the freight traffic of a road that the operation of the through-freight traffic by steam locomotives, though at present cheaper, would in time, as the cost of coal increases, grow less, until those roads operating an electric passenger service would ultimately use electricity exclusively. Mr. Arnold considered that the principal problem before the electric railway engineer to-day is how to make the most effective use of the high-pressure transmission and high-tension working conductor and maintain safety of operation.

Resonance Instruments at St. Louis.—The resonance instruments exhibited at St. Louis by Messrs. Hartmann and Braun, of Frankfort, of which a description, with the accompanying diagrams, is given in the *Electrical World* of New York, include an electro-acoustic tonometer. In this apparatus 36 sounding steel tuned tongues are arranged scale-wise in a straight line, and exciting magnets can be passed before the tongues on both sides. In connection with an interrupter, which is constructed so that it can be driven by means of a spindle from the axle of a machine by holding it on directly by hand, the slip of motors can be demonstrated and measured with this apparatus. This method also gives a very convenient means for connecting alternators in parallel, and it has the great advantage that it gives all the necessary information for this operation on one single scale; it enables the attendant to read simultaneously the number of revolutions of the running machine and that of the machine to be added; furthermore, to know exactly the moment of synchronism and the moment of the machines being in phase. Fig. 1 illustrates the connections, and it will be seen that the apparatus possesses three frequency meters, F/1, F/2, F/3. The magnets of F/1 and F/2 have only one coil each, but that of F/3 has two coils of equal number of turns. The frequency meters F/1 and F/2 are of the same construction. They consist of six tongues (Z) each, of which three are above and three below the normal frequency. The frequency of F/3 has only three steel tongues, of which the middle one is tuned exactly for the frequency of the station, while the left blade is $\frac{1}{4}$ per cent. lower, the blade on the right side $\frac{1}{2}$ per cent. higher. The alternator already in service is connected to the terminals I. and II., to which the frequency meters F/1 and F/3 are connected per-

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manently, so that F/1 indicates the momentary and F/3 the normal frequency. Should another alternator be connected to the switchboard in parallel to the first, the voltage of this machine is impressed upon the terminals I. and II., the switch U being thrown to the right. Then only F/2 is connected and indicates the number of revolutions of the alternator, so that the switchboard attendant is able to see if the prime mover has to run faster or slower. As soon as this question is settled, the switch, U, is thrown to the left, sending the current now into the second coil of F/3 and bringing this frequency meter in

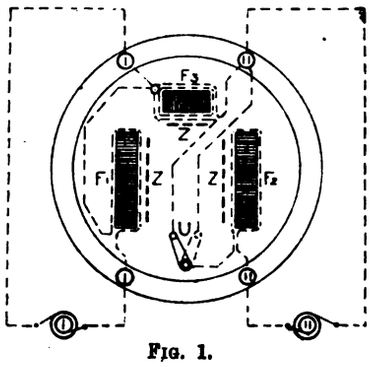

FIG. 1.

action. The magnetic field of F/3 is then composed of two magnetic fields of equal strength, but unequal frequency, bringing the tongues into vibration. If synchronism is approached very closely, these vibrations become slow and clearly pronounced so that they increase gradually from zero—*i.e.*, when the tongue is standing still—to a maximum amplitude of 30 mm., and this extension of the amplitude indicates the moment when the alternators are in synchronism and in phase. An apparatus of similar construction is used for counting the number of revolutions or the velocity of a belt, etc. The counter possesses 62 tuned tongues, and is either connected to an alternator

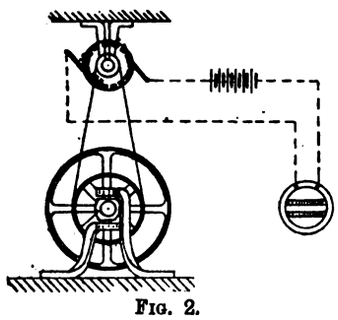

FIG. 2.

with a known number of poles or to a rotating direct-current interrupter as illustrated by Fig. 2.

A Gas-Turbine.—After the successes scored by different systems of steam-turbines in many fields of application which so far were reserved to steam power, the production of another type of engine could be anticipated. The question was to combine the advantages of steam-turbines—that is, their simplicity of design, small dimensions, and ready superintendence—with the principal advantages inherent in that other rival of steam-engines, the gas-motor—that is to say, with a smaller consumption of fuel. A gas-motor with a wheel-shaped recipient—viz., a gas-turbine—had to be designed. A similar prime mover would, like the steam-turbine, be free from any pistons, crank mechanism, and flywheels; being susceptible of construction in small dimensions even for large outputs, such a motor would be of a small first cost. Its superintendence would be rather simple, on account of the small number of running parts, and very cheap because of the smallness of the engine, while for the same reason the acquisition of the ground area occupied by the engine would be rendered easy. These principles were enunciated by Prof. Riedler at the last annual meeting of the Association of German Engineers. This expert is of opinion that the gas-turbine is the motor of the future and destined to surpass both the modern-day gas and steam engine. The idea of a gas-turbine is, by the way, a rather old one, Mr. Redtenbacher in his book on the caloric engine having as far back as 1853 drawn attention to the fact that a similar kind of engine would be an ideal hot-air motor, though the necessity of handling enormous speeds induced him to think that a constructive realisation of this idea would be impossible. Now, our methods of engine construction have been immensely improved upon since that date, while modern-day steam-turbine construction has shown means of reducing the speed to suitable limits by dividing the pressure gradient. A turbine designed by Dr. S. F. Stolze, of Charlottenburg-Berlin, patents for which were applied for as far back as 1873, but granted only in 1897 (this being due to some peculiar circumstances) is being brought out in Berlin by the Stolze Gasturbinen-Gesellschaft, and attracting much attention in engineering circles. In this "fire turbine," as the engine was originally called, the graduation of the pressure gradient with a view to diminishing the speed (which plays so important a part in steam-turbine construction) has already been made use of; in fact, the specification of more than 30 years ago describes fully the application of multiple-step turbines, while, on the other hand, a tightening device very similar to the labyrinth tightening designed subsequently by Parsons, is made use of. A large size engine of an effective output of 200 h.p. is in course of construction according to the above patent, and the following are the most striking features of this engine: On a common axle are mounted two sets of turbines of different design. One of these serves as air-compressor pump, while the other drives the shaft by means of heated air. Both of these consist of several rows of guiding vanes fitted to the engine casing, and of several rows of running vanes of a corresponding design, which are fitted to a common rotating cone, turning along with the shaft. Now, one of these turbine sets of turbine vanes will suck fresh air, compressing it to a given pressure through a preheater, which is heated with exhaust gases, and conveying the greater part into a chamber lined with fireproofing material. The smaller part is conveyed beneath the grate of a producer, where it gasifies a convenient fuel. The gas thus formed penetrates into the above-mentioned chamber, to be burnt there in suitable burners by the compressed air to carbonic acid and water vapour, while evolving large amounts of heat, these gases penetrating into the second turbine system, where they yield useful work by expansion in traversing the various steps. The process is thus mainly analogous to the cycle characteristic of all combustion engines, and which consist of a suction of air followed up by compression, mixing with fuel, combustion, expansion, and discharge. In most of the gas-motors now being built, the mixing, it is true, takes place before compression, and the combustion under increasing pressure. The working cycle of the gas-turbine resembles most the one of the Diesel motor. The efficiency of the turbine is doubtless susceptible of being increased beyond that of any existing type of prime movers. The Carnot cycle is, for instance, approached to more closely than with any other design of motor. Instead of producer gas, any other kind of gas can evidently be used, as well as carbonated air or benzine, alcohol or petrol vapours. The high practical importance of this system for automobile construction, which so far had at its disposal no other smoothly-running motors than electromotors in connection with accumulators, with their drawbacks, need hardly be pointed out.

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THE GUANAJUATO HYDRO-ELECTRIC TRANSMISSION.*

The accompanying sketch map (Fig. 1) shows the location of a notable hydro-electric power development and high-potential long-distance transmission recently completed in the States of Michoacan and Guanajuato, Republic of Mexico. This plant is a very interesting one because of its many advanced engineering features, the remarkably short time within which it was constructed, and the fact that the work was completed within the estimates of cost. Under a concession from the Department of Encouragement, Colonisation, and Industry of the Republic of Mexico, the Guanajuato Power and Electric Company constructed a canal, pipe line, power generating station, transmission line, sub-station, and distributing systems for developing and marketing the energy of 8,000 litres (283 cubic feet) of water per second, diverted from the Duero River at the confluence of the Camecuaro and Chilchota Rivers, and returned above the Chaparacho Dam.

The following are some of the distinctive features. The head works, canal, and power-house are of massive and permanent construction. Special arrangements are made for regulating and measuring the water, and for collecting and disposing of the detritus carried by the water during the rainy season. The pressure pipe is large, conducting the water at a low velocity. It has no horizontal bends, and only a few vertical bends, all made with long radii. It is bedded in masonry at each end and is laid in a deep trench and completely covered. It terminates at the bottom in branches leading directly to the waterwheel nozzles. The nozzles are the largest yet used. The hydro-electric generating units have two 1,125-h.p. waterwheels mounted directly on the ends of the generator shaft and overhanging the two bearings. Energy is transmitted at 60 kilovolts a distance of 101 miles, over 19-strand hard-drawn copper cables, carried on specially designed porcelain insulators larger than any heretofore used. It is the first long-span steel-tower transmission line.

The inception and development of this enterprise are interesting. Some three or four years ago Mr. Leonard E. Curtis, who had been for a long time counsel in patent matters for the Westinghouse Electric and Manufacturing Company, and who had been obliged to leave New York and go to Colorado on account of his health, was sent to Guanajuato by clients to examine the title to certain mining properties there. In the course of this examination he became interested in the place, and was impressed with the very high cost of the power used for mining operations. Being familiar with modern developments in long-distance electrical transmission, it occurred to him that the conditions there were exceedingly favourable for the introduction of electric power if a suitable water power could be found within working distance. He employed a young American, whom he found there, to search for a water power, giving him a radius of 100 miles from Guanajuato to work in. The water power which has since been developed was found and an option obtained on it during the following year. In the meantime Mr. Henry Hine, under whose management the Stanley Electric Manufacturing Company had been built up, and who had resigned his position in that company when the ownership of it changed hands, had joined Mr. Curtis in Colorado, and the two had taken up the installation of power transmission plants together. After making a preliminary examination, they presented the matter to prominent capitalists at New York and Boston, who quickly subscribed the necessary capital, subject to an engineering examination. This examination was made by Mr. Robert McF. Doble, of San Francisco, Mr. H. H. Filley, of Kansas City, and Mr. Charles T. Main, of Boston. Their report was favourable, and the company was organised and proceeded with the construction work. Mr. Filley was employed as chief engineer of the company, Mr. Doble as consulting engineer, and Mr. Norman Rowe, formerly with the Westinghouse Company, was put in charge of the construction work at Guanajuato, and now has charge of the plant as general superintendent.

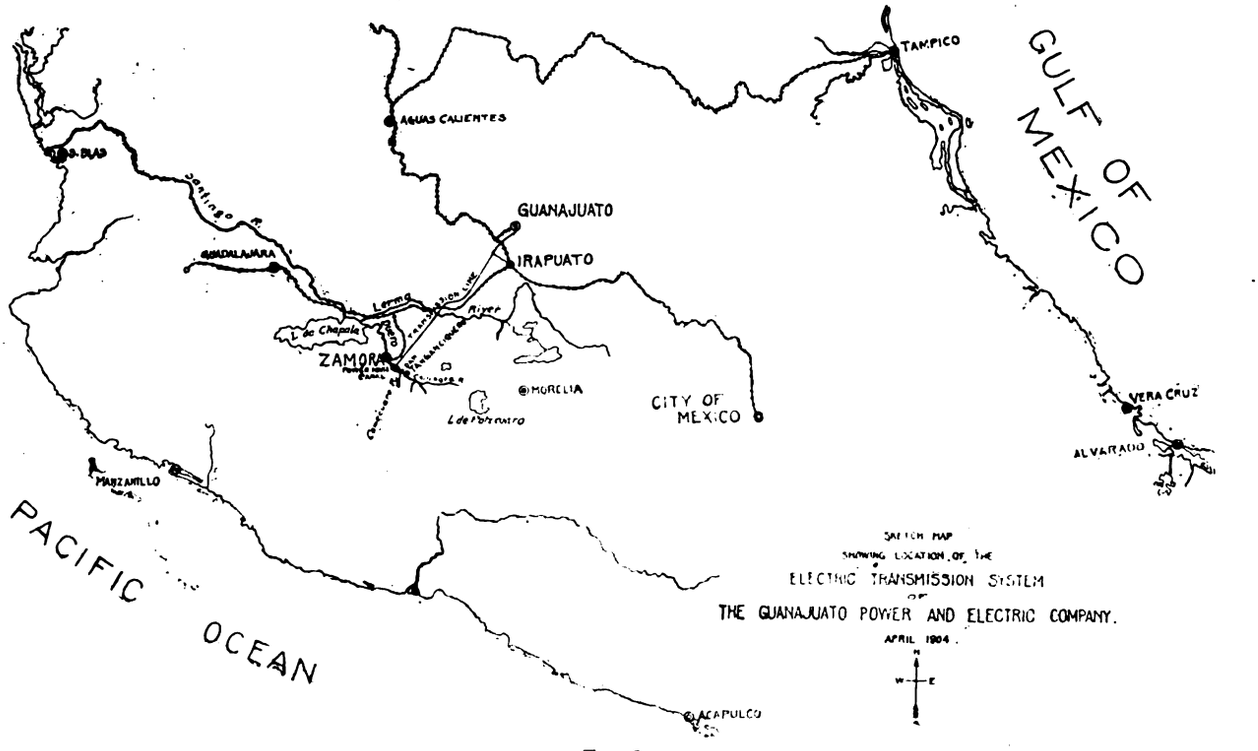

FIG. 1.

The watershed which supplies the Duero River has never been thoroughly explored. Its area is estimated at 400 square miles; it extends to the Continental Divide, and includes high timbered mountains and land-locked lakes. This portion of the State of Michoacan is a series of fertile valleys, lying one above the other, very like a series of vast terraces. The elevation is from 5,000 to more than 12,000ft. above sea-level. About 10 miles to the south of the Zamora Valley, and about 400ft. higher in elevation, lies the broad, beautiful, and fertile valley of Tangancicuaro, beyond which, to the south, at a greater elevation lies the valley of Los Once Pueblos (The Eleven Villages). The Tangancicuaro Valley is nearly surrounded by mountains, which toward the south are timbered and reach an altitude of from

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10,000ft. to 12,000ft. Lake Patzcuaro, a large and deep lake with no known outlet, is located high up in this mountain range. The entire area is of volcanic origin. The rain-waters falling upon the high mountain lands penetrate the crevices in the basalt, slowly percolate to lower impervious strata, and then issue from the springs which abound in the valleys mentioned. The catchment area is so extensive, and the distance which the water probably traverses so great, that the subterranean reservoirs yield an exceedingly uniform volume through the numerous springs, which, during the dry season, furnish the entire volume of the Duero River. Such geological formation and source of supply for a river of considerable and of

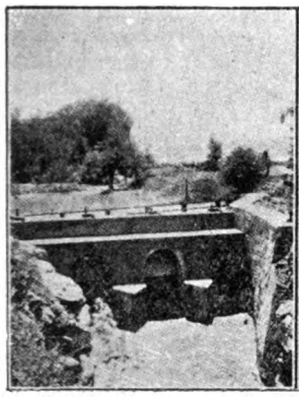

FIG 2.—The Head Works from the down-stream side.

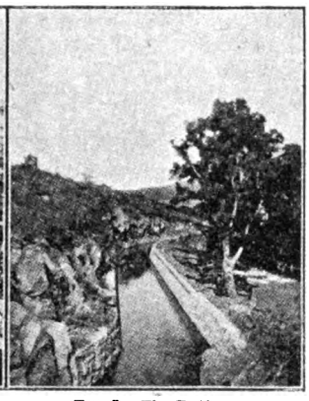

FIG. 3.—The Rating Flume.

uniform discharge is not without a parallel, though somewhat uncommon. Similar cases may be found in the lava districts of Northern California. The Duero River is formed by the confluence of the Camecuaro and Chilchota Rivers, which unite at the northerly edge of the Tangancicuaro Valley just above where a low ridge of basalt crosses between the neighbouring mountains. Through a break in this formation the river commences its rapid descent into the Zamora Valley, about 400ft. below. The Chilchota branch, with its many tributaries, extends in several directions throughout the Tangancicuaro Valley and to the similar valleys terraced above it, notably Los Once Pueblos, where are located the Chilchota Springs. It has a very extensive watershed, reaching to the high timbered mountains, and from it extensive irrigation is practised.

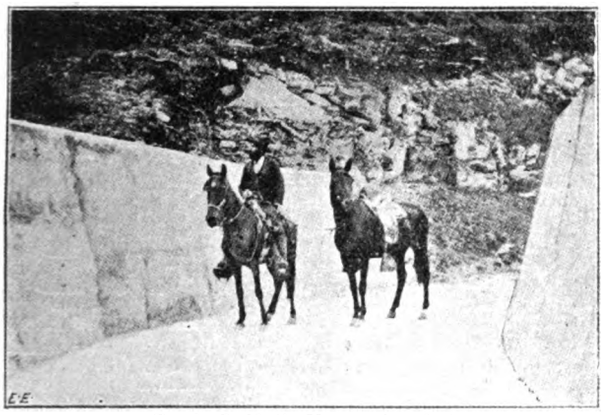

FIG. 4.—Inside the Masonry Aqueduct.

Hence during the rainy season it becomes a rushing torrent, and during the dry season the demands made upon it greatly diminish its volume. Its banks are closely lined with the sabino, or ahuehuete, trees, and from an eminence its course can be plainly traced through broad wheatfields.

The Camecuaro branch is only about a mile in length, with practically no catchment area. It is supplied by a large group of springs, the water issuing from the lava formation on the northerly side of a low hill. These picturesque springs are surrounded by a fine grove of very large sabino trees, which also closely line the banks, and confine the stream within its meandering channel until it unites with the Chilchota. The Camecuaro branch has very little fall from its source to the Chilchota, and it is plainly evident that its volume is remarkably uniform throughout the year. No water is taken from it for irrigation, but at times it receives a small addition to its volume as a result of the excessive irrigation of the wheatfields lying above it with water brought through a ditch from another spring. A number of careful current meter measurements were made, and compared with figures collected from every possible source, to determine the minimum discharge of the Duero River. These data led to the conclusion that there would never be less than a sufficient quantity of water available to warrant the construction of a generating plant of 8,000 e.h.p. capacity. The possibility of increasing the low-water flow by means of storage reservoirs located in the high mountains has not yet been fully investigated. Between the point where the water is taken from the Duero River—namely, at the confluence of the Camecuaro and Chilchota branches—to the point where it is returned to the river—namely, at the Chaparacho Dam—there are three dams in the river for the purpose of diverting portions of its waters into irrigation canals for the ranches of La Rojena, La Planta, and Tamandaro.

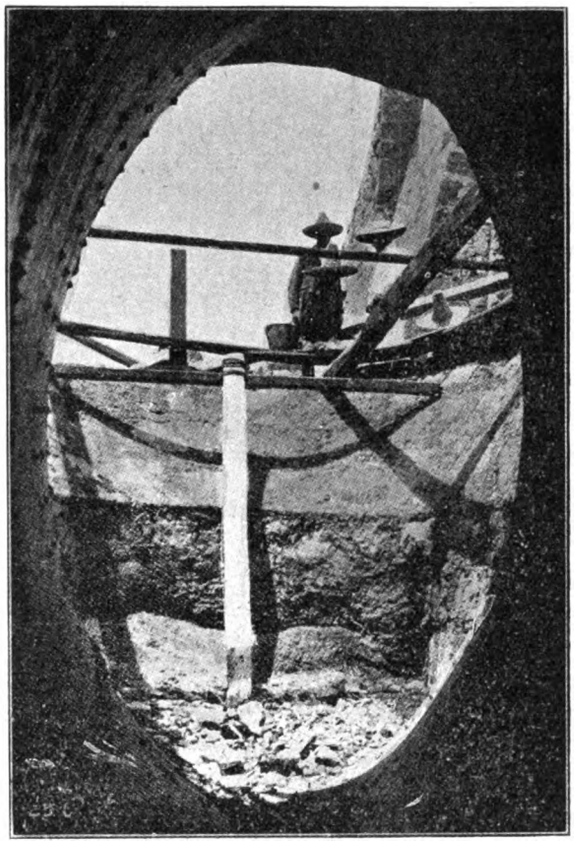

FIG. 5.—Looking out through the mouth of the great Oval Taper Section during the construction of the Penstock.

The masonry diverting dam is built of volcanic rock, the interior being laid up with lime mortar, and the exterior with Portland cement. It is a curved structure, with a radius of 88 19m., the length of the crest being 80m. Its elevation is 1,662·40m. above sea-level. It is computed as a gravity dam for a maximum depth of 1·60m. of water over the crest. A heavy steel fender, securely braced against the masonry, protects the entrance to the canal from the drift brought down by the freshets during the rainy season. Water is admitted to the canal through four head gates (see Fig. 2), each with an opening 1·25 by 2·00m at a maximum velocity of about 0 80m. per second. These head gates run in an angle-iron frame set in the concrete. They are made of wood heavily ironed, and are operated through a worm gear which runs on the threaded gate stem like a nut This worm gear nut is held stationary between ball bearings. The worm which turns it is provided with bronze thrust collars, and is mounted on a spindle having a removable hand crank at one end. The canal is 6,650m. long, is of trapezoidal section, 4m. wide on the bottom and 2·10m. deep. The side slopes are 1 : 1 in soft earth, 0·5 : 1 in hard rock, and 0 2 ; 1 where

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the canal is lined with cement. Its slope is unifom 1 : 2,500. Its carrying capacity is 283 cubic feet per second at a velocity of between 2ft. and 3ft. per second. To provide for accurately measuring the volume of water allowed under the concession, a "rating flume" was constructed near the head works. It is about 100ft. of straight canal, lined with Portland cement held in place by sheets of expanded metal. The top of the wall on the side towards the river is finished with an adjustable metal weir (Fig. 3), which is set so as to act as a spillway when more than the proper volume of water is flowing. A short distance down stream the canal is widened and deepened, causing a reduction in the velocity of the flowing water to about one-third of the normal, so that any sand may settle to the bottom. This settling basin is provided with six valves opening from its bottom into a culvert which leads out from under the canal to the river. These valves are of new and interesting design, consisting of a circular cast-iron opening 18in. in diameter, closed by means of a conical cast-iron bell, drawn point up into the opening from below, and held there by means of a threaded stem and nut, which rests upon two channel beams spanning the canal. By turning the nut the cast-iron bell may be lowered to open the valve and wash out the sand which has collected at the bottom. Immediately below the settling basin there is an adjustable submerged weir. By means of the head gates and by the adjustable lip at the rating flume, in conjunction with the submerged weir, the quantity of water flowing in the canal may be closely regulated. From this point the canal meanders along the southerly side of the canyon; under a substantial masonry arch road bridge, 33ft. wide and 16ft. span; over a massive masonry aqueduct (Fig. 4) to a spillway, and thence to a second sand-trap, near the forebay. The spillway and second sand-trap are located so as to make use of the Barranca de la Rojena as a waste waterway leading to the Duero River.

A small storage reservoir is constructed alongside the canal at the forebay, by means of which a sufficient reserve of water is maintained to admit of cleaning the canal when required, and also to carry a very considerable peak load in excess of the normal capacity of the canal. A simple arrangement is provided for allowing the surplus water to flow into the reservoir from the canal during the hours of light load, and during that time to maintain the maximum head or pressure on the pipe line, regardless of the elevation of the water in the reservoir. Four suitable automatic gates, like flap-valves, are placed in the reservoir, near its bottom, opening outwards into the forebay. So long as the supply of water in the canal is equal to or in excess of the discharge through the waterwheel nozzles in the power-house, the maximum water-level is maintained in the forebay; if there is a surplus of water, it overflows from the forebay into the reservoir over a suitable weir. Whenever the requirements of the waterwheels are in excess of the quantity of water flowing in the canal, the water-level in the forebay is lowered, relieving the pressure on the outside of the automatic gates, which then open and let the reservoir discharge to make up the deficiency. At the entrance to the forebay the water passes over a measuring weir. On passing from the forebay to the penstock the water flows through a screen which removes all floating *débris*. The massive masonry penstock is strengthened by iron hoops embedded in its walls, and is interesting because of its excellent hydraulic lines. The water, after passing through the screens and through four gates similar to those at the head works, enters two ellipsoidal masonry basins, which gradually diminish in diameter toward the bottom, merging into the great oval taper sections, which are the heads of the pipe lines (Fig. 5). The design causes a gradual acceleration in the velocity of the water, and also prevents the formation of the whirling vortex which would draw air into the pressure pipes. The pipe line is 3,300ft. long, with no lateral bends. It varies in diameter

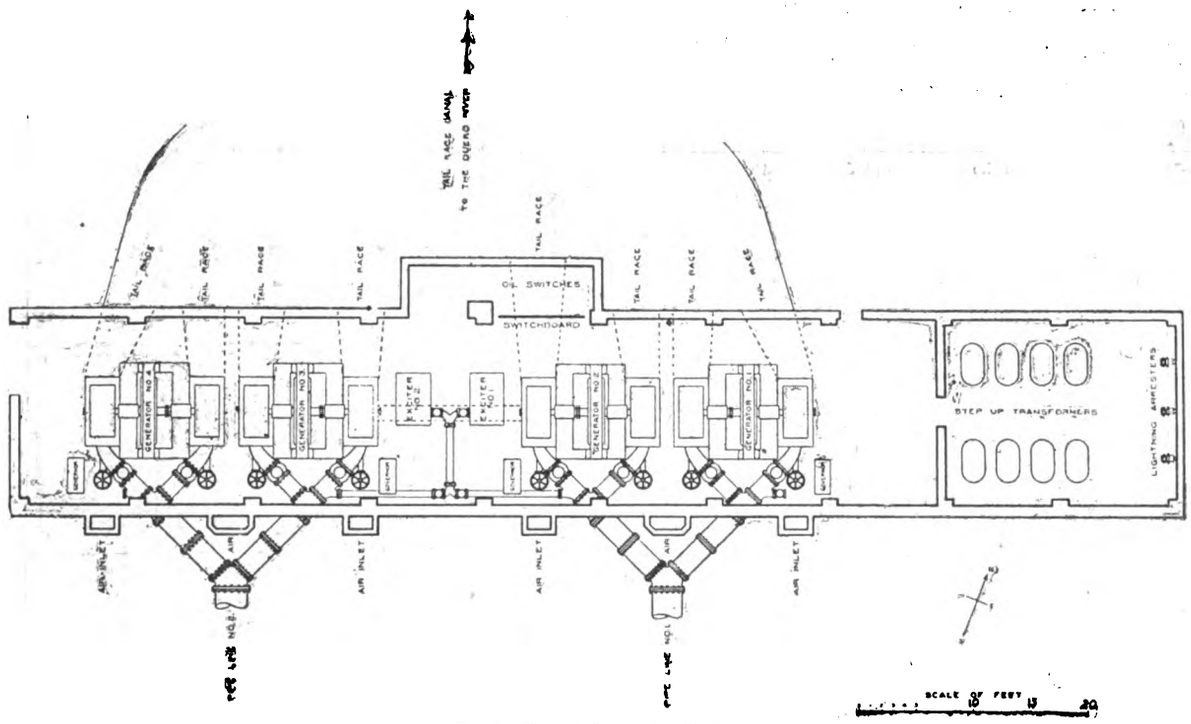

FIG. 6.—Plan of Generating Station.

and thickness, as shown in the following table, and was designed with a safety factor of 5.

Inside diameter of pipe.	Thickness of plate.	Approximate length.
69in.	$\frac{5}{16}$in.	1,100ft.
63in.	$\frac{3}{8}$in.	1,000ft.
63in.	$\frac{7}{16}$in.	100ft.
57in.	$\frac{7}{16}$in.	350ft.
57in.	$\frac{1}{2}$in.	350ft.
57in.	$\frac{9}{16}$in.	200ft.
57in.	$\frac{5}{8}$in.	200ft.
Total		3,300ft.

The decrease in the diameter of the pipe sections causes an acceleration in the flow of the water as it descends. This also made possible the nesting of sections for shipment. The pipe was made up from steel plates, in sections 27½ft. long, and weighing from 7,000lb. to 10,000lb. each. The steel plates were carefully selected and tested, the metal being required to have the following characteristics: tensile strength, 52,000lb. to 62,000lb. per square inch; elastic limit, not less than one-half the tensile strength; elongation, 25 per cent.; 180deg. cold quench bend flat on itself without fracture on the outside of the bent portion.

There are 480 separate plates in the pipe, each rolled tapering, the small end of one fitting inside the large end of the one next below it. All seams were lapped, and the longitudinal seams were designed so as to have at least

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70 per cent. of the strength of the plate. These longitudinal seams were placed so that they are on top of the pipe and alternately opposite, with the caulking edges up. The longitudinal seams are double riveted, the circular seams single riveted. All the shop riveting was done by a large hydraulic riveter. The field riveting was done by hand by a gang of expert boilermakers sent to Mexico for that purpose. Two

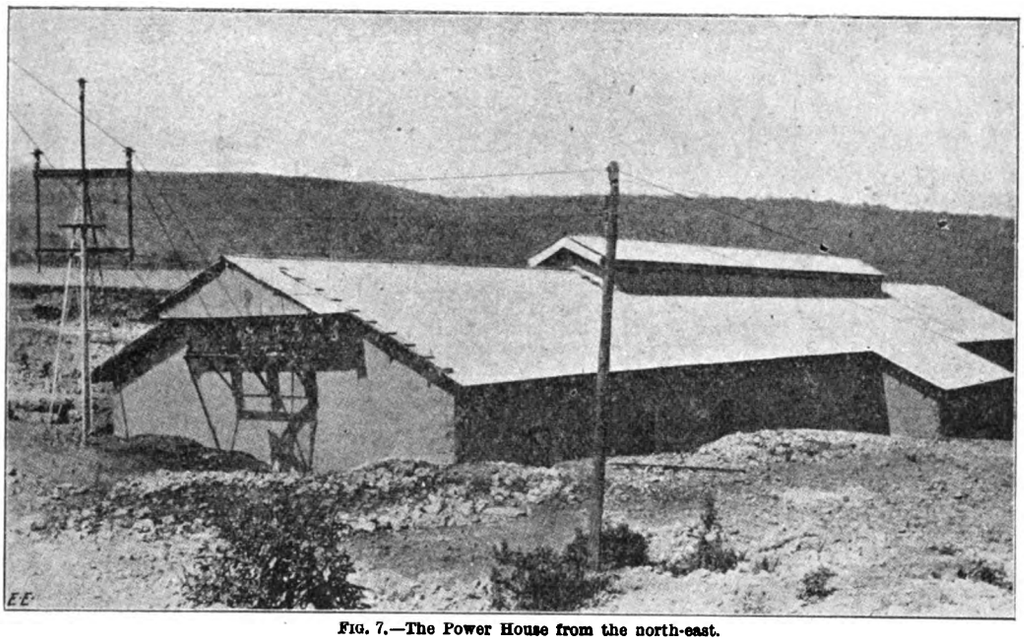

FIG. 7.—The Power House from the north-east.

riveters, a helper, and a man at the forge to heat the rivets could finish one circular seam a day. When riveted the pipe was caulked and an extra coat of preservative paint was applied. Each section of the pipe had on top near its lower end a hole, through which the hot rivets were passed from the forge to the man inside. The hole was tapped and a plug screwed in after the joint was riveted. Each section was plainly marked at the factory with letters indicating its position in the pipe line. The common practice of laying pipes of this character on top of the ground and supporting them on piers was not followed. A deep trench was dug, the bottom of which was graded on long tangents and with slight vertical angles. The pipe was laid in this trench beginning with the section nearest the power-house, and riveting on section after section, working up hill. Bell-holes were dug in the bottom of the trench so that the riveters might have room to swing their hammers. The back filling of the trench was done with great care, the earth being dampened and thoroughly tamped under and around the pipe. During the early morning hours, while the pipe was cool and at its minimum length, the top covering was completed. On Aug. 24, 1903, the pipe was tested, and so well had the work been done that not a single leak was found, although there are over 70,000 rivets. The pressure pipe terminates at the bottom of the hill in branching cast-iron pipes leading through the south wall of the power-house to the nozzles, as shown on the plan (Fig. 6).

The power-house (Fig. 7) has masonry walls, built of native volcanic rock. The roof is of galvanised iron supported by steel roof trusses, and lined with an anti-condensation lining. As shown in the illustration (Fig. 7), it is built in an excavation extending to a considerable depth below the natural surface of the ground. This was done for economical reasons. The pipe line profile is quite flat at the lower end, where the pipe line is the thickest and most expensive, and it was concluded that it would be cheaper to excavate a longer length of tail race and to dig deeper for the power-house than to extend the pipe line, as each additional foot on the 57in. pipes $\frac{5}{8}$in. thick would cost a considerable amount. The inside dimensions of the power-house are: length, 200ft.; width, 32ft. The floor is of cement. A low wall separates a length of 40ft. at the easterly end of the building, where the transformers are placed, which portion is 2ft. lower than the main room, and is provided with drains into the tail race. There are two 10-ton hand-operated cranes, which run the entire length of the building over both generator and transformer rooms. The erection of these cranes was an unusually simple matter. They were rolled into place from the surface of the ground, and subsequently constituted the basis of a movable platform, upon which the roof trusses were carried to place. The cast-iron branch pipes convey the water to heavy 30in. gate valves equipped with by-passes. The nozzles are attached to the gate valves, as shown in the accompanying plan (Fig. 6). These pipes are made of close-grained grey cast iron, and have lip and recess bolted flange joints with lead gaskets and are entirely buried in concrete. As shown in the plan, the nozzles are

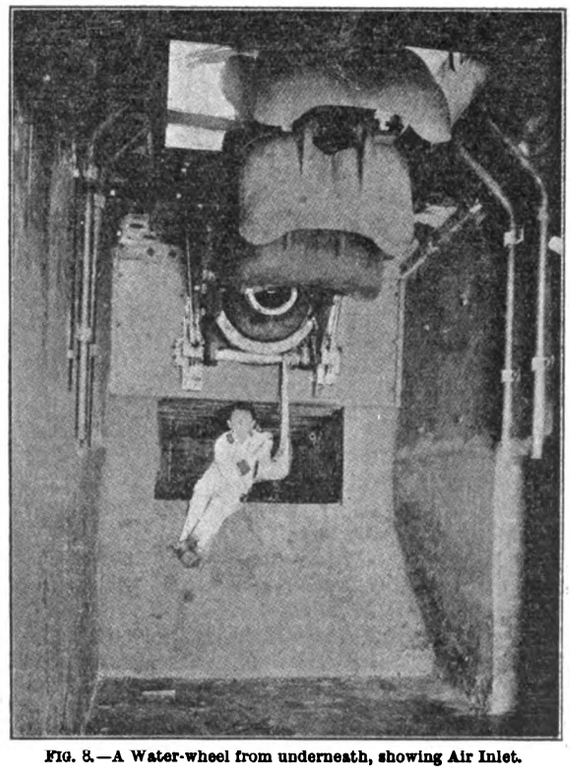

FIG. 8.—A Water-wheel from underneath, showing Air Inlet.

curved in form, making a 45deg. bend, so as to bring the axis of the jet at right angles to the waterwheel shaft. Each nozzle is provided with a removable tip, of cold blast charcoal iron, held in place by means of 14 $\frac{7}{8}$in. Tobin bronze studs with steel nuts. The nozzle is of the needle regulating type, having a core piece movable axially within it by means of which the annular area of the orifice is changed. The core piece is a Tobin bronze

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stem with a phosphor-bronze bulb fitting into the nozzle tip. A continuation of the stem through a gland in the convex side of the nozzle casting is threaded, and by means of a bevel gear nut operated through a hand-wheel stand the needle is moved in and out to adjust the quantity of water discharged by the nozzle, so that the maximum economy in the use of water may be attained. This construction produces a solid jet of good form and of high efficiency over a wide range of discharge. Each nozzle is equipped with a deflecting hood, operated through a system of levers by a governor, for regulating the speed of the generating unit. The water, emerging from the nozzle tips in solid jets more than $\frac{1}{2}$ft. in diameter at a velocity exceeding $1\frac{1}{2}$ miles per minute, with a pressure of 138lb. per square inch, is projected into the buckets of the waterwheels (Fig. 8; also cross-section of generating station, Fig. 9). Each waterwheel has 15 huge buckets, more than 2ft. in width and weighing 254lb. apiece, made of close-grained cold-blast charcoal iron. The buckets are accurately fitted to the rim of the cast-iron wheel centre, and secured thereto by means of two fitted steel stud bolts. The entrance edges are sharpened, the hydraulic surfaces are ground smooth and painted, and each bucket is brought to a standard weight so as to obtain a dynamic balance. The cast-iron wheel centres are machine-finished all over, bored taper, key-seated, and secured to the projecting ends of the generator shafts by means of a feather and a large bronze nut.

The solid carbon steel shaft is 12in. in diameter from the waterwheels through the bearings, being enlarged to 16in. diameter in the middle portion. The bearings are 36in. in length by 12in. in diameter, of ring-oiling, water-cooled type of special design. The generators are revolving-field, engine-type, 2,300-volt, three-phase, 60-cycle, 200-revolution-per-minute machines, rated at 1,250 kw., but designed for a 25 per cent. continuous overload. Their characteristics as determined by factory test are as follows: full-load commercial efficiency, 95·77 per cent.; three-fourths load, 94·92 per cent. Regulation at full load and 100 per cent. power factor is 4 4 per cent.; temperature rise of armature, 21deg. C. after six hours' full-load operation. The total weight of the revolving element, consisting of the field, the shaft, and the two waterwheels, is about 50,000lb., carried on two bearings. The speed is regulated by means of a governor, operated by an oil-pressure system, actuating the deflecting hoods already described. The governors and the oil-pressure pumps are bolted from the generator shaft, as shown in Fig. 10.

The hydro-electric generating units above described are conspicuous by reason of their compactness and simplicity, there being only the stationary armature, the electric and hydraulic revolving elements mounted on the shaft, and two bearings. The 1,250 kw. unit occupies a floor space of only about 17ft. by 25ft. Continuous current for exciting the alternators is supplied by two 120-kw. 500-revolution-per-minute self-contained hydro-electric units, each of sufficient capacity to excite the four generators, so that one exciter is a spare. The exciter base is extended so as to receive the waterwheel housing. The waterwheel is mounted on the extended end of the shaft overhanging the bearing. Water is supplied to the wheel through a hand regulating needle nozzle, being conveyed from the main branch pipe as shown by the plan (Fig. 6). The current is conveyed from the generators to the switchboard,

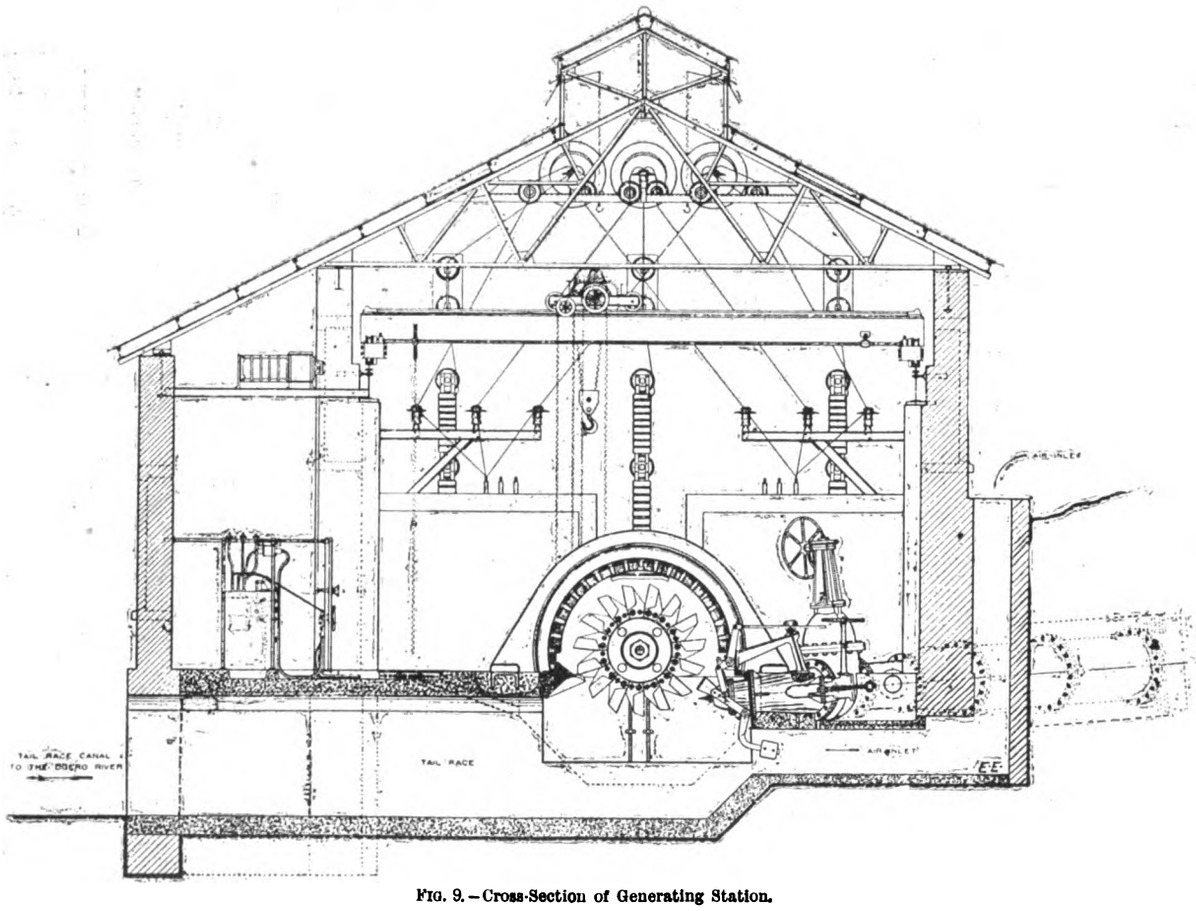

FIG. 9.—Cross-Section of Generating Station.

and thence to the step-up transformers, through lead-covered, rubber-insulated, copper cables laid in shallow covered ducts in the cement floor. The current passes from the generators through 600-ampere oil-break switches, each installed in a separate concrete compartment, to the 2,300-volt 'bus bars. The field rheostats are supported on 4in. I beams above the switchboard, and are operated by means of chains and sprocket wheels. The 'bus bars, oil switches, and wiring for the instruments are all back of the board and out of the way, being located in an alcove on the north side of the building, as shown in the plan (Fig. 6). The switchboard has seven marble panels, one for each of the generators, one for each exciter and one for two step-up transformer circuits. From the switchboard the 2,300-volt current is conducted to the 1,080-kw. static transformers, where the potential is raised to 60,000 volts for transmission. The transformers are delta connected on the low-potential side and Y connected on the high-potential side, having taps brought out through the top of the tank for line potentials of 40,000, 50,000, and 60,000 volts, the neutral being grounded. The efficiencies of the transformers as determined by factory tests are as follows: full

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load, 98·295 per cent.; three-fourths load, 98·028 per cent. The transformers are of the oil-insulated water-cooled type; the tanks are 9½ft. in height, and occupy a floor space of 3ft. by 6ft.

From the step-up transformers the current is conducted to the transmission line, the wires passing out of the building through circular openings in the wall to a set of 60,000-volt disconnecting switches mounted just outside

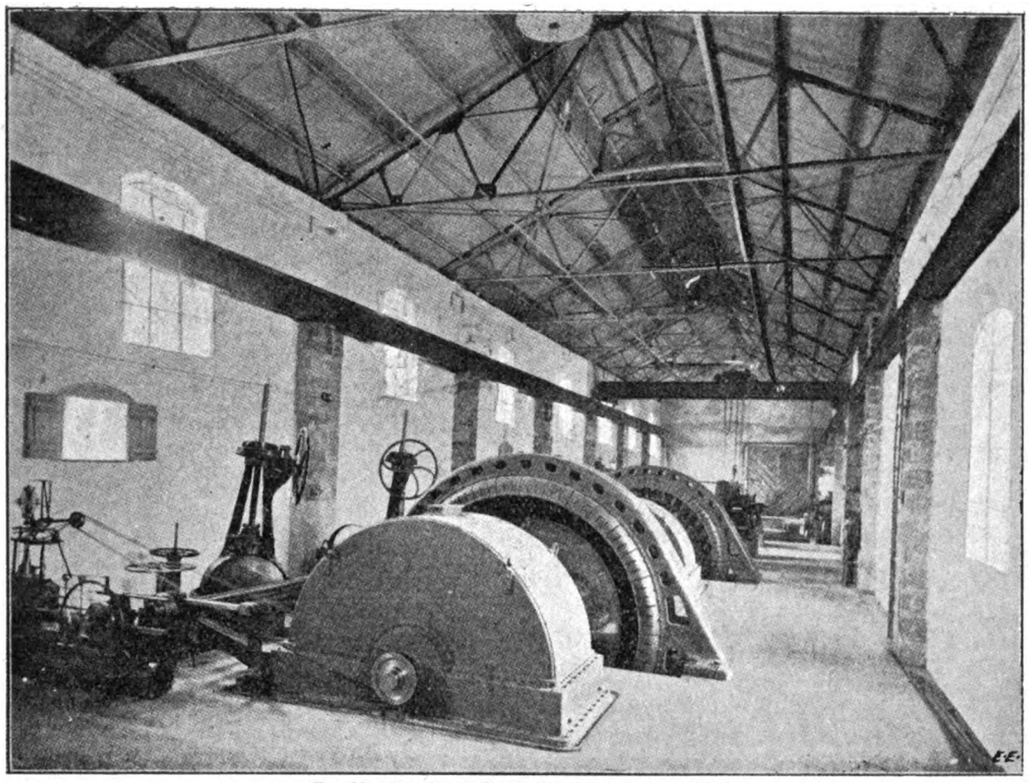

FIG. 10.—Interior of Power House, looking westerly.

of the building and thence to the first tower of the transmission line as shown in Fig. 7. On the inside wall of the building three rows of 60,000-volt lightning arresters are mounted, being connected through switches to the outgoing beds.

The 101-mile 60,000-volt transmission line differs materially in design from any line heretofore constructed, notably in the use of a hard-drawn copper cable instead of the usual solid conductor, metal pins, cross-arms and

FIG. 11.—Making a Joint in the Transmission Cable. Twisting.

towers for supporting the insulators, and unusually long spans. From the power generating station near Zamora the line passes for about 30 miles over rough mountainous lava formation cut by deep ravines. Near Guanajuato also there is some rough country, but for about 60 miles the line passes over clear rolling country, the most of which is under cultivation. The conductors are 19-strand hard-drawn copper cables, approximately ⅜in. in diameter, equivalent in carrying capacity to a No. 1 B. & S. G. wire, and weighing 1,340lb. per mile. This type of conductor was finally determined upon, after much study and many tests, because of its high conductivity, flexibility, and mechanical strength, the wires composing it having a tensile strength of over 55,000lb. per square inch. The cable was made and shipped in lengths of about two miles. The joints were made with special copper tube connectors, 12in. long and elliptical in cross-section. The two ends to be joined were passed through the connector in opposite directions, and three complete twists were given by means of special wrenches. Figs. 11 and 12 show the making of a joint. No soldering was done. The cables are placed in grooves on top of the insulators, 78in. apart, at the points of an equilateral

FIG. 12.—Making a Joint in the Transmission Cable. Splice completed.

triangle, and are tied in with No. 14 soft copper wire, it being considered that the small wire wrapped about several times would make an easy tie and not be apt to damage the small, hard-drawn strands of the cable. The cable was shipped on reels in lengths of about two miles. Where the topography and roads permitted six of the reels were delivered from the wagons each four miles. The cables then were pulled out over the cross-arms on rollers and spliced and tied in. In the mountainous sections the cable

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had to be cut into shorter lengths. Diagrams showing the proper sag to be allowed at various temperatures and for spans up to 1,320ft. were prepared, based on a maximum strain of 20,000lb. per square inch, in the coldest weather and with the most severe wind. The calculations include an allowance for the mechanical elasticity of the cable.

The insulators are larger, heavier, and better than any heretofore used, and were required to stand a test potential of 120,000 volts for five minutes. They are over 12in. in height and 14in. in diameter, and weigh about 15lb. They are made of porcelain with a brown glaze and consist of four parts, as shown in the cross-section (Fig. 13). The top and the first petticoats were glazed together in the kiln, and the other two joints were made with neat Portland cement. The pins were likewise secured into the completed insulator. The pins are of cast iron, conical in shape, and cored hollow. The pin which carries the top insulator has an enlarged base, threaded on the inside, and is screwed on to the end of the 3½in. extra heavy pipe, which projects from the top of the tower. The pins which carry the lower insulators have rectangular bases, which are securely clamped between the ends of the 4in. channels which constitute the cross-arm, as

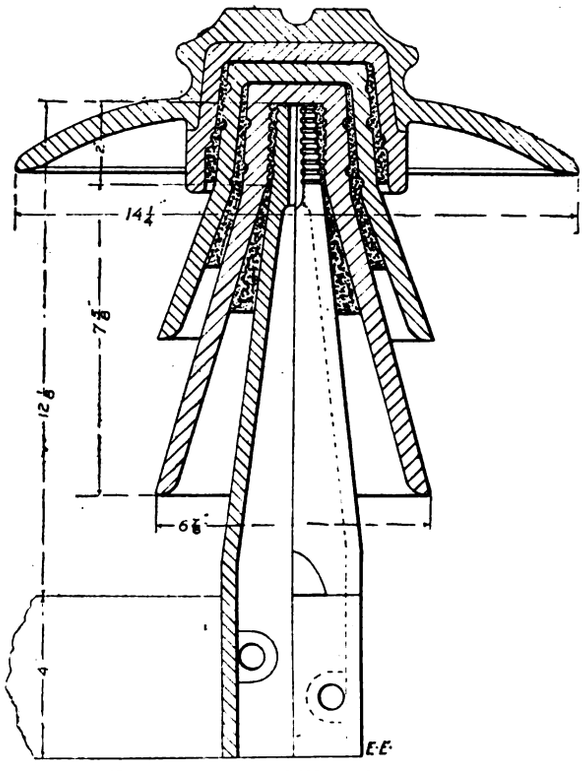

FIG. 13.—Cross-Section of 60,000-volt Insulator and Pin.

shown in the sketch of the top of the tower (Fig. 14). The insulators were shipped in two parts in barrels, and the cementing together of the parts and the cementing in of the pins had to be done in the field. After the parts were assembled the "field" was covered with the packing straw from the barrels in order to protect the insulators from the hot sun while the cement was hardening. The completed insulators, with the pins in place, were then carried out from the construction camps to the required location on the line two at a time by "man power." This was found to be the most satisfactory and economical method, as human labour is very cheap in Mexico.

The towers (Fig. 15) are special 40ft. four-post galvanised steel structures weighing about 1,500lb., made of 3in. by 3in. by $\frac{3}{16}$in. angles, braced and stayed with smaller angles and rods. Each post terminates in an anchor consisting of a piece of angle iron 30in. long secured at right angles. A 40ft. tower with the 3½in. extra heavy pipe fixed in position at the apex was built for testing. This tower was bolted in its assembled state to the 30in. wall of a five-storey brick building, so that its axis was horizontal instead of vertical as normally. A rope sling was attached to the pipe 70in. above the apex of the tower, and to this a wooden platform was attached. Weighed masses of pig iron were then placed upon this platform and the deflections of pipe and tower noted. When the load amounted to 900lb. the pipe began to show signs of yielding; the tower, however, was perfectly rigid. When the load was 1,234lb., the deflection of the pipe from a straight line amounted to about 6in. On removing the load a permanent deflection of about 1in. was found. The load was replaced and increased about 70lb. at a time. With each increase the pipe took an additional permanent set, and at a load of 1,560lb, it continued to bend until the load rested on the floor. The transportation and distribution of the towers was carefully planned and very satisfactorily carried out. The necessary quantities of parts were shipped to the several railway stations which had been selected as centres for the distribution along the line. From the railway stations the towers were hauled in wagons to convenient points on the highway and then were transported piecemeal through the fields on pack animals to the proper places on the transmission line; some of the longest pieces being carried by two burros in tandem. The assembling and erecting of a tower in place required skill and care. A gang of six Mexicans could assemble three towers a day. This was done with the tower lying

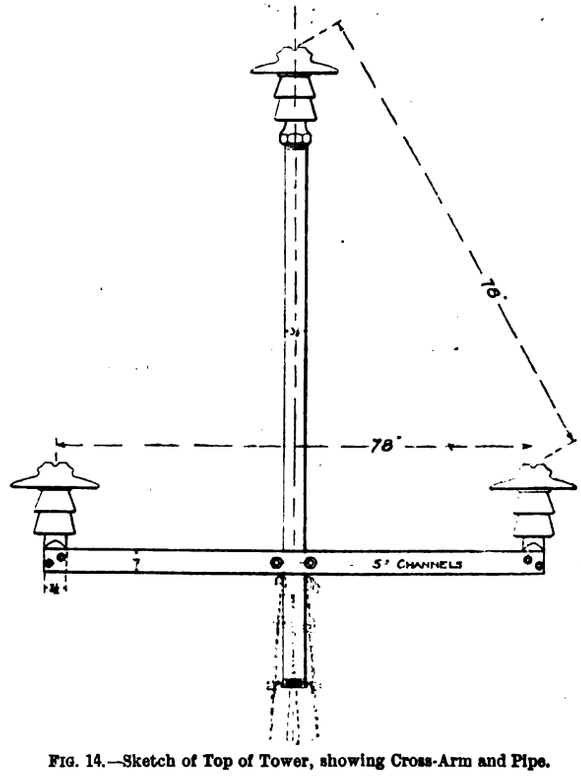

FIG. 14.—Sketch of Top of Tower, showing Cross-Arm and Pipe.

on the ground. A gang of 12 Mexicans under an American foreman could easily erect 12 towers a day. The all-metal construction of the supports for the transmission line was determined upon only after very thorough study and analysis and with a full realisation of the fact that the insulators must then be of the most reliable and simple construction. The quality and suitability of the insulators were, therefore, carefully looked after.

The advantages of long spans, with consequent reduction in number of supports and of insulators required, were so obvious that it was at once decided to adopt that type of construction. After careful study and many calculations and estimates the 40ft. towers spaced 12 to the mile were determined upon. The towers are spaced 440ft. apart, 12 per mile, except near Guanajuato, where the nature of the ground necessitated the use of a few 60ft. towers and spans up to 1,320ft. in length. Two No. 9 B B double galvanised iron wires for a telephone circuit are fastened on the transmission towers 10ft. below the copper power cables. They are tied to regular glass insulators placed on 12in. painted oak brackets bolted to tower legs. The telephone wires are transposed one complete revolution every four towers; the power cables are not transposed. High-resistance instruments are

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used, and the telephone service is quite satisfactory. The climatic conditions for high-voltage transmission are usually good, and during the dry season, when the water is lowest, and when all the losses should be kept at a minimum, the atmospheric conditions are very favourable. Once or twice insulators at the top of the pole have been shattered, possibly by lightning. The long line of shining galvanised steel towers will catch the eye of the traveller as the train nears Palo Verde on the Guadalajara branch of the Mexican Central Railroad, or on approaching Irapuato on the main line from the north, at which points the transmission line crosses the railroad. It is almost straight, there being only a few slight horizontal angles.

The line is divided into four sections of about 25 miles, and is in charge of a superintendent whose headquarters are at the middle storehouse. At each of the three division points there is a first-class storehouse, a set of 60,000-volt disconnecting switches in the main line, a line foreman, and patrol man both mounted. In the middle of each section there is a second-class storehouse in the care of a mounted patrol man. At Guanajuato the transmission line cables enter the sub-station through a set of 60,000-

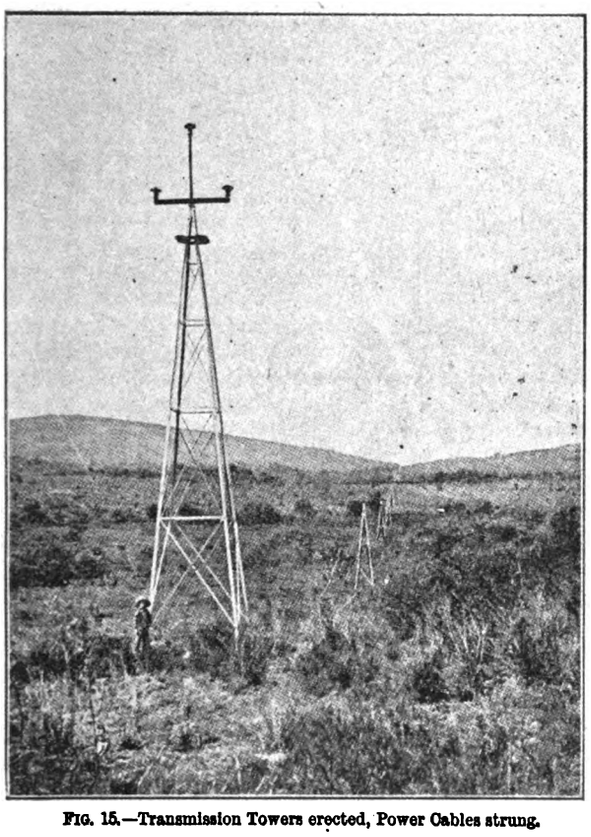

FIG. 15.—Transmission Towers erected, Power Cables strung.

volt disconnecting switches, the same as at the generating station. The Guanajuato sub-station is a handsome stone building with brick trimmings and a flat roof, standing in a beautiful grove of trees. The dimensions of the building are: length, 113ft.; width, 89ft. There is a central portion two storeys high, with well-proportioned one-storey wings on either side. One wing contains an office for the general manager, a drafting room, an accounting room, and a reception room. The other wing is fitted up for a repair shop and storeroom. The central portion contains the transformers. A 10-ton hand-operated crane runs over the shop and transformer room, passing through folding iron doors. The electric current enters the building, passes a set of lightning arresters with disconnecting switches, like those at the generating station, and goes to a bank of oil-insulated water-cooled transformers, where the line potential is reduced to 15,000 volts. These transformers are rated at 970 kw. each. Their efficiencies as determined by factory test are as follows: full load, 98·193 per cent.; three-fourths load, 97·93 per cent. From the step-down transformers the cables pass through ducts under the floor to the switchboard, thence to the six 15,000-volt three-phase distributing circuits, each of which is equipped with lightning arresters, and air-break switches with tube fuses. The solid copper wires of the distributing circuits are carried on 5½in. brown porcelain insulators, supported on wooden pins in wooden cross-arms on square yellow pine poles, 30ft. to 35ft. in height, 9in. by 9in. at the butt, and 7in. by 7in. at the top. The iron telephone wires are carried on the same poles, but are frequently transposed. The power wires are not transposed. At the mines and mills where the electric power is used, the potential is reduced in three-phase transformers from 15,000 volts to 460 volts for motor service. The Guanajuato city two-phase, 2,100-volt lighting system is supplied through a bank of 150-kw. three-phase to two-phase transformers, with a feeder regulator in each phase. A branch line leads from the main transmission line to Irapuato, the "Strawberry Station" on the Mexican Central Railway. The Irapuato sub-station is a brick building equipped with 60,000-volt disconnecting switches and lightning arresters, and the following oil-insulated, air-cooled transformers: four 200-kw. line potential to 15,000 volts; four 75-kw. 15,000 to 460 volts for motor service; two 40-kw. 15,000 to 2,200 volts for the city lighting system. Power is supplied to various small industries throughout the city, including three grist mills, a foundry, a wagon works, a paint factory, and various pumps used in irrigating the strawberry fields.

To the ingenuity of the American engineers, backed by American capital, is due this noteworthy development by which the energy of the swift and boisterous Duero River has at last been harnessed, and after conversion into electricity, has been transmitted over the 100 miles of intervening country to revivify the mining and other industries of the picturesque old city of Guanajuato, famous for its great mines, which are said to have produced during the past 350 years about one-fifth of all the silver in the world. Of late years these mines have not been worked to any great extent, largely because of the high cost of power. There were many interesting as well as difficult features connected with the construction work. The task of hauling to the construction camp was by no means easy, although the distance was not more than 10 miles. The way lay through the city of Zamora, thence to the little town of Jacona, and thence about six miles along the State highway to the construction camp at the little Indian village of El Platanal, where the power generating station is located. American mules were purchased, and specially-designed American wagons were provided, in order that adequate means should be at hand for carrying the heavy parts to their places. The roads through the country are mostly over black adobe soil of indefinite depth, and a few rainy days are sufficient to convert such roads into regular quagmires. The haul through Zamora and Zacona was by far the worst part, since the streets had been improved (?) by a pavement of stones of no small diameter, and in spite of the wide tyres the wagons would break through the pavement into the underlying mud during the short intervals of time allowed for the animals to rest. It is to the credit of the transportation organisation that all of the hauling was done without the loss of or damage to a single piece of apparatus. Carrying out a project of this magnitude in Mexico is made doubly difficult by the dense ignorance and absolute carelessness of the labouring class. The labourers, or peons, are mostly Indians or half breeds, except where they are specially imported. These people wear as little clothing as possible, eat and drink whatever comes to hand, smoke cigarettes incessantly, are always ready to talk or play, and are never ready to work. From time immemorable they have carried things on their backs, and it becomes necessary for the American to adapt himself to their ideas in order to get work done. It is exceedingly difficult, if not impossible, to teach them new methods of working. The customary method of handling dirt is by means of baskets or costals (a small piece of burlap) carried on the back. It is reported that when one contractor attempted to introduce the use of wheelbarrows the peons preferred to carry the barrow, load and all, on their backs rather than learn how to wheel it on a runway. The wages paid to the labouring man vary from 40 cents to 60 cents per day, Mexican, if he be unskilled, 75 cents to 1·25dol. if he be a cabo (gang boss), from 2·50dol.

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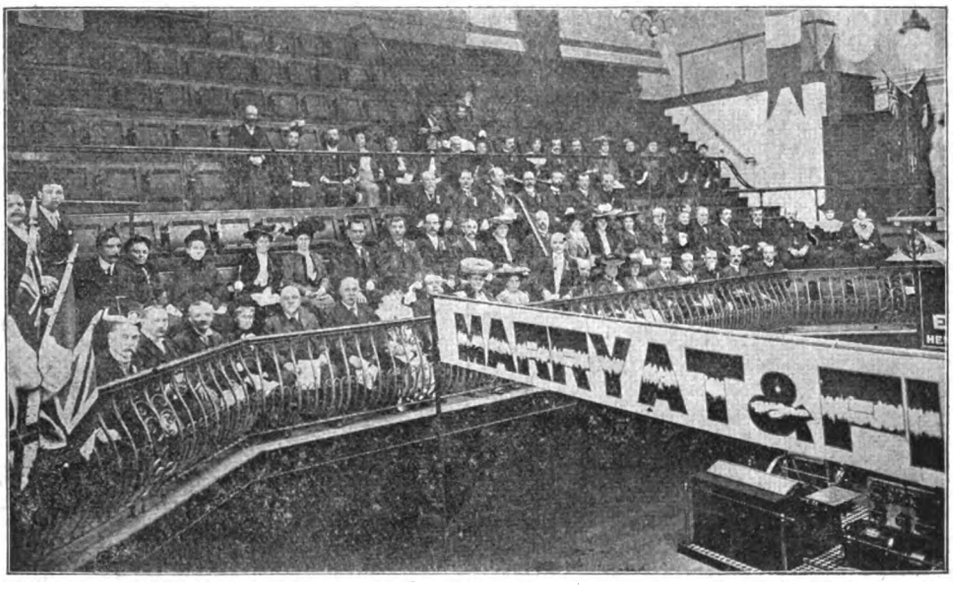
upwards if he be a skilled artisan, and are unquestionably greater than he knows what to do with. On Saturday night the man whose week's work has brought him 2·40dol. in Mexican silver is so wealthy that he makes a bee-line for some place where he can spend his money with the least exertion. Saturday night is usually spent in drinking the vile intoxicants, which are very cheap, and in gambling, and there is rarely a Sunday in a large construction camp that is not celebrated by some shooting or stabbing affray. Monday has been christened San Lunes (Saint Monday), because the men are entirely missing or medio crudo (half drunk), and trying to taper off. In addition to Sundays and Mondays, there are in each month a few church holidays upon which no good Mexican works. The men bring their wives and families into the camp and set up housekeeping in a one-roomed shack, easily constructed in half a day, of boulders, and thatched with weeds. Packing boxes were good enough for some, and one family squatted in a short spare length of steel pipe 69in. in diameter. Nature is kind to these people, furnishing warmth and food, such as it is. The only incentives to work are curiosity and a desire to obtain the means with which to get drink and to gamble.

The short time in which this project was executed is most remarkable, and is characteristic of the management. The preliminary examination was made in March and April, 1902, construction was begun in the fall of the same year, and in October, 1903, the plant was put into regular operation. This undoubtedly establishes a record in Mexico for rapid and efficient execution of construction work of a technical character and of considerable magnitude, especially in view of the fact that the work was completed within the estimates of cost.

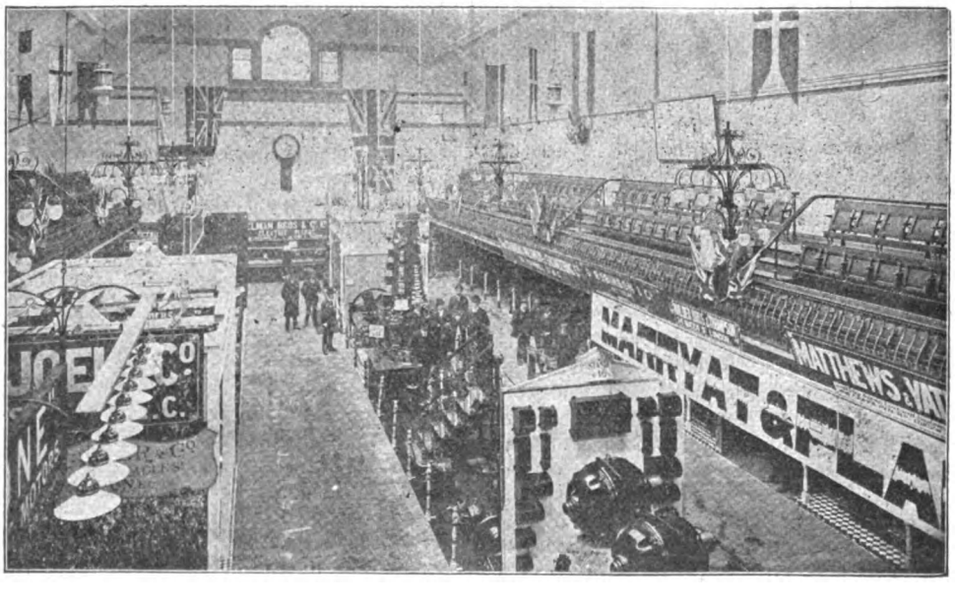
SHOREDITCH ELECTRICAL EXHIBITION.

If the number of visitors to this exhibition, the opening of which we chronicled last week, be any index to its success, then assuredly the efforts of the promoters will be well repaid. When our representative paid another visit to the exhibition on Wednesday he found it thronged, and the borough electrical engineer, Mr. C. Newton Russell, informed us that the sightseers up to that day totalled something over 14,000. More gratifying still, we understand that the exhibitors' order-books have been in frequent requisition, and that there have been numerous enquiries. Through the enterprise of one of the committee, a series of picture postcards with excellent views of the exhibition has been produced. These postcards, specimens of which we reproduce, are on sale at the exhibition, and are in great demand.

Our attention was specially directed to the planing machine exhibited by Messrs. J. Sagar and Co., of Halifax,



Shoreditch Electrical Exhibition.



Shoreditch Electrical Exhibition.

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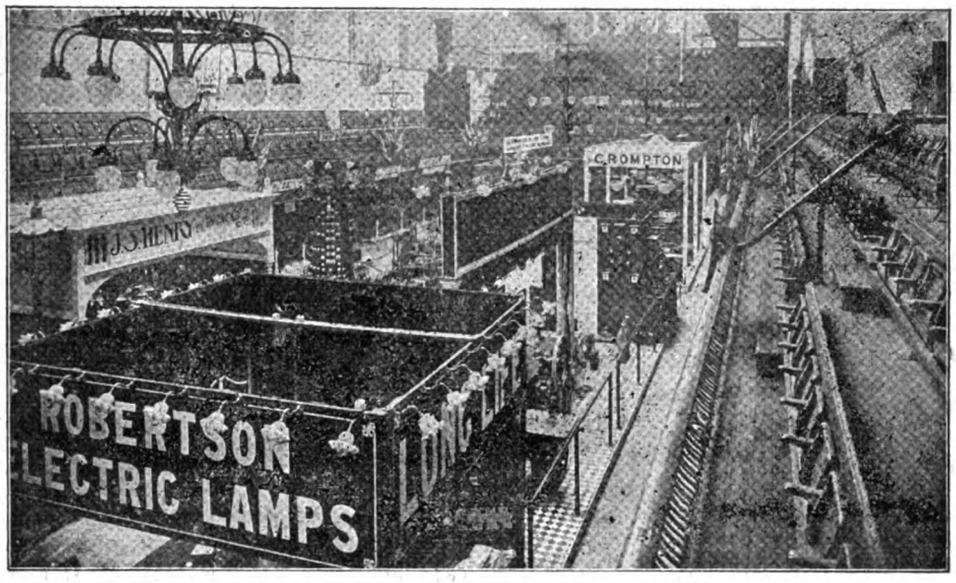
and Watling-street, E.C. This machine, with two others they are exhibiting, was driven by a 6½-h.p. motor, and it performs a variety of planing operations with the greatest facility. A good deal of interest attaches to this exhibit, as woodwork is one of the chief industries of the neighbourhood. Now that those engaged in the trade have had an opportunity of seeing the efficiency and economy of electric motors, from the smallest size upwards, it may reasonably be expected that there will be a substantial increase in the demand. The appliances of Messrs. Joseph Richmond and Co. for manufacturing articles of stationery attracted a good deal of attention. After the gum has been applied to the paper by the "Pellatt" machine, layers of the paper are operated upon by the "Reay" folding machine, with the result that, operating at a moderate speed, 2,500 envelopes are turned out per hour.

The Electromotor and Dynamo Company include in their extensive exhibit the Grisson "E.D.C." speed-reducing gear. This ingenious device occupies little space, runs silently, and has a mechanical efficiency of 95 to 96 per cent. We had a further opportunity of witnessing the admirable qualities of Messrs. Humpage, Jacques, and Pedersen's electric hoist. This apparatus is under complete control, being self-sustaining on the brake. The hoist is driven by a direct-current motor coupled direct to the high-speed side of one of the firm's special enclosed spur reducing gears.

An illustration of the firm's combined motor and reducing gear appeared in last week's issue. The reducing gear can be used with the motors of any maker. It is made in all standard ratios from 5 to 1 to 20 to 1. The gear is coupled to the armature spindle of the motor; it has a balance double drive; and the gearing, which runs in an oil bath, is covered in so as to protect it against dirt and dust. The results of tests given in Messrs. Humpage and Co.'s catalogue testify to its high efficiency.

Messrs. Marryat and Place had crowds watching their electric furnace, in which steel was being melted. The following night platinum was to be subjected to the furnace, which develops a temperature of 3,700deg. C. The General Electric Company's stall, on which demonstrations are given of the manufacture of the Robertson lamp, was likewise surrounded, this attraction being in great favour with the onlookers. The other prominent features were recorded in last week's issue.



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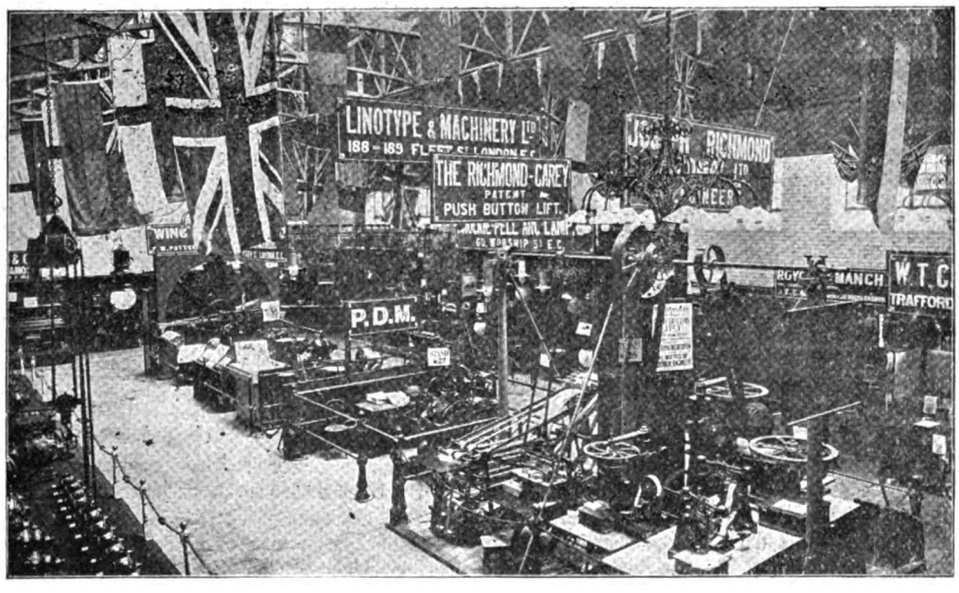

Shoreditch Electrical Exhibition.

The promoters are certainly to be congratulated upon the extensive patronage which is attending their efforts. Those who have not been to the exhibition should lose no time, as it closes to-morrow.

Portsmouth.—A proposal is on foot to carry the arc light system into all roads in the borough where there are tramway lines. The matter is under consideration by the Corporation.

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NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(Continued from page 551.)

In addition to the above requirements, which apply equally to every starting switch no matter for what purpose it is required, there are also special necessities in many starting switches which are called for owing to the special purpose for which the motors they control are used. The switches so far considered have been for direct-current, shunt-wound motors, leaving out of the question alternating-current motor switches. There are other types which must receive consideration. These include the starting switches for series-wound and compound-wound motors, and also the switches required for reversible motors. This latter type of switch is usually employed for lift work, and while in the majority of cases the lift is controlled only at the cage, there are many instances where it is necessary, or at any rate desirable, to control the motor from one or more points at a distance. When the points of control are manifold, it is essential that while each shall be independent of the others, yet it shall be impossible for the operator at one point to supply current for a downward direction of the cage at the same time that an operator at another point is supplying current for an upward journey. All this means special contrivances in the switch. In dealing with hoist switches, it may be remarked that for dinner lifts it is usual to arrange the controlling apparatus so that the lift will travel only to the intended floor. Various other starting switches are required for special purposes. At times it is necessary that the motor shall be started automatically when the water-level in a tank attains a certain height, and so on. Whatever the special purpose, or whatever the special type required of starting switch, the requirements already laid down hold good, and the switch should conform to these; the special arrangements must be considered as additionals, and not as equivalents for some of the specified requirements.

The conditions specified as necessary are not difficult of attainment, and if the customer will pay the price for a well-designed switch, he can be supplied with one that will be a sound electrical and mechanical engineering piece of work, and which will last for years without giving any trouble provided it receives anything like fair treatment. The unfortunate part is that, as a general rule, the customer is not prepared to pay the price of high-grade switch, but requires something cheaper and at the same time reliable. This being the case, some of the specified conditions must be deleted and others modified, and the question then becomes which of the conditions shall be abandoned.

The type of starting switch which is most commonly met with in practice is designed so as to be simple in construction, and usually has a movable lever operated by a coiled spring so arranged as to bring the lever back to the zero position if the retaining force is withdrawn; the switch is usually fitted with a no-load release. This is made in the shape of a small electromagnet energised by the shunt current, a small soft-iron armature being fitted to the lever of the switch, so that when this latter is pressed right home the soft iron closes the magnetic path across the poles of the no-volt bobbin. The lever is thus magnetically held in position; should the current be interrupted, the bobbin loses its magnetism and the lever flies back and so opens the switch. In addition, the switch may or may not be fitted with an overload preventer. The contact lever may either be operated by hand, in which case the speed at which the motor is started is left entirely to the discretion of the operator, or the lever may be moved by means of a screw and worm wheel. In this case, when either the no-volt release or the overload preventer comes into operation, a bar drops so as to prevent the current being switched on again until the lever has been screwed back to its off position. This type of switch appears to answer all the necessary conditions, provided it is well made and is of ample size to deal with the maximum current taken by the motor, and also provided that the shunt is so coupled up that a path for the induced current is afforded. The switch, however, is far from being a perfect piece of mechanism, and possesses several faults. In the first place, it is not advisable to leave the speed of starting in the hands of the operator, and the device of adding a wormwheel, while it cures part of the evil, is not altogether satisfactory. We have seen that the break from contact to contact should be as quick as possible, while the lever should rest on each contact sufficiently long to enable the motor to attain the speed corresponding to the current supplied at each contact. This condition is not attained, and instead of the time of starting being occupied only while the lever is on the contacts, it is equally distributed over the whole operation of break between contact and contact and of resting on the contacts, so that burning must inevitably occur.

Another point of great moment is that the price of the switch has to be cut to compete against other makes, and consequently due attention is not paid to the resistance coils. These are usually mounted behind the slate on which the switch proper is mounted, and then enclosed in a ventilated iron cover. Too often the coils simply consist of iron wire wound on a removable mandril, which is withdrawn after the coils are wound, and there is nothing to prevent sagging taking place. The iron should be, and often is, galvanised, but in time it rusts, and then the switch gives infinite trouble, the only cure being to rewind the coils entirely. At times an advance is made on this method, and the coils are wound on fibre or paper mandrils. This is only a temporary improvement, for the mandrils or cores prevent the free radiation of heat, and are soon affected by the atmospheric conditions, and commence to buckle. Then the effect of sagging is greatly aggravated, and the coils must be rewound.

The effect of starting the motor too rapidly is to cause a big rush of current through the armature. Now, while in theory we know that Ohm's law holds universally in every case, there are modifications which occur in practice and which can be usefully employed. If there are two paths open to the flow of a current of electricity, theory will state that the current will divide itself between the two paths inversely in proportion to the resistance of each. Practice shows that if the resistance of the two paths varies greatly, all the current will flow through the path of low resistance and none through the path of high resistance. This is shown in the case of a shunt-wound generator, which will refuse to excite on closed circuit if the resistance of the outer circuit is very low. It is also shown in the action of the overload preventer of many starting switches, which simply short-circuits the release coil, thus offering a path of such negligible resistance that no current will flow through the higher resistance of the bobbin. The same effect has been used in the design of one type of starting switch. The switch is fitted with two handles, so arranged that it is impossible to move the second switch, which actually controls the supply of current to the motor, until the second switch has been first moved to its far position. This auxiliary handle is held in its on position by means of a small subsidiary coil, similar to the release coil of the ordinary starting switch, and in parallel with the main supply. If, now, the main lever be gradually moved from step to step the motor will start, but if moved suddenly, so that at any time there is a large rush of current, the small coil will become demagnetised, and the auxiliary handle will fly back, and the whole operation must be started again. In a similar manner, other makers have devised various ratchet forms of attachments for operating the starting lever. This device is a distinct advance on the differential arrangement just described, for while in the former the time of starting is uniform over the whole range, in the ratchet type of switch a most important condition is fulfilled, and the lever rests for an appreciable time on each contact, and the break between contact and contact can be made very rapid. The worst feature about these ratchet type switches generally is that the parts being complicated some of them have to be put at the back of the slate, and there is no easy method of getting at them in case repairs are necessary. Some makers put the ratchet gear at the back, and some the electrical or contact part. It is questionable if either arrangement possesses any merit over the other. It is essential that the contacts should be examined from time to time, in order that any effects of burning may be made

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good, while at the same time the ratchet gear is liable to get out of order, and should therefore be continually inspected. Notwithstanding this drawback of hiding part of the gear, the switch posseses undoubted merits, and if well made should be capable of fulfilling its functions satisfactorily.

In all these switches there is a great necessity to see that the resistance coils are well wound, and, therefore, as it is desirable to prevent any tendency to buckling, the adoption of a type of switch in which the coils are surrounded with sand is not to be condemned. In this case, however, the sand should be removed, and the coils thoroughly inspected before the switch is mounted, for while the sand will serve a useful purpose it will also hide any defects which should be sought for before the apparatus is put to actual work. The writer fully admits the usefulness of sand, but at the same time, if porcelain mandrils are employed, good resistance wire used, and the whole properly mounted, there is no necessity for any substance such as sand, and the apparatus is easier of proper inspection, and any fault which may develop can be seen and put right without any trouble.

In the cheaper form of switches the contact pieces are generally made permanent. This is a great mistake, and it would be well worth the additional money to have them made renewable. Care should also be taken to see that the pressure of the lever on the contacts can be adjusted if necessary. Above all, attention must be directed to seeing that the switch is fully equal to its work, and if a 5-h.p. switch, for instance, is ordered it should be distinctly understood that 5 e.h.p. is not meant, but 5 b.h p. In none of these switches is much attention paid to arranging the amount of resistance between the various steps, and, therefore, if the motor to be controlled is of any size, with the order for the switch should be given information as to whether the machine will customarily start up light or under load.

With the higher priced starters the control is usually by means of electrical solenoids. This is a great advance on either the magnetic control of the differential type switch we have already described, or on the ratchet device. One of the great benefits that is to be attained is that with solenoidal control only a small shunted current need pass through the actual contacts of the switch, while at the same time a more flexible and perfect piece of apparatus generally is the result. The solenoidal type is of rather restricted use, but lends itself to an infinite arrangement of the parts, and it will be advisable in this regard to study the construction of switches actually on the market.

In the majority of instances the solenoid switch is arranged so that the current first of all passes through a main solenoid-controlled switch, which when closed causes the contact lever to move from step to step; the current that passes through the lever may be the main current or a shunted current only. In the former case the switch then acts in the usual manner, but if a shunted current only flows through the contacts, the amount of resistance in circuit with the main path is cut out by subsidiary solenoidal switches. The principle is well illustrated in the switch shown in Fig. 3, which may be considered as a forerunner of the solenoid switch. The figure shows a slate slab, on which are mounted a number of knife-type switches in a line, also a small no-volt release coil in the upper left-hand corner, and below it a maximum release or overload preventer. The principle on which the switch is designed is the familiar one we have already dealt with—that if the current has a choice of two paths which have great difference of resistance between them, the majority of the current will flow through the path of low resistance. The armature external resistance is connected up with the various switches, so that when the first switch is closed all the resistance is in series with the armature circuit; when the second switch is closed, a certain part of the resistance is cut out, as this switch opens a path through the resistance at a point nearer to the armature. The current may all flow through the second switch, or part may flow through the path of higher resistance offered by the first switch—this is immaterial. The third switch cuts out more resistance, and so on, until when the last switch is closed the armature circuit is directly connected across the mains, and all the resistance is cut out.

This switch is not automatic in its action, and differs therein from the solenoid type of switches; apart from this it possesses some very good features. In the first place, slow motion is attained, as it is impossible for any operator to close the switches instantaneously, and it is equally impossible to close the switch in the wrong order. This is prevented by a special interlocking arrangement, and the switch is also arranged so that should the automatic no-volt release or overload preventer come into action, all the switches automatically open. The second good point is that the break from switch to switch—the equivalent of from contact to contact in the ordinary type of starting switches—is a quick break, and a specially good point is that the break occurs on parts specially adapted for it—viz., between the blades and the contact pieces of the switches—and there is nothing like the same tendency for the arc to be maintained, or for burning to take place, as there is with the ordinary flat surface contacts of a step switch. It will also be noted that the requirement that the time spent in operating the switch should be chiefly used while the lever makes contact with the various steps and not during the different breaks is fulfilled, and that there is ample time for the armature to attain the speed corresponding to the value of the current supplied while the operator is releasing

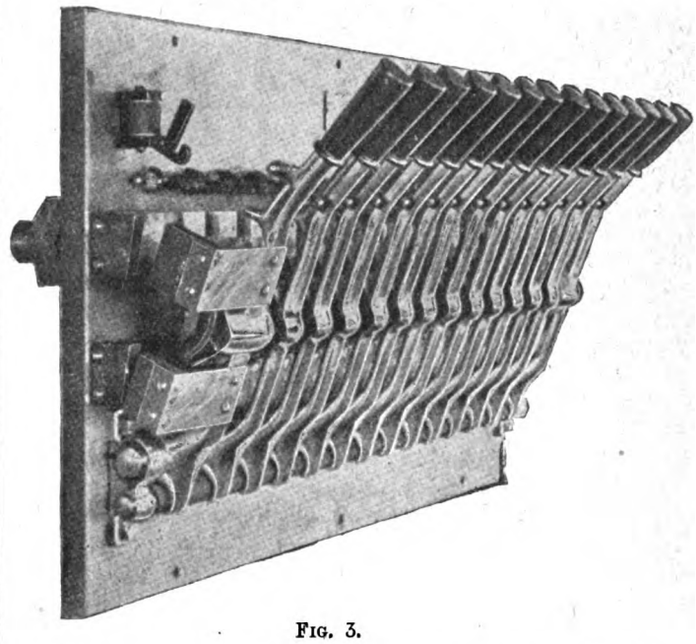

FIG. 3.

his hold on one handle and taking hold of the next in operating this switch.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, OCT. 21.

Institution of Mechanical Engineers.—At 8 p.m., "A Scientific Investigation into the Possibilities of Gas Turbines," by Mr. R. M. Neilson.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle, general meeting.

SATURDAY, OCT. 22.

Institution of Electrical Engineers. — Manchester Students' Section: visit to British Westinghouse Company's works. Assemble at Trafford Park at 2.15 p.m.

FRIDAY, OCT. 28.

Physical Society.—At 4.15 p.m., council meeting. At 5 p.m., "An Interference Apparatus for the Calibration of Extensometers," by Mr. John Morrow and Mr. E. L. Watkin; "A Sensitive Hygrometer," by Dr. W. M. Thornton; and "Note on a Property of Lenses," by Dr. G. E. Allan.

Institution of Electrical Engineers (Glasgow Section).—At 7 p.m., annual dinner, at the Grosvenor Restaurant.

SATURDAY, OCT. 29.

Junior Institution of Engineers.—At 3 p.m., visit to the National Physical Laboratory, Bushy House, Teddington.

Glasgow Technical College.—At 7.30 p.m., "The Law of Workmen's Compensation," by Mr. W. B. Anderson.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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OBSOLESCENCE.

We do not know who imported the terms obsolete, obsolescent, obsolescence into financial discussions upon electrical undertakings, but whoever he was, either his imagination was defective or the immediate object served his purpose. Usually the usage comes to the effect—of course, from an opponent—that a municipal authority is not running its concern in the proper manner—not making sufficient allowance for depreciation. If you mildly suggest that the sinking fund is really a depreciation fund, you gain no credence, and at the next speech or in the next article the formula is repeated—insufficient allowance. It must have been a grand acquisition to the opposition when someone brought out the idea of obsolescence, and it has done duty ever since. The poor, much-abused authority is condemned upon every possible and impossible count. The good old English custom of looking upon a man as innocent till he is *proved* guilty has gone by the board. We now assume guilt, and will not admit innocence. The authorities take up duties which we think ought to be rigidly outside their sphere of operations. Having undertaken these duties at the behest of the majority, it is not within the sphere of our operations to assume ignorance or incompetence to organise and carry them out successfully. It is not within our sphere to interpret their actions in a different manner to the interpretation put upon the actions of a company. We ask then, When, where, and in what manner obsolescence has in days gone by been accepted in the working of companies? We are rather given to archæological studies, but the term is new to us so far as it applies to company working. We never heard of a factory or railway company being expected not only to depreciate, to put aside for reserve, etc, but also for obsolescence, and it seems to us that to do so would partake of foolishness. The London and North-Western Railway did not scrap their old engines when Webb's compound was introduced. The improvement of a type of machine has never been taken to indicate that all users of the unimproved machine must scrap what they have got in order to instal the new arrival. Further, if there is anything in this cry of obsolescence, it is ten thousand times more important in the organisation of competing concerns than in those that are of the nature of monopolies. Our conception of the case as concerns municipal authorities is this. Their large undertakings are generally of the nature of monopolies. Assume for a moment such an undertaking as a tramway scheme—where there is no horse or competing tram system—assume the design for the undertaking to be in competent hands, the material and apparatus fully up to date. The income and expenditure is estimated upon the use of *this* material and apparatus—its life, its effectiveness, its economy, its everything is taken into account, and we cannot see why further you should take into account possible improvements that may or may not be introduced during the years to come. Those who contribute the income have the benefit in the years before the improvement is introduced, and so gain by early enterprise. The loss in efficiency is generally small, and only comes into play, and then only comparatively, during the later years of life; the gain, on the whole, averages out all right. Assuming materials and apparatus to fulfil the expectations they were estimated to fulfil, where does obsolescence come in? Simply like this. An opponent comes along years after the original installation commenced work, says improvements have been made; things can now be done more economically and on a bigger scale; you are losing so much a year by working as you are working, compared with what would happen if you worked as we would have you

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work. Unless there is an absolutely new departure, the natural obsolescence, old age, out-of-datism is allowed for in the first instance, and, therefore, need not be allowed for two or three times over. If the idea of obsolescence be pushed to extremes, it forbids all work or all progress, for we cannot conceive of machinery or systems not being improved. If the authority or company is so old-fashioned as not to accept the improvements made when extending the business or making renewals, the authority is to blame; but because a man says "I should not do that or use that now if I was starting," is no proof that originally he ought to have waited or to have estimated differently to what he did.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

XII.—On Competition.

My Dear Young 'Un,—I beg to acknowledge receipt of your last letter, the contents of which made me chuckle. You *were* in a paddy when you wrote! I imagine that if you had had the gentleman you refer to within your power, you would have torn him up and thrown him away. Failing that, you sat down and gave me the biggest treat I have had for a month.

And what's all the rumpus about? Just because "a lout who never passed his Seventh Standard, and whose highest engineering diploma is an Ordinary South Kensington Machine Construction Certificate," to quote your own graphic epitome, has been promoted to the marking-off table when you thought you were going to get there, you howl as if you had buckled your front wheel and smashed three ribs in a cycle spill. The best I can hope for you is that you haven't exhibited any traces of this nasty temper to the fellow or to any of the other shopmates. Jealous words are like boomerangs—the harder you thow them, the quicker they come back and hit you. And another thing—don't despise a man because he has not had the same educational opportunities as you have. You can't judge a cigar by the picture on the box; neither can you estimate a man by the school he went to. I don't think, after the letters I have previously written, you will accuse me of underestimating the value of education, but I would point out to you that most of our pioneers were indifferently-educated men, and that even nowadays from the heads of our engineering firms (and not sleeping partners, either) can be picked out men who look woebegone when you mention calculus, but who know what organisation and initiative mean. When they want pure science they hire a tame theorist, and supply the gumption themselves.

Your best mental attitude will be that of comparative analysis of your own ability and that of the man who has beaten you. Schedule your attainments: (1) theoretical groundwork, (2) accuracy, (3) energy, (4) stamina, (5) resource, and so on. Give yourself and the other fellow comparative marks; tot them up, and see which is the better man on analysis. You may be pluming yourself on some out-of-the-way virtue and neglecting the rest. You had better cast back, and see if you can recollect any time when some action of yours gave your foreman a strongly unfavourable opinion of some part of your character. A foreman may try to be as honest as he can, but his knowledge of the men under him is largely experimental, and some unfortunate accident may have created a bad impression which it will take some time to eradicate. If you can spot the mischief, lay yourself out to neutralise it. It is no good chucking your tools about, and saying that so long as the foreman has favourites it is no good trying. You will have favourites when you become a foreman, unless you have got batter pudding where your brains ought to be. The point is to make yourself one of the favourites.

Too many fellows when they are in the shops make the same mistake that astronomers used to fall into. Before the days of Galileo and Copernicus we on this planet had a very inflated notion of our own importance. The sun used to circulate round us, and the stars used to come and play bo-peep with us. When Galileo came along and blared out the truth, the principalities and powers that then were got so mad that they never let up on Galileo until he had signed a document to the effect that he had made a slip of the tongue, and was sorry he had ever had the audacity to be born. But the truth remained all the same. We aren't so big as we thought we were. In the same way, some fellows think that their shopmates, their foreman, the works, and the engineering firm exist for their benefit, and get wild if everything doesn't go as best suits them. If you fall into this error, you must at once readjust your mental centre of motion. You are not a fixed star. You are only a planet; and if you don't do your work and be civil, you will soon be a shooting star. Other fellows must have their chance as well as you; and if other fellows—whatever their initial position may have been—use their chance better than you, don't grumble when you find them walking on your head.

Again, one man oftentimes gets a pull over another because he is more adapted to the particular set of circumstances. A wedge gets on because it has got a sharp nose followed by a strong flank. A piece of straight bar steel may have more substance than the wedge, but it won't push along at a quarter the rate, because its substance isn't properly disposed for the work. When you are in competition (and when are you not?) you must study your circumstances and adapt yourself to them. You may depend on it your employer will soon size you up, and if you are the tool for the work he wants done he will push you forward. There are two old saws applying to competition which I recommend to your earnest consideration. The first, which I strongly agree with, is "One man's meat is another man's poison." You are feeling sick because the other fellow has got the job. He is probably as pleased as a dog with two tails. Just store that up in your memory against the day when you succeed against other competitors. Don't gloat; the others are feeling bad enough already, and they will put something into your tea if you aren't careful. No battleship goes forth to meet the midnight foe with the deck lights burning. It isn't safe to laugh much at other people's expense in this wicked world, and if you *must* do it, get into the middle of a lonely field and put your handkerchief in front of your mouth before you begin.

The other proverb, which strikes me as a highly immoral one, is—"All's fair in love and war." Most people add, "and business"; but I venture to suggest that everything isn't fair. Some men seek to appreciate their own virtues by telling lies about those of others. It is common to lay snares in order to trap competitors. I know that engineering is in a great state of depression just now; but if it is necessary to do dirty gutter business like this in order to make a livelihood, I almost wonder whether the time has not come to see if a clean living cannot be made at navvying.—Yours,

The Old 'Un.

DESCRIPTION OF THE ELECTRICAL EQUIPMENT OF AN ENGINE WORKS AND SHIPYARD, WITH NOTES THEREON.*

BY H. O. WRAITH, ASSOC.MEMBER.

(Concluded from page 556.)

Starters.—Wherever possible, liquid starters and controllers were used. For non-reversing machinery a type was used with an automatic release, which merely consisted of a solenoid coil, in the shunt circuit, which held the dipping blade down. If current was shut off the blade was released, and a spring caused it to fly up. No overload release was used. These were tried on some metallic starters, but were found to be too "kittlish" for use in a place where non-stoppage of work is essential. A momentary overload which would not seriously affect a motor, and is of too short duration to blow the motor fuses, makes the overload release act, and stops the motor until somebody can be found who knows where to look for the cause of stoppage

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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and how to put it right. A fuse is reliable enough to act when the overload is serious, or of long duration. Each motor was fitted with a double-pole main switch, double-pole fuse, and starter, in addition to the double-pole fuse on the distributing board, so that there were two sets of double pole fuses to safeguard each motor. The author does not deny that there are excellent metallic starters on the market, although many of them are badly arranged, badly divided off, and too light for their work. There is, however, no fault to be found with some, on whatever ground, as a starter. It is not, however, on technical grounds that the author prefers liquid starters, as on the general grounds of the use to which they are put. As a rule it is inevitable, without over-manning the electric staff grossly, that in a works of this description motors have mostly to be started by unskilled men, or, rather, men who know nothing about electrical machinery. Even if the shop foreman is the only non-electrical man allowed to start a motor, there are plenty of shop foremen who are quite capable, after dozens of lessons, of putting in the main switch, cutting out all the resistance with one vigorous shove, or even of reversing the order of those operations, and then cursing because the motor does not start. The liquid starter, to the uneducated mind of the ordinary workman, more resembles a stop valve. He can see something is happening by the bubbling of the solution. If it bubbles too much he is moving too fast, if it doesn't bubble at all, and the motor doesn't start, something is wrong and he sends for an electrician. But with the majority of metallic starters a handle projects in some form outside a closed box, and the man starting the motor cannot see anything going on, beyond flashing at the contacts, which probably takes place under any circumstances. So he doesn't take so much interest, and moves the handle at the pace which seems most expedient to him. In addition to this the liquid starter can be constructed in a much simpler manner, and with fewer parts to get out of order, than a metallic starter, which makes repairs easier and cheaper. In the case of cranes and other reversing machinery the same thing applies. The liquid controller, to the mind of a man accustomed to steam, resembles a stop valve, and if he treats it as he would a steam-engine stop valve he will not go very far wrong. For cranes, etc., the tramway controller is probably as capable of withstanding rough usage as any liquid controller, but its initial cost is high, which will, where low prime cost is an object, throw the balance in favour of the liquid controller. A great advantage of the liquid controllers is that all making and breaking contact is done on the surface of the liquid, and so sparking at metal contacts is avoided. The chief objection to the liquid starter — viz., that the solution must be of the necessary strength and quantity, and that it is liable to creep and make things in a mess—has no grounds in a works where an electrical staff must be kept, and where someone can be made responsible for examining and attending to them all at stated intervals.

Cranes.—The electric cranes in use were all in the engine works and brassfoundry, as follows:

Situation.	Maximum load, tons.	Motor B.H.P.			Controller.
		Hoisting.	Travelling.	Traversing.	
Brassfoundry	5	6	4	3	Liquid.
Erecting shop	30	15	10	5	Metallic.
,,	10	6	4	2	Liquid.
Boiler shop	30	14	8	4	Liquid.
Unloading gantry	20	15	10	4	Liquid.
Boiler shop	40	30-h.p.	single motor		—
,,	10	20 ,,	,,		—
Erecting shop	20	15 ,,	,,		—
Turning shop (2)	¾	1	1	—	Metallic.
Upstairs fitting shop (2)	¾	1	1	—	Metallic.

Besides these there were one or two small hoists in the shipyard. All the three-motor and two-motor cranes were fitted with automatic brakes, to act when current is shut off. The trolley wires, except in the case of the brassfoundry, where an old solid rod trolley wire was used, were of stranded hard-drawn copper, and were both mounted on one side of the shop, to save the expense of a double set of brackets, and to minimise the number of holes drilled in the girder work. The current collectors were all of the sliding shoe pattern, which lifted the trolley wire off the brackets as the crane passed along. Collectors of the wheel type were tried, but these were found very liable to jam and wear the trolley wire badly, and were all replaced by long shoes. At first the crane circuits were protected by double-pole fuses only, but as one or two short-circuits occurred, owing to careless men putting oil-cans, etc., down on the two trolley wires and bringing out the generator circuit breakers in the power-house, all crane circuits were protected by overload circuit breakers. After they were fitted, they answered perfectly satisfactorily. The author thinks that all crane circuits, where bare trolley wires are used, should be fitted with automatic overload circuit breakers, as in the case of a dead short, fuses heavy enough to stand the ordinary load act too slowly, and there is a danger of bringing out main circuit breakers when these are used. In the case of ordinary motors, driving tools of any kind, a circuit breaker is unnecessary. He is unable to remember a case of a short-circuit on a motor other than cranes bringing out the dynamo circuit breaker, and the rareness of the occasion justifies the leaving off of circuit breakers on all circuits (other than crane circuits). Stranded trolley wires were used in preference to solid ones, because of the greater ease of handling and repairing. However badly a stranded wire is burnt by short-circuiting, it is possible to patch it up, so that, at any rate, it can be used till a new one can be run, whereas if a solid wire gets burnt through, or nearly through, the chances are it cannot be used at all again, and the shop cranes have to stand till a new one is put up. It was the author's practice always to keep ready to hand a spare pair of trolley wires for the erecting and boiler shops (which were of the same length), for the cranes are the life of a busy shop, and without them the shop soon comes practically to a standstill.

Spares.—In converting a works of any size to electric driving, as a rule not nearly enough attention is paid to the matter of spare gear. No man nowadays hesitates to insure his premises and goods against fire, and to pay heavy sums annually, so that he may not lose, or that his loss may be a minimum, in the case of fire breaking out. At the same time he may be firmly convinced that a fire could not possibly happen in his works. Spare parts are an insurance premium, paid to cover the risk of serious loss from stoppage of work due to breakdown of machinery. Thirty or forty years ago, and even with some firms to-day, steam-engines and other machinery were only in very exceptional cases built so that the parts of any two machines were interchangeable without an excessive amount of fitting, even though the machines were supposed to be exact duplicates in every dimension. But with present-day electric, steam, or gas machinery, as, of course, with many other classes of present-day machinery, all parts which are likely to require renewal, or are likely to break down in case of anything untoward happening, can be made exactly interchangeable for machines of the same type and size. For the generating sets a stand by plant is necessary, and this is a complete set of spares by itself, so that, in the case of the dynamo, no spare armature is wanted, nor need any other spare parts be kept, except small parts, a set of piston rings, a complete set of governor or other springs, carbon brushes, and any other special part that might require renewal. It is advisable, where possible, when deciding on the correct plant to buy, to keep the units of exactly the same size and type, and, moreover, of such a size and type that it will suit for any future units that may have to be laid down for possible extensions. Then one set of spare gear will fit each and all of the units. This is not always possible, but unless there is a strong reason against it, the units ought to be kept identical, for not only are spare parts reduced to a minimum, but the attendants get more familiar with, and handle more easily, a number of identical units than a heterogeneous collection of machines. A spare armature should be kept for every different size motor in the works. Great improvements have lately been made in the manufacture of motors, and as a machine they are now, mechanically and electrically, perfectly sound. But accidents will happen As an instance of an accident, the author has known cases of a playful lad throwing a nut, or

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some such handy missile, at an equally playful companion, and hitting the open door of a motor, the nut getting jammed between a pole-piece and the armature, fireworks and a stoppage resulting. As everybody can appreciate, very serious losses may result from the stoppage of even a small section of a shop, if it is a case of rewinding an armature or waiting for a spare one to be sent off from the manufacturers, whereas even in the cases of motors up to, say, 30 h.p., it is, as a rule, only a case of waiting one to three hours to put in a spare armature that is ready to hand. A small, though important, point about all armatures is that the pulley should be fixed on by a set-screw and feather key, or in some manner so that it may be easily removed from the shaft, to prevent loss of time in getting out a stubborn-driven key. It therefore behoves the buyer of plant to use as small a number of sizes of motors as possible, and have a spare armature for each size. It is better to underload a motor in a case where only one or two of the correct size would be wanted, so as to keep to the standard size and have the use of the standard spare gear for that size. Spare brush gear is also a necessary for each size of motor, and may save a good deal of time in renewal work, which must necessarily be done in overtime, when the shop is not working.

Recording of Loads.—The methods that were adopted for registering current generated and consumed were chosen so that as much information as possible might be obtained from the readings taken, and at the same time the instruments and readings might be easily understood by the working staff. The system consisted of three compound-wound dynamos, feeding in parallel on to a pair of common main 'bus bars, off which 'bus bars all circuits were taken through double-pole switches and fuses. An automatic circuit breaker, with magnetic blow-out arrangement, protected each generator. The current fed on to the 'bus bars by each of the three generators was registered on a recording low-potential ammeter on the main switchboard, with a paper speed of 1in. per hour. As the shipyard was worked as a separate department from the engine works, the switches for the shipyard circuits were all mounted on a separate panel of the main switchboard, and for the purpose of determining the consumption of current by the shipyard, an ammeter of the above type, with paper speed of 1in. per hour, registered the aggregate current passing to this panel. A portable ammeter of the same type, with a paper speed of 6in. per hour, was kept for the purpose of testing loads on motors, or any particular circuit, etc. This speed, $\frac{1}{10}$in. per minute, was ample to show the exact durations of the load, as well as its magnitude, and the instrument was very useful. The paper recording instrument was used in preference to the summation type for recording the dynamo current and the current used by the shipyard, because of the greater amount of information to be obtained from the charts. On them could be traced the exact nature of the load at any minute of the day, and any apparent irregularity could be enquired into. Also it acted as a check on the regular rotation of running of the three dynamos, the load during portion of the day being small enough to be carried by two machines, the third being put in when the lighting load came on; and it was an object, as far as possible, to distribute the work evenly between all the machines. All records were filled in books kept for the purpose, the working up of the results being extremely simple, and done as follows: The total area enclosed by the line marked by the pen and the zero line, was measured by a planimeter registering in square inches. This area, multiplied by a constant depending on the paper speed, the breadth of the paper and its graduations, gives the total ampere-hours. Thus, suppose the paper speed is 6in. per hour, paper breadth is 3in. and graduated to 200 amperes, area of card 12·5 square inches

$$\left(12{\cdot}5 \times \frac{200}{3} \times \tfrac{1}{6}\right) (= \text{total ampere-hours}) \times 225 \text{ (voltage)}$$

$$= 32{,}500 = \text{total watt-hours.}$$

This method of recording, although it may be open to the charge that it is not as accurate as if the watt-hours were recorded direct on a watt-hour meter, is, nevertheless, accurate enough for all purposes, and possesses the advantages that it is simple and one can see exactly where the various loads are coming from and going to.

Relation of Current Demand to Rated Motor Power.—In the shipyard, where there was only one small two-ton crane, the aggregate brake horse-power of the motors of all kinds employed was 553. Taking four amperes at 220 volts as being required to give 1 b.h.p. from the motor, the total current required if all the motors were working simultaneously at full load would be 2,212. Let us call this the rated full-load current. Then from observations taken

$$\frac{\text{Maximum actual demand by motors}}{\text{rated full-load current}} = \frac{800}{2{,}212} = {\cdot}362.$$

In the engine works and brassfoundry, etc., the aggregate rated brake horse-power of the motors was 504, but this included

Two	30-ton	three-motor	cranes.	One	40-ton	single-motor	crane.
One	20 ,,	,,	,	One	20 ,,	,,	
One	10 ,,	,,		One	10 ,,	,,	
One	5 ,,	,,					

The engine works rated full-load current was, therefore, 2,016 amperes, and the actual maximum demand about 700 amperes. Therefore, for the engine works,

$$\frac{\text{Maximum actual demand by motors}}{\text{rated full-load current}} = \frac{700}{2{,}016} = {\cdot}347.$$

Generating and Coal Costs.—In giving tables and figures for generating costs, etc., the author does not claim that the figures are by any means what they ought to be, although they will probably compare favourably with a great many large private installations in works. They serve to show, however, in this particular case, wherein the defects in the generating plant lay, and in a general way, on which the author wishes to lay stress, the enormous importance, not realised by a great many private owners of installations, of collecting and tabulating all possible data, so that any weak point in the installation or possible improvement may be spotted at once, and acted on as may be necessary. Of course, in all public or private supply stations where the business is solely generation of electric current, accurate figures and data are kept and published, and the general run of the cost figures for generating current are well known and accessible to anyone who reads the weekly technical electric papers. Unfortunately, or fortunately, the installation which the author has made the basis of his remarks was put down piecemeal, and prior to his advent on the scene it was deemed advisable to lump all electrical generating and upkeep costs with the ordinary works maintenance cost accounts. In addition to this, the feed-water system for supplying water to the steam-boilers for driving the electric plant was common to another boiler used for driving steam hammers, feed-water pumps, and a steam-driven set of accumulator pumps. Steam from the boilers raising steam for the electric generators was also taken for driving two air-compressors of about 25 h p. apiece. The whole of the water softened was not used for the electrical plant boilers, some of it being sent down to the shipyard for feeding an auxiliary boiler there. In spite of these difficulties, the author took all possible readings and observations with the object of ascertaining exactly the proportion of coal and water used for the generating of electric current, and managed to fix down pretty accurately the proportions he wanted. Although, therefore, he cannot say that the figures are scrupulously exact, they are reliable, and serve the purpose for which they were intended—viz., to find out, in detail, what the generation of electricity was costing the firm, and whether the figures arrived at represented the best practice under the circumstances. The figures given are not picked in any way, but are taken from the electric costs book, and are taken from five continuous months during which both double—*i.e.*, night and day—and single—*i.e.*, day only—shifts were worked.

GENERATING COST DETAILS PER BOARD OF TRADE UNIT.

Month	Sept.	Oct.	Nov.	Dec.	Jan.
Shift	Double	Double	Double	Single	Single
Coal	·441	·407	·345	·422	·421
Water	·026	·022	·022	·023	·024
Wages	·082	·084	·084	·117	·115
Stores and repair material, etc...	·013	·027	·105	·053	·058
Wages for repairs	·077	·092	·092	·087	·090

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Works' costs	·639	·632	·648	·702	·708
Taxes, rents, and general charges	·092	·101	·117	·135	·130
Interest and depreciation	·202	·186	·188	·280	·289
Total cost	·933	·919	·953	1·117	1·127

The capital outlay per kilowatt was £23. 4s. The average price paid for coal was 11s. 6d. per ton. Now let us examine these figures. The cost per unit of coal in September is nearly 50 per cent. of the total cost per unit. Referring to the coal sheets, we see that the total coal used during the month for electrical purposes was 314·1 tons. The total output of the plant (double shift) was 98,274 Board of Trade units. This works out at 7·175lb. of coal per Board of Trade unit, or, taking 82 per cent. as the average combined efficiency of engines and dynamos, 4·39lb. of coal per 1 h.p. per hour, or, again, 5·35lb. of coal per electrical horse-power per hour. This seems to be higher than it ought to be, a thing the author expected to find, for, as before said, the feed-water heating arrangements were very defective, and there was a run of about 100ft. for the main steam-pipes from the boilers to the engines, and this, although the pipe was covered with non-conducting composition and run inside the building, must have been a source of considerable condensation. The cooling tower had also for some time been too small for its work, and, in consequence, the condensing water returned to the condenser at too high a temperature to keep a proper vacuum, which would, of course, cause a rise in the coal consumption. However, an investigation was made to see whether any immediate steps could not be taken to reduce the coal consumption, with the result that it was found that the mechanical stokers on the boilers, although they reduced smoke, were, from whatever cause, throwing the coal badly, a good deal of hand firing having to be done, as well as admitting too much air to the furnaces. They were, therefore, as hand firing could be done without increase in the number of firemen, dismounted and hand firing resorted to, with the result that in October the cost of coal per unit is reduced by nearly 8 per cent., the coal used per electrical horse-power per hour in October being 4·03lb. on a total output for October of 106,641 Board of Trade units. This is an improvement, although the figure for coal consumption was by no means as low as it ought to be, and may be, with a well-designed installation. In November the coal cost is still further reduced. No special reason can be given for this, except that the condenser was retubed at the beginning of the month. The cooling water was extremely hard, and the inside of the condenser tubes very speedily became coated with a very hard flinty scale, very difficult to remove. In fact, the author has not come across a tube brush or scraper that would efficiently cope with it, and the condenser had to be periodically retubed. The coal used per electrical horse-power in November worked out at 4·18lb. per hour, on a total output of 104,977 Board of Trade units. None of the other figures for the first three months call for any special comment, except, perhaps, the high figure for stores and repair material in November. This was due to two new sets of piston rings being charged, and also examining and overhauling the cylinders of three engines in that month. Depreciation was calculated at 5 per cent. on the total capital outlay on generating plant. At the end of November the night shift was knocked off. First let us see what reduction is made in the output of the electrical machinery. The average output per month for September, October, and November, when two shifts were running, was 103,297 Board of Trade units. The average for December and January, with only a single shift, was 71,580 Board of Trade units, or a reduction of, roughly, 30 per cent. of the output due to the night shift being stopped. It may be objected that December and January are, owing to the holidays, broken months, and, therefore, the comparison is hardly fair, but that does not affect the broad principles which the author is seeking to prove. As a matter of fact, as will be seen from a comparison below, the actual number of hours during which the electric plant was running was about 60 per cent. in December of what it was in November. This high proportion was due to a large amount of overtime worked during December in the shipyard, and would be expensive running for the electric plant. Returning to the cost sheet, we see that in December and January the coal cost per unit has risen again to nearly what it was in September, although it is not such a large proportion of the total cost (about 35 per cent.). To see exactly how this extra coal used was to be accounted for, and what proportion went to banking up, etc., the coal used in the electric plant boilers was accurately measured for every hour of the day for a number of days, as well as the output of the dynamos during each hour of the day. The figures given below represent the mean of the daily readings taken.

Coal Used during Different Portions of the Day.

—	Before 6 a.m.	6 a.m. to 8 a.m.	8 a.m. to 9 a.m.	9 a.m. to 12.	12 to 2 p.m.	2 p.m. to 5 p.m.	5 p.m. to shut down.	Banking up.
Total lbs. coal used.	2,987	3,920	933	3,593	2,659	3,920	1,960	1,260
Total units generated.	97·5	714·25	163	882·92	318·25	870	335·5	—
Lbs. coal per E.H.P. hour	23	4·1	4·27	3·04	6·23	3·36	4·35	—

The shipyard breakfast time was from 8 till 8.30 a.m., and dinner hour from noon till 1 p.m. The engine-works breakfast time was from 8.30 to 9 a.m., and dinner hour from 1 to 2 p.m., so that 8 to 9 a.m. and noon to 2 p.m. were times when the load was light. The reason of the coal consumption being so high between 12 and 2 was that advantage was taken of the light load to clean out the boiler fires during that time. Now, during the actual time the plant was being used—*i.e.*, from 6 a.m. to the time of stopping—the total amount of coal used was 16,985lb., or about 80 per cent. of the gross total, for a total output of 3,283·92 Board of Trade units. This gives us 3·91lb. of coal used per electrical horse-power per hour, or taking into account the coal used in banking up and restarting 4·71lb. of coal per electrical horse power per hour, as against 4·56lb. of coal per electrical horse-power per hour used in October and November, the two months of double shift, during which the boilers were being fired under similar conditions. During the period of double shift the night load was about five-twelfths of the day load, so that these figures show that the extra coal used per unit in banking up and restarting is not very much more than the increase per unit of coal used during double shift due to the decreased efficiency of the working of the night load. We may expect that had the night load while double shift was running been the same as the day load, the coal used would have come out at about the 3·91lb. per electrical horse-power per hour given above as the coal actually used during working hours. We see also that wages for running the plant were increased about 40 per cent. per Board of Trade unit, rents and general charges about 28 per cent., and interest and depreciation about 48 per cent., due to the night shift being stopped. The following comparison shows the proportion in which the various items were increased or decreased by the stopping of the night shift.

Comparison between Double and Single Shift.

	November, double shift.	December, single shift.
Total output	100	70·5
Total hours run	100	60·2
Total cost	100	83·0
Cost per Board of Trade unit	100	117·2
Total coal used	100	86·5
Coal per electrical horse-power hour	100	121·1
Total water used	100	70·0
Total wages—Electricians	100	72·7
Enginemen	100	51·6
Firemen	100	100·0
Millwrights	100	101·0
Interest and depreciation per B.T.U.	100	148·9
Total labour per B.T.U.	100	116·0

The items of proportionate increase of cost on stopping the night shift are, in order of importance, interest and depreciation, coal and labour, which are, of course, just as we should expect them. The labour and coal are not very excessive when double shift is running, in spite of the defective condensing and steam-pipe arrangements mentioned before, but the change in the total cost when single shift only is worked is very marked, which goes to show, what probably all present know, that the nature of the load makes very much more difference to the cost per unit gene-

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rated of a plant than any mechanical defects or perfections of the machinery used. The author does not mean to imply by that that not much attention need be paid to mechanical and labour-saving details. Very great attention must be given to all details of an installation, so that all apparatus used is of the very best and most economical type, but the refinement of cost-saving machinery may easily be carried so far that some of it saves less than it costs in interest and depreciation, especially in the case of poorly loaded plant, and there is no doubt that this happens so in the case of a great many central stations. In far too many cases where it is decided to instal electric plant the subject is not understood by anyone in the employ of the works owners, and the matter is placed in the hands of a well-known firm of electric contractors. They will probably supply machinery satisfactory enough in itself on the scanty information furnished, but as often as not, not the most suitable class of machinery for the particular circumstances. To get the best results the matter must be investigated thoroughly by an employé of the works owner, who knows exactly, or can find out, the system under which work is carried out, the nature of the probable load on the generating plant, in general, knows the particular set of circumstances under which the plant will have to work, and, of course, knows intimately all the different points about generation of electricity in all possible manners—steam, gas, water, etc.—and transmission of power by electricity. Above all, must all possible data be tabulated and all costs kept in such a manner that all fluctuation in loads, consumptions, and costs may be readily seen and the cause investigated, and, if necessary, remedied. This is a most important point. Thirty or forty years ago people would stick down a set of boilers, steam-pipes, and engines and connect them up to their shaftings, and never up to the present day had they the faintest idea what work they were doing, or what they were costing. But that was in the days when fortunes were made. Nowadays manufacturers have to take orders at under cost prices (or so they say), and it behoves them to see that, among other things, their methods of generating power are the most economical and, therefore, efficient possible. As an instance, a few months ago the author had the pleasure of advising the head of a large works to adopt electric driving. On going roughly into the question, it was clear that a saving of at least £2,500 per annum could be made in the works expenses with a capital outlay of about £8,000, and there must be hundreds of works in the country where similar results could be arrived at. In this case the owner had not much idea how much his power was costing him, beyond the fact that he was burning so many tons of coal per annum, and some of that in heating furnaces. Another very general and also fatal mistake that is made in converting large works to electric driving, is converting by degrees, and not allowing in the first instance for the maximum proportions to which the installation may extend. Electric driving is now past its infancy, and its performances and capabilities are pretty well known, but, in spite of that, the man who is thinking of converting the whole of his works, taking, say, 2,000 h.p., will be distrustful, due to ignorance, and will convert a portion of the works, taking, say, 200 h.p. Instead of laying down his power-house, boiler plant, generating units, etc., on the assumption that ultimately he will require 2,000 h.p., he sticks down a little 200-h.p. dynamo in a corner of the shop out of the road, and makes his arrangements so as to spend as little as possible over his "experiment," instead of employing somebody who knows intimately all about his little "experiment" and laying down proper plant. The consequence is that when he finds electric driving seems to be quite practical and much handier than steam, that nothing explodes or misbehaves itself, although, perhaps, he has only a general idea that he has made any saving in £ s. d., he decides to convert the rest of his works, and must then face two alternatives: (1) add to the plant he has already bought, without regard to its suitability for the larger installation, and so sacrifice economy in running expenses; or (2) disregard (partly or altogether) the plant he has bought, and lay down a complete and up-to-date generating plant and station. In this case his total capital cost is a good deal greater than it would have been had he laid the first plant down on the assumption that he needed 2,000 h.p. altogether. Of course, the idea of such a man is that the "experiment" may be a failure, and have to be pulled out again: therefore, looking to such a contingency, he wishes to keep his possible loss as small as possible, but, as was said before, electric driving is now well past the experimental stage, and electric machinery, as now manufactured, is as reliable as, or more reliable than, any other kind. It only needs proper knowledge of the local circumstances to be able to say definitely what is the most suitable plant to lay down in any particular case, its prime cost, and the cost of running it.

Adaptability of Electric Driving.—As a very good instance of the pliability and adaptability of electric driving, rather than with any idea of its being in any way extraordinary, the author introduces a disastrous fire which occurred in the engine works in September, 1901. It was discovered about 5 o'clock in the morning, when a day shift only was working, by men coming in to fire up the boilers, and the net result of it was that a great portion of the engine works was gutted. Fortunately, the power-house was unharmed, but the supply mains to the shipyard which passed along portion of the engine works roof were damaged. By 9 o'clock in the morning it was possible to get up to examine the shipyard cables, when it was found that very little damage was done, except that the insulation was all burnt off for a considerable distance and one supporting bracket was broken down. This was soon temporarily put in working order, and the supply to the shipyard resumed by mid-day. The engine works, however, was in a different plight. The whole of the small machine shop, erecting shop (containing the larger planing, turning, and boring machines), and portion of the boiler shop were gutted. Luckily, the new brassfoundry between the engine works and the offices was practically completed, and it was at once resolved to convert this into a temporary shop for the smaller machine tools, and let the large machine work out to neighbouring firms. A pair of $^{19}/_{14}$ was at once run to the brassfoundry building, wooden baulks and platforms were erected to support the necessary shafting, and the shafting put up in two sections with two 20-h.p. motors, which happened to be available, with starters, etc, to drive it. Lathes, etc., were wired for and put down with all possible speed. The motors were, without haste, ready to run within two or three days of the fire, and the shafting very shortly after, and, if necessary, all this portion of the work could have been ready in 48 hours. In consequence of electric power being available, therefore, a few machines which the makers had had in stock were running within about a week of the fire, while within three weeks nearly as much work was being done in the temporary building as had been done in the burnt-out small machine shop. The pliability of electricity was further illustrated in rebuilding the engine works, in the use of temporary arc lamps and clusters, and of portable saw benches, a tool largely used in ship work for sawing joists, flooring, etc. These portable saw benches have, in the works under consideration, almost entirely superseded hand sawing and hand adzing on ships in course of construction, with a large saving in cost.

Lighting.—Although in deciding on the number of arc lamps to put in a building each case must be considered from its own standpoint—that is to say, the reflecting power of the surface of the walls, any obstructions there may be, etc., have to be allowed for—the author gives below a few figures for the watts installed in arc lamps alone in various shops. He is inclined to be in favour of enclosed lamps, on the ground that they cost less in upkeep, although not so much light is obtained for an equal consumption from enclosed as from open type lamps.

Shop.	Approximate floor area (sq. ft.).	Watts per 1,000 sq. ft. of floor area.	Remarks.
1. Joiners' shop.....	6,000	1,100	All inverted arcs.
2. Marking-off loft ...	4,800	917	,, ,,
3. Turning shop.....	5,400	1,630	Enclosed arcs.
4. Erecting shop	13,200	583	,, ,,
5. Blacksmiths' shop...	7,200	460	Open arcs.
6. Boiler shop	13,200	500	,,
7. Quay shop	2,772	800	Enclosed arcs.
8. Plumbers' shop.. ...	1,850	600	,, ,,
9. Pattern shop.....	5,400	1,020	,, ,,

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No. 1 is, the author thinks, the best illuminated shop he has ever seen. No. 3 is rather a dark shop, with a great number of belts. The arranging of the lamps was rather difficult in order not to leave any badly-lighted corners. In addition to the arc lamps, there were, in Nos. 3, 4, 6, 7, 8, a number of incandescent hand lamps for use on machinery, inside boilers, etc., where local light was required.

In conclusion, the author wishes to express his indebtedness to Messrs. W. Donford and Sons, Limited, for allowing him to publish the figures in this paper.

DUDLEY ELECTRICITY ACCOUNTS.

The accounts of the Dudley electricity department for the year ended March 31, 1904, show a total expenditure on capital account of £70,727. An abstract of the revenue account, together with the statement of electricity generated, sold, etc., is given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	4,177	0	4
Distribution of electricity	114	17	3
Attending and repairs to public lamps	298	3	0
Rents, rates, and taxes	385	10	10
Management expenses, salaries, etc	624	7	3
Special charges, insurance, etc.	49	18	2
	5,649	16	10
Gross profit carried to net revenue account	5,012	2	1
	£10,661	18	11

Cr. Income.	£	s.	d.
By sale of current per meter	9,230	16	2
Public arc lighting	1,120	0	0
Ditto incandescent lamps	196	18	8
Rental of motors, meters, etc.	54	19	4
Sale and repairs of lamps and other apparatus	9	18	10
Testing fee	0	10	6
Miscellaneous receipts	48	15	5
	£10,661	18	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,736,240
Quantity sold	Public lamps	112,117	
	Tramway company	1,035,021	1,526,713
	Private consumers by meter	379,575	
Quantity used on works			101,065
Total quantity accounted for			1,627,778
Quantity not accounted for			108,462

Total maximum supply demanded (kilowatts): trams, 850; lighting, 354. Number of public lamps: 56 arcs, 222 incandescents.

HACKNEY ELECTRICITY ACCOUNTS.

From the accounts of the borough of Hackney electricity department for the year ended March 31, 1904, it appears that the total expenditure on capital account to that date amounted to £246,575. Appended are abstracts of the revenue account and balance-sheet and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	6,170	19	8
Distribution of electricity	495	13	1
Attending and repairs to public lamps	1,014	17	7
Rents, rates, and taxes	1,252	18	9
Management expenses, salaries, etc.	1,567	19	9
Total expenditure	10,502	8	10
Gross profit carried to net revenue account	16,190	2	10
	£26,692	11	8

Cr. Income.	£	s.	d.
By sale of current, less discounts	20,756	16	4
Public lighting	4,860	4	11
Current supplied to dust destructor	739	0	9
Rental of meters and other apparatus	328	3	4
Free-wiring rentals, sale of lamps, etc.	7	15	4
Miscellaneous receipts	0	11	0
	£26,692	11	8

CAPITAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans from London County Council, less redeemed	241,439	0	0
Sundry creditors	1,513	18	10
Treasurer—overdraft	3,622	15	11
	£246,575	14	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	246,575	14	9
	£246,575	14	9

REVENUE BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Sundry creditors	1,549	17	11
Consumers' deposit account (security for current)	39	0	0
Reserve fund account	2,450	17	1
Reserve fund account for renewals, etc.	7,837	6	3
	£11,877	1	3

Cr. Assets.	£	s.	d.
Reserve fund and interest on deposit	2,291	2	7
Stores in hand	1,581	19	2
Sundry debtors	7,781	11	3
Cash in hands of officials	222	8	3
	£11,877	1	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units			2,548,083
Quantity sold	Public lamps	539,006	
	Private consumers	1,598,916	2,181,391
Quantity used	On works	159,322	
	On accumulators	51,780	366,692
	On distributing system	155,590	
Number of 8-c.p. lamps connected			94,816
Total maximum supply demanded (kilowatts)			1,479
Load factor			16·83

EASTBOURNE ELECTRICITY ACCOUNTS.

Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., taken from the accounts of the Eastbourne electricity department for the year ended March 31, 1904.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	5,165	2	5
Repairs, etc., of buildings and plant	337	15	3
Distribution of electricity	401	19	4
Public lamps	293	9	10
Purchase of motors	78	15	4
Installation and repairs of motors	29	5	2
Rents, rates, and taxes	1,041	3	0
Management expenses	856	3	11
Costs of electrical exhibition	73	4	7
Miscellaneous expenses	135	14	0
	8,412	12	10
Gross profit carried to net revenue account	13,008	11	10
	£21,421	4	8

Cr. Income.	£	s.	d.
Sale of current, meter rents, etc.	20,976	17	0
Sale of carbons, testing fees, etc.	55	1	2
Rent of cottages, electric light sign, etc.	54	9	0
Installation and repairs	87	16	10
Miscellaneous—work done and ashes	42	18	3
Sale and hire of motors	106	10	3
Radiator and cost of running engine for private lifts	27	17	6
Returns from exhibition	69	14	8
	£21,421	4	8

Note.—The net revenue account shows a profit of £3,858, £750 of which was allocated in aid of the rates, £1,000 added to the reserve fund, and the price per unit reduced from 6½d. to 6d., and for public arc lamps from £25 each per annum to £22.

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Corporation stock—less redeemed	136,252	6	3
Sundry creditors	3,279	19	11
Cash owing to bank	2,541	1	10
Cash owing to revenue account	8,710	4	8
Depreciation fund account	3,000	0	0
Sinking fund in hand for redemption	14,735	6	8
	£168,518	19	4

Cr. Assets.	£	s.	d.
Capital outlay on buildings and plant	145,988	15	6
Apportionment of costs of issue of stock	14,935	12	11
Sundry debtors	7,352	18	9
Stock on hand	241	12	2
	£168,518	19	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,106,266
Quantity sold	Public lighting	163,871	
	Private consumers	733,322	897,193
Quantity used on works			13,841
Total quantity accounted for			911,034
Quantity unaccounted for			195,232
Number of lamps connected			62,998
Number of consumers connected			988
Maximum load observed (kilowatts)			743

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TRADE NOTICES AND NOVELTIES.

Linolite Lamps.

We have received a copy of an interesting report on these lamps by Mr. J. S. Dow, A.C.G.I., who subjected eight of the lamps to an extended trial lasting 1,200 hours. The trial was made with a double object, the first being to see whether the reflector had any effect on the life of the lamp, and, further, to ascertain the average life and efficiency of the lamps. On the first point, the evidence is clear that the presence of the reflector close to the lamps, to which the distinctive name of Linolite has been applied, has no influence whatever on the life of the filament. Of the eight lamps under trial, one failed after 650 hours, but the other seven were still in operation after the 1,200 hours. The curves accompanying the report show that the average decrease in candle-power during the first thousand hours is about 15 per cent. The interesting feature from the consumer's point of view is the energy consumed per candle-power hour. At the beginning of the test the average consumption for the eight lamps was 3·75 watts per candle-power, the average watts per lamp being 47·13. At the end of the thousand hours' run the average watts had only increased to 47·21, which is an increase of ·169 per cent. This is considerably lower than the average increase with the ordinary type of incandescent lamps. In the same way the mean watts per candle-power rise from 3·75 to 4·40, being an increase of 17·95 per cent. This figure is also good, and leads one to the conclusion that either the Linolite Company are exceptionally successful in the choice of their filaments, or that the form of lamp has some influence on the life of the filament.

Street-Lighting.

The Reason Manufacturing Company, Limited, of 11, Victoria-street, Westminster, S.W., and Brighton, have specialised in street-lighting, and that they do not intend being left behind is evident from their latest catalogue, which includes much interesting matter, and is, moreover, exceedingly well printed. Accompanying are illustrations of a few examples of their recent progress in fittings for the purpose in question. Fig. 1 shows a three-way lamp bracket of the firm's "K 3" type. This fitting can be supplied with switches and fuses if desired, and is suitable for use with "A" and "B" type Nernst lamps or small enclosed arcs. Attention is particularly called to the new reflector lantern (Fig. 2). This is one of the latest developments for Nernst, incandescent, or small arc lamps. It can be supplied either with clear or frosted glass, and when two lamps are used there are no shadows. Another advantage of this lantern is the accessibility of the lamps and internal fittings, it being only necessary to unscrew the top finial to remove the cover. In the tramway or arc lamp-post fitting (Fig. 3), the brackets are so arranged that they can be adjusted to any horizontal angle. By means of the firm's patent reflector system, which this fitting also combines, the candle-power is increased in the required direction to that shown by the figures on the illustration when using 16-c.p. incandescent lamps. The lamps, which are of the ordinary type, are fixed vertically, which is the position most suited to withstand the strain of vibration. Diagrams are included in the catalogue to show that in practice the "Reason" system of reflectors and globes increases the efficiency by about 200 per cent. Thus the 16-c.p. lamps, instead of giving a mean of 32 c.p., give a maximum of 80 c.p. and a minimum of 32 c.p., or a mean of about 60 c.p. No pretence is made to compete with arc lamps, but, on the other hand, it is claimed that by the aid of these reflectors the cost of lighting with incandescent electric lamps is reduced to a minimum, enabling it to compete successfully with incandescent gas when using 80 watts per post. The Reason Manufacturing Company certainly deserve every encouragement in the efforts they are making to develop the use of electricity for street lighting, and a copy of their latest catalogue should be obtained by all who are interested in the question.

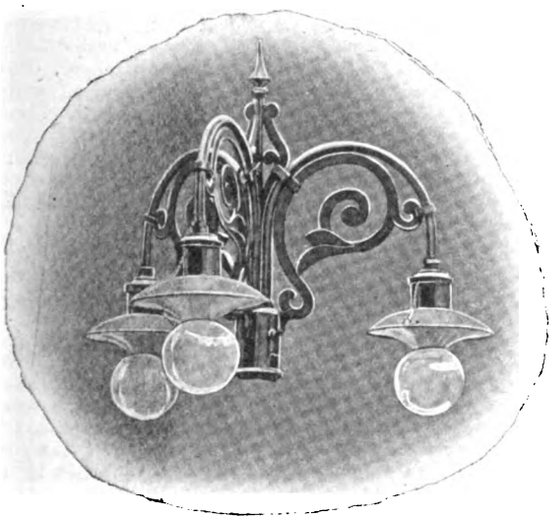

FIG. 1.—Reason Three-Way Lamp Bracket.

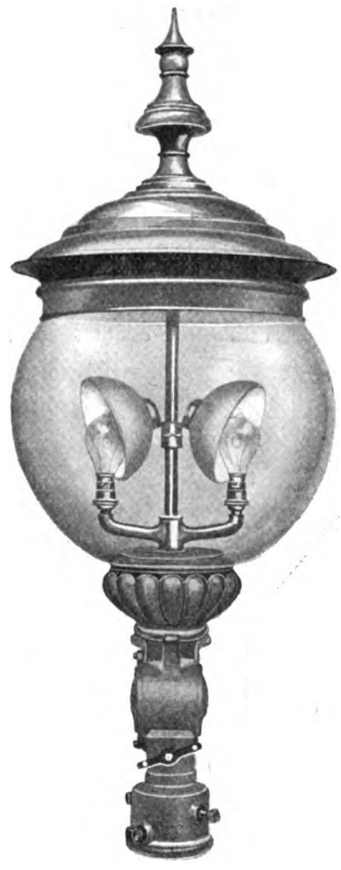

FIG. 2.—Reason Globe Type Lantern.

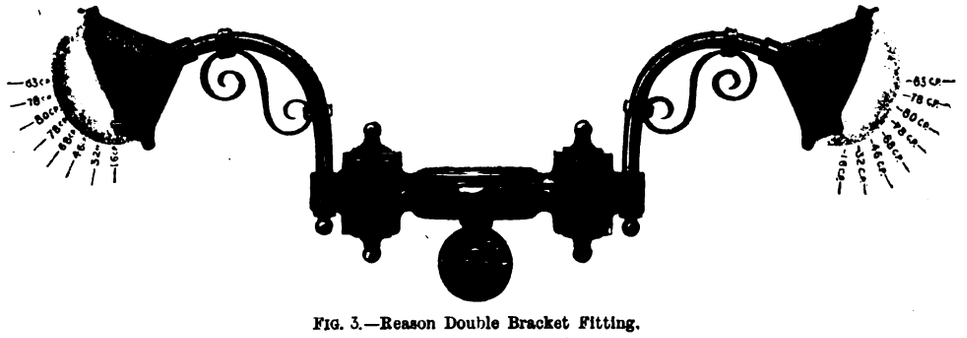

FIG. 3.—Reason Double Bracket Fitting.

New "Lundberg" Switches.

We illustrate herewith some new switches introduced by Mr. A. P. Lundberg, Pioneer Electrical Works, 477 to 487, Liverpool-road, Islington, N. The "pivot intermediate" switch (Fig. 1), Mr. Lundberg informs us, is the first switch of tumbler action, on a single base, ever produced for intermediate wiring—i.e., for controlling lamps from any desired positions in a circuit.

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Previously, turn-type switches have been employed throughout the circuit, or tumbler-type switches have been used for the terminal positions and turn-type switches for the intermediate positions, so that no uniformity existed. Occasionally, when tumbler-type switches were specified for use throughout, it was necessary to couple two two-way switches together for the intermediate positions. This meant an ugly fitting being employed and more complicated circuit connections. The

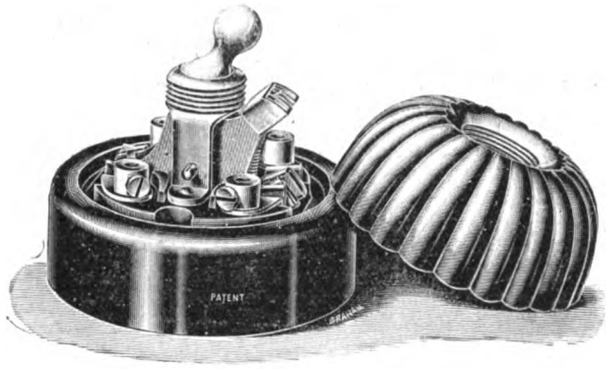

FIG. 1.

accompanying diagram of connections (Fig. 2) will show how simply the switches can be arranged. To Mr. W. H. Massey, M.I.C.E., are we indebted for the introduction in 1891 of this system, which ensures that all switches are on one pole, and consequently safe from short-circuiting faults. The method is found most useful for the lighting of corridors, staircases, or large rooms, allowing control from any door, floor, or position respectively. The "pivot intermediate," although a little higher, is of the same diameter as standard single and

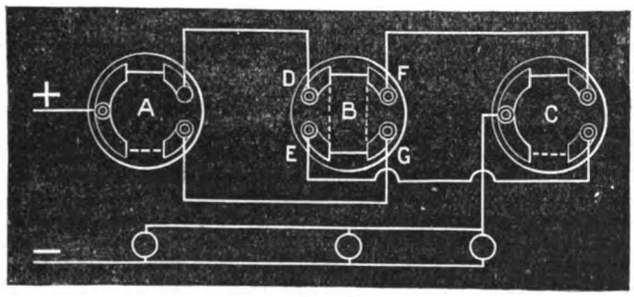

FIG 2.

two-way switches of the tumbler type, and all covers, etc., used with those switches are interchangeable with it. It has a patent variable leverage action, which is very definite. The patent *locked* type of cover can be fitted, and large size loop-in terminals are arranged, or it can be supplied for flush work, and all types of standard fronts, etc., are interchangeable. It may also be conveniently used as a reversing switch. Another application is its use as a parallel-series switch for hospital wards, nightlights in nurseries, etc., the removal of one of the copper contacts on the rocking contact arm being the only alteration necessary to convert it for this purpose. In the

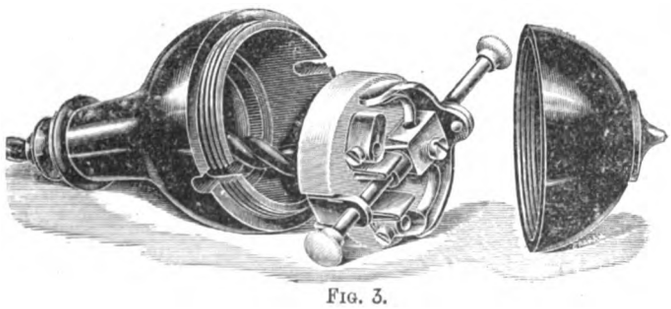

FIG. 3.

improved bowspring pear switch (Fig. 3) the current-carrying parts are mounted on a vitreous porcelain base. A wider break than in previous patterns is also arranged, in addition to improved terminals. The porcelain base is easily removable from its containing case, in order to facilitate wiring up. Samples of these switches submitted to us for inspection are of excellent finish.

Workshop Gauges.

A new catalogue recently issued by the Newall Engineering Company, Limited, Atherton's-quay, Warrington, deals with workshop gauges of the several types manufactured by the firm, who inform us they have now extended their well-known system to limit gauges, and make a number of new gauges. As an example of the latter, mention may be made of a very useful form of internal micrometer. This instrument has three measuring points, which are hardened and ground on the outside ends to a spherical form, the diameter of this sphere being somewhat below the smallest diameter the tool is intended to measure. These three measuring points are operated by means of a micrometer spindle contained in the body. The conical end of this spindle comes in contact with the inner ends of the three legs. As the spindle moves forward, so the three legs are thrust outwards until they come in contact with the sides of the hole that is to be measured. Fine springs keep the legs in contact with the conical end of the spindle. The thimble which operates the spindle is graduated to thousandths of an inch, and may be adjusted to take up wear. The legs are made interchangeable, so that one or two handles, with several sets of legs, will cover a range of sizes. The further contents of the catalogue include measuring machines, standard measuring rods, adjustable and fixed point external limit gauges, double setting and reference bars, standard snap gauges, surface plates, etc.

THE USE OF ELECTRICITY IN FACTORIES.

A circular letter has been issued to all occupiers of factories by the Home Office with regard to the use of electricity in factories, etc., accompanied by a draft of regulations which the Secretary of State proposes to make, in pursuance of Section 79 of the Factory and Workshop Act, 1901, for the use of electricity in factories and other places under that Act as follows:

FACTORY AND WORKSHOP ACT, 1901.

Draft Regulations for the Use of Electricity in Factories and other Places under the Factory and Workshop Act, 1901.

Whereas the generation, transformation, and use of electricity in electrical stations and in any factory, workshop, dock, wharf, quay, warehouse, or other place to which Section 79 of the Factory and Workshop Act, 1901, is applied by that Act has been certified in pursuance of the said Section 79 to be dangerous, I hereby in pursuance of the powers conferred upon me by that Act make the following regulations, and direct that they shall apply to all places named above, other than electrical stations, in respect of the distribution and use of electricity where the normal working pressure is greater than 250 volts and less than 650 volts between any two conductors:

1. All wires in connection with the supply shall, where practicable, be completely enclosed in strong metal casing, and where this is not practicable they shall be so arranged that there shall be no danger of any shock or of fire.

2. All main and branch circuits shall be protected by switches and by fuses or other automatic cut-outs.

3. The supply to every motor or arc lamp shall be controlled by means of an efficient switch, so placed as to be easily handled by the person in charge of the motor or arc lighting, and connected so that by its means all pressure can be cut off from the motor or arc lamp, and from any regulating switch resistance or other device in connection therewith. Provided, however, that where the arc lamps are connected in series across the outer conductors of a three-wire system and the pressure cannot exceed 250 volts from earth, it shall be sufficient if one such switch be provided for each series of arc lamps.

4. All switches and cut-outs shall be so enclosed and protected, or be in such positions or of such construction, that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

5. All metal holders for incandescent lamps, the frames of all motors, and the metal casings of all wires, switches, fuses, and cut-outs shall be efficiently connected with earth.

6. Where the electricity is derived from a public supply, the following conditions shall be observed: (*a*) A suitable safety fuse or other automatic cut-out shall be inserted in each service line, as close as possible to the point of entry into the premises, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box, but no fuse or cut-out shall be inserted in the intermediate conductor of a three-wire system. (*b*) All service lines and apparatus shall be highly insulated and thoroughly protected against injury to the insulation and against access of moisture, and any metal forming part of the electric circuit shall not, unless efficiently connected with earth, be exposed so that it can be touched. All electric conductors shall be so fixed and protected as to be free from risk of electrical discharge to any adjacent metallic substance. Provided that in regard to service lines and apparatus under the sole control of a person other than the occupier of the premises to which the supply is given, it shall be a sufficient compliance with Regulation 6 on the part of such occupier if he obtains from such person in the month of January in each year a certificate that the regulation is fully observed in regard to the said service lines and apparatus. Such certificate shall be produced at any time when required by H.M. inspectors of factories.

These regulations shall come into force on Jan. 1, 1905.

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LEGAL INTELLIGENCE.

DISPUTE ABOUT AN ELECTRIC METER.

Midland Electrical Corporation v. Parsons and Sons.

This action was tried at the Wolverhampton County Court on Monday before Judge Roberts. The plaintiffs were the Midland Electrical Corporation for Power Distribution, represented by Mr. R. C. E. Plumptre (instructed by Mr. Hayward), and the defendants (for whom Mr. J. Clarke, of West Bromwich, appeared) were Messrs. David Parsons and Sons, ironfounders, The Leys, Brierley Hill.

The plaintiff company sought to recover £46. 19s. 3d. for electrical energy consumed by the defendants at their works between Sept. 28 and Dec. 31, 1903.

Mr. Plumptre, in stating the case for the plaintiff company, said the defendants were under a contract to receive electric power from his clients at the rate of 4½d. per unit. On Dec. 21 a man named Bray, in the employ of the plaintiff company, went to the defendants' works to take the reading of the meter. According to his reading the meter on that date registered a consumption of 770 units. Bray was a man of very little experience, and it was evident he had made a mistake, because on a further reading of the meter on Jan. 5 it was found to register a consumption of 1,770 units, although during the interval the works had not been in operation, and no electrical energy had passed through. There might have been a leakage owing to a defect in the installation, but the company were not responsible for that.

Counsel called several employés of the plaintiff company, who gave evidence as to the readings of the meter at different times. One of the witnesses stated that on his visit to the works he found a leakage in the installation, and he reported his discovery to a member of the defendants' firm. On March 10 last the meter was taken out and tested, and it was then found to register 2,772 units. It was also found to be 7 per cent. slow on a full load. This was rather against the plaintiff company and in favour of the defendants.

For the defence it was stated that Messrs. Parsons had not had the benefit of the number of units for which they had been charged by complainants.

The case was adjourned for independent expert evidence in regard to the meter.

TRAMCAR COLLISION.

An action arising out of a collision between a tramcar and a wherry was heard last week in the Leeds County Court, before his Honour Judge Greenhow. The plaintiff, Richard Atkinson, mineral water manufacturer, of 190, St. Ives-terrace, Armley, sued the Corporation of Leeds to recover £37 damages sustained by his wherry in the collision. The Corporation counter-claimed £4 damages done to the tramcar.

Mr. Arthur Willey appeared for the plaintiff, and Mr. Coutts Trotter, instructed by the town clerk, represented the Corporation.

The collision occurred on Feb. 27 of this year on the Stanningley-road, in a blinding snowstorm. The plaintiff's wherry was crossing the road, when it was run into by a tramcar coming from Leeds. Both the wherry and the car were damaged, and a quantity of boxes and bottles on the former were smashed, whilst the driver was seriously injured. On behalf of the Corporation, it was contended that the driver of the cart was on the wrong side of the road at the time, was driving at an excessive speed, and disregarded the warning given by the driver of the tramcar.

His Honour found for the plaintiff, holding that the wherry was run into whilst it was crossing the road, and that the driver of the tramcar did not give sufficient warning. He awarded £15 damages.

The claim of the driver of the cart for £50 damages for personal injuries was not contested by the Corporation, Mr. Trotter, on their behalf, consenting to judgment for the amount claimed, with costs.

TRAMWAY COLLISION.

At the Westminster County Court last week, before his Honour Judge Woodfall, Messrs. Wild and Robbins, market gardeners, of Sipson, Middlesex, sought to recover damages from the London United Tramways, Limited, in respect of an accident at Isleworth, whereby one of their vans was damaged.

From the plaintiffs' story it appeared that a market van drawn by a small traction engine was proceeding towards Hounslow, following another van heavily laden with manure, etc., when the driver had to pull out on to the up track to pass a steam-roller. A car approaching from Hounslow was then 30 yards away, and the car driver not making any effort to stop, collided with the van.

Wm. Connell, driver of the traction engine, gave evidence in support, and in cross-examination admitted he had had several collisions with tramcars, and that the collision was the second he had had that day.

For the defence the **Car Driver** stated that he rang his gong on seeing the manure van coming, and when he was passing the van the traction engine suddenly shot out from behind the market van on to the track. He at once applied his brake,, and was almost stopped when the collision occurred.

Cross-examined: He was quite unable to see anything behind the first market van, as it was loaded up so high. He did not consider it necessary to stop his car when approaching laden vans in case anything should drive out from behind.

His Honour, in giving judgment, said he could not see there was any negligence on the part of the car driver, and if he accepted the proposition of the plaintiffs' counsel that the car driver should have stopped when he saw the first van in case any other vehicle should come out from behind, it would be an utter impossibility to run trams at all. Judgment for the defendants, with costs.

OVERCROWDING.

A conductor of one of the West Ham Corporation electric trams was summoned for carrying 20 passengers in excess. The bulk of the passengers were going to the football match between West Ham and Tottenham Hotspur. A police-inspector said the conductor could have had 30 policemen to help to evict the excess passengers if he had wanted; while the defending solicitor pointed out that the Act under which the defendant was summoned was passed in 1842, long before electric cars were thought of. "A string of cars ought to be allowed to stand so as to take the people away," said the chairman (Mr. Berry). "I can't understand the police acting in this way. I am speaking my own mind now. The summons will be dismissed."

ACTION AGAINST LANARKSHIRE TRAMWAYS COMPANY.

In Hamilton Sheriff Court Mr. David Colville, ironmaster, of Motherwell, sued the Lanarkshire Tramways Company for £40, representing the damage done to his brougham by its being run into by one of the defenders' cars. The Sheriff found that the driver of the car was only learning his business under an experienced driver, and the accident was caused by his failure to keep a proper lookout, while no fault was proved on the part of the driver of the brougham. Judgment for pursuer for £30. 13s., with costs.

WESTINGHOUSE METER PATENT.

With regard to the report that the Westinghouse Company are commencing an action against Messrs. A. W. Tait and Arthur Whittaker, receivers and managers of Ferranti Limited, for infringement of meter patent, we are informed the firm are defending this action, also that they are giving indemnities to anybody thinking it necessary.

COMPANIES' MEETINGS AND REPORTS

EDISON AND SWAN ELECTRIC LIGHT.

The twenty-first ordinary general meeting of this Company was held at Winchester House, Mr. Henry Wolfenden presiding.

In moving the adoption of the report and accounts (of which we gave particulars last week) the **Chairman** said that the quality of the manufactures and the costs were alike favourable, and the financial position had continued to improve. They had still to contend against active competition, which they were fully prepared to meet, and the Board's confidence in the future was unabated. Their stocks had been priced in the usual conservative manner. After providing £18,760 for debenture interest, £5,000 had been appropriated to depreciation of freehold and leasehold property—a much larger sum than in previous years—and £5,000 had also been allocated to depreciation of plant, this being about 6½ per cent. of the sum at which it stood in the books. They had written off £1,000 from tool account, stocks had been written down by £1,442, and the usual £1,000 had been provided for future stock depreciation. The balance of the Altrincham debt had been reduced by £1,466. As to the auditors' reference to this debt in their report, he considered that the Board were acting in a perfectly correct manner. They had no reason to assume that the debt was not a good one. The resolution for reducing the capital of the Company was confirmed by the Court on July 26 last. The amount cancelled, however, fell short of the debit balance brought forward last year by £3,589. This amount, therefore, had to be deducted from the credit balance brought into the net revenue account, leaving £5,302 to be carried forward. The Board were advised that, whether they wished or not, this sum could not be dealt with in any other way this time, the sanction of the Court having only been given after the termination of their financial year.

The report was adopted.

UNDERGROUND ELECTRIC RAILWAYS COMPANY OF LONDON.

This Company has issued its second annual report, covering the year ending June 30 last, and we append the balance-sheet: Share capital, £2,500,000; 5 per cent. profit-sharing secured notes, £7,000,000; amounts received in respect of construction contracts, £636,276. 10s.; liabilities in respect of parliamentary deposits, £203,093. 18s. 11d.; sundry creditors, credit balances, and retentions, £576,600. 18s. 8d.—total, £10,915,971. 7s. 7d. Freehold land and buildings at Lots-road, Chelsea, including expenditure to date on construction of generating station and transmission line, £826,553. 4s. 11d.; investments in stocks and shares at cost, £2,501,124. 10s. 9d.; parliamentary deposits (£292,493. 11s. 9d. Consols) at cost, £277,256. 2s. 5d.; cost of railway construction and expenditure chargeable to various construction contracts after crediting income from investments, £6,022,313. 8s. 7d.; discount on issue of 5 per cent. profit-sharing secured notes (issued at 96), £280,000; sundry debtors, debit balances, loans, and deposits, £51,843. 4s. 1d.; cash at London and Westminster Bank, Limited, £1,556,157. 11s. 2d. (profit-sharing secured notes trustee account); cash at short call and on hand, £400,723. 5s. 8d.—total, £10,915,971. 7s. 7d.

The ordinary general meeting was held on Tuesday at Hamilton House, Mr. Charles T. Yerkes presiding.

The **Chairman** said that the power-house at Chelsea was nearly finished. The electrification of the District Railway had been kept

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back somewhat by the manufacturers of materials and by the car builders, and while it was expected that electric trains would be on the railway by the first of the year, the whole of the line would not be running electrically at that time. The Baker-street and Waterloo Railway was progressing quite rapidly. The Company would be a little late there owing to the laying of the permanent way and the building of the street stations, but the delay would not amount to much. The Great Northern and Brompton and the Charing Cross, Euston, and Hampstead were going along as fast as could be expected.

Replying to a question, the **Chairman** stated that in all probability the first electric trains on the District Railway would be run from Ealing to the Mansion House.

The report was adopted.

The **Chairman** then moved a resolution to the effect that the directors be authorised to borrow a sum of money for the purposes of the Company not exceeding £850,000, and in doing so said that the present authorised amount would leave the Company a little short of the sum required, and the directors therefore asked for the authority to borrow the amount stated.

The resolution was carried.

NORWICH ELECTRIC TRAMWAYS.

The ordinary general meeting of this Company was held last week at the offices, 20, Bishopsgate-street Within, Baron E. B. d'Erlanger presiding. Particulars of the report for the year ended June 30 appeared in our issue of last week.

The **Chairman** said that satisfactory progress had been made during the year covered by the report, but the advance had not been quite so rapid as could have been desired. Taking into consideration, however, the bad state of trade throughout the country, and especially in the Eastern Counties, it was encouraging to find that the net income had exceeded that of the previous year, and was sufficient to allow the directors to recommend a dividend of 3 per cent. instead of 2½ per cent. In addition to paying the dividend, the directors proposed to place £1,200 to reserve, which would bring that fund up to £3,196. It would be the directors' policy to increase the reserve and to hold it as much as possible apart from the affairs of the Company. Of course, that object could be attained not only in buying trustee securities, but also by purchasing the Company's debentures, which yielded a better rate of interest than could be obtained on stocks specified in the Trustee Act.

The report was adopted.

ELECTROLYTIC ALKALI.

The report for the past year states that, after allowing for expenditure on maintenance of buildings, plant, and machinery, and for depreciation, the net profit amounts to £521; this, with £852 from previous year, is carried forward. The process is working well, but great depression exists in the market for bleaching powder.

NEW COMPANIES REGISTERED.

Scottish Electric Traction Company, Limited (Edinburgh).—Capital, £500. Objects: to promote, form, assist, and establish companies, syndicates, and associations for the purpose of carrying on any business or adventures of any description, whether relating to electrical enterprise or not, etc.

Amman Anthracite Collieries, Limited.—Capital, £3,000. Objects: to carry on the business of colliery proprietors, coke manufacturers, tin, terne, and black plate manufacturers, miners, smelters, engineers, electric light generators, steel converters, etc. Registered office: Brynamman, Glamorganshire.

Premier Light, Limited.—Capital, £3,000. Objects: to carry on the business of manufacturers, importers, and exporters of and wholesale and retail dealers in incandescent and other lamps, burners, mantles, and all apparatus and appliances used in connection with the employment, supply, generation, and distribution of gas and electricity, etc.

Hughes's Atlas Works, Limited.—Capital, £1,000. Objects: to adopt an agreement with the Industrial Bank, Limited, and to carry on the business of gas and electrical engineers and fitters, manufacturers of gasoliers, chandeliers, electroliers, and gas and electric fittings and appliances generally. Registered office: 9½, Union-court, Old Broad-street, E.C.

Muirhead and Co.—Capital, £50,000. Objects: to acquire the business carried on at Elmers End, Kent, under the style of Muirhead and Co., and to carry on the business of electrical, mechanical, and telegraph engineers and contractors, engine-builders, boilermakers, electricians, manufacturers of and dealers in dynamos, telegraphic instruments, wires, cables, insulators, and any apparatus and things required in connection with the generation, distribution, supply, regulation, accumulation, and employment of electricity, heat, steam, or other power.

APPOINTMENTS VACANT.

Draughtsman. See advertisement.

Improver, Mansfield. See advertisement.

Resident Agent or Manager for Singapore electric tramways.

Pupil, corporation lighting and power station. See advertisement.

Canvassing Engineer, Wolverhampton, Oct. 31. See advertisement.

Assistant Electrical Engineer, Erith Urban District Council. See advertisement.

Assistant to Canvasser, Woolwich, £2. 2s. per week, Oct. 22. See advertisement.

Engine-Driver, lighting and traction station in the Midlands, Oct. 31. See advertisement.

Assistant Electrical Engineer, Farnworth Urban District Council. Salary £120 per annum. Applications by 31st inst.

Lecturer and Demonstrator in Electrical Engineering, New Zealand Government. Salary £300; saloon passage. Oct. 29. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Melbourne.—The Federal Postmaster-General requires tenders for 6,000 yards of telegraph cable. Tenders by Nov. 15.

Crejour (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Middleton.—The Corporation invite tenders for dust destructor, boilers, etc., at the electricity station. Tenders by 25th inst.

Porto Alegro (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Pretoria.—The Commanding Royal Engineer at Army Head quarters, Pretoria, is calling for tenders for the electric lighting of cantonments.

Guirgia (Roumania).—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Ipswich.—The Corporation invite tenders for the supply of continuous-current meters for the ensuing 12 months. Tenders by 24th inst. See advertisement.

Mexico.—The Federal District Railway Company of Mexico require tenders for the electrification of six tramway lines in the town. Applications are to be made direct.

Richmond (Surrey).—The Guardians invite tenders for the installation of electric telephones at the workhouse, Grove-road. Tenders to the Guardians by 4 p.m. on 27th inst.

Pangbourne.—Tenders are required for lighting the village during the coming winter, for the Pangbourne Parish Council. Particulars may be obtained of Mr. C. West, jun., clerk.

Rugby.—The Urban District Council invite tenders for the supply of about 440 yards of ·15 three-core low-tension paper-insulated and lead-covered cable. Tenders by 25th inst. See advertisement.

Erith.—Tenders are invited for material and work in connection with the installation of electric light at the Education Committee's offices at Picardy, Belvedere. Tenders by Nov. 11. See advertisement.

Liege.—Tenders are required for the construction and working (concession) of three electric tramways. A deposit of £400 is required. Particulars from the Provincial Government, Liège. Tenders by Nov. 14.

Darlington.—The Darlington Co-operative and Industrial Society, Limited, invite tenders for installing the electric light in their offices in Priestgate, and their premises now in course of alteration in Corporation-road.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Cumberland and Westmoreland Lunatic Asylum, Carlisle.—Tenders are required for plant. Copies of tender may be inspected at the office of the Consulting Engineer, Electricity Works, Northallerton, Yorks. Tenders to the Clerk to the Committee of Visitors by Nov. 1.

Mexico.—A consular report states that there is at present a demand for the undermentioned classes of manufactures: electrical accessories for street railways, including traction, rolling-stock, rails, posts, cables, etc., electric conduits, electric motors and other accessories for motive power, irrigating machinery, steam and electric.

Rochdale.—The Tramways Committee require tenders for the wiring of car depôt. Applications, with £1. 1s. deposit, to Mr. C. C. Atchison, borough and tramways electrical engineer, Rochdale. Extra copies 5s. each. Tenders, endorsed "Car Depôt Wiring," to be addressed to the Town Clerk, Town Hall, Rochdale.

Sunderland.—The Corporation invite tenders for the supply of two 300-kw. three-phase generators, 5,500 volts, to be coupled to existing Belliss engines, and two 300-kw. synchronous three-phase motors, 5,000 volts, to be coupled to existing multipolar Silvertown dynamos. Tenders by 28th inst. See advertisement.

Liria (Spain).—The Alcalde requires tenders for the public lighting by electricity of the town, in accordance with conditions which can be seen at the office of the Secretary of the Municipality. The total amount of candle-power required will be 2,000, and the basis of the contract will be an annual payment of 6,000 pesetas (about £175).

Madrid.—An application has been received from Don José Xinxo for a concession for an electric tramway starting from the Plaza Rovira in Gracia and terminating at San Juan de Horta. The notice is published with a view to eliciting any applications for the same concession on more advantageous terms; such applications to be made by Nov. 10.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will

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be supplied to applicants by the Council's agents, Messrs. John Peok and Co., 63, Leadenhall-street, London, E.C. Tenders by March 31.

Craiva (Roumania). — The *Moniteur des Intérêts Matériels* (Brussels) announces that the adjudication will take place at 4 p.m. on Oct. 25 (Nov. 7) at the Mayoralty of Craïova, of the concession for construction and working of a line of tramways (mechanical traction) in the town of Craïova. The duration of the concession is fixed at 50 years. A provisional deposit of £200 is required.

South Africa.—Orders for the supply of plant and material for the electric lighting of Vryheid will shortly be placed. Orders for 300 direct-current and 300 alternate-current meters, also for 600 fuse boxes, have just been placed by the Johannesburg Municipality. The directors of the Nourse Deep gold mine are arranging for an extension of their electrical plant.—*British South African Export Gazette.* We refer to the forthcoming contracts for Port Elizabeth (£90,000) and other South African towns in another column.

La Rochelle (France).—The Chamber of Commerce will shortly issue tenders for a crane with a lifting power for 30 tons. The beam, or the part which projects over the water or vessel alongside, should be long enough to unload from a point about 26ft. 6in. from the edge of the quay. The height of the distal end above the quay should be 15m. (49·21ft.); the vertical distance between the edge of the quay and that part of the crane directly over it, 8m. (26·4ft.). A locomobile is preferred, but should the conditions be unfavourable for installing such a machine, then a fixed crane would be adopted.

Switzerland.—The *Feuille Fédérale Suisse* of Oct. 5 contains the text of a decree of the Swiss Federal Assembly, granting a concession for the construction and working of a narrow-gauge electric railway from Sierre to Inden or Rumeling, to a syndicate formed by MM. O. Zen-Ruffinen and H. Gentinetta, of Louèche, and three other gentlemen. The capital to be raised for this purpose is fixed at 2,000,000fr. (about £80,000). The *Feuille* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegraph Office Yard, Thursday Island, of 109 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Watford.—The Urban District Council have accepted the tender of Messrs. Clifford and Gough, at £3,745, for additions to electricity works.

Foreign Contract.—Messrs. W. F. Jones and Co., of 50, Cannon-street, E.C., have secured a contract from the Brussels Corporation for 500 iron-clad three-wire house-service fuse boxes.

West Ham.—The Town Council have accepted the following tenders for material required in the electrification of the tram system in Romford-road and Leytonstone-road: 4,000 to 5,000 tons granite pitchers, Griffiths and Co.; 870 tons British steel rails, etc., P. and W. McLellan; points, etc., E. Allen and Co. (Askhams, Limited).

Johannesburg (South Africa).—The contract for lighting and tramway cables, amounting to £106,377, for the municipal scheme, has been awarded to W. T. Glover and Co., Manchester; and that for copper wire and cables, £10,789, to the British Insulated and Helsby Cables, Limited, Prescot.—*British and South African Export Gazette.*

Weymouth.—The Town Council have received the following tenders for the wiring of 12, Gloucester-row:

Ekless Bros. and A. W. Hine, Victoria-arcade (accepted)	£24	18	0
W. Gee, 28, Abbotsbury-road	33	15	0
W. Dickinson, Highfield, Bexleyheath, Kent	32	10	0
C. Jett, 7, Queen-street	30	16	0
W. D. Orchard, Market House	29	15	0
H. J. Rider and Co., 27, Chancery-lane, London, W.C.	48	0	0
R. J. Nicolson and Co., 26, Cannon-street, Manchester	48	6	6

London County Council.—The following tenders have been received for the first portion of the Greenwich generating station:

Steam, exhaust, and other piping, valves, etc.

J. Spencer, Limited, Wednesbury*	£9,785	2	0
Stirling Boiler Company, Limited, Motherwell	9,792	15	9
Mechan and Sons, Limited, Glasgow and London	9,884	5	0
S. Russell and Sons, Leicester	10,095	19	0
Foster Bros., Limited, Wednesbury	10,145	14	11
Aiton and Co., London	10,530	19	6
T. Piggott and Co., Limited, Birmingham	10,559	10	0
E. Le Bas and Co., London	10,592	15	0
Westwood and Wrights, Brierley Hill, Staffs	10,801	0	0
J. Musgrave and Sons, Limited, Bolton	11,242	7	4
T. Potter and Sons, London	11,247	2	3
Hefford and Shuttlewood, Limited, Leicester	11,513	3	6
J. G. Moore, Hartlepool	11,940	18	9
J. Fraser and Son, London	15,468	9	0

* Recommended for acceptance, with sub-contractors as follows: Holwell Iron Company, Melton Mowbray, cast-iron work; T. Piggott and Co., Birmingham, riveted pipes; Cape Asbestos Company, London, pipe covering.

Condenser and other piping, valves, etc.

J. Oakes and Co., Alfreton*	£6,418	13	1
Sir Hiram Maxim's Electrical Engineering Company, London	6,486	12	3
J. Spencer, Limited, Wednesbury	6,725	2	10
Aiton and Co., London	6,910	15	10
Holwell Iron Company, Limited, Melton Mowbray	6,974	12	5
J. Musgrave and Sons, Limited, London	7,365	0	0
E. Le Bas and Co., London	7,430	9	2
Sheepbridge Coal and Iron Company, Chesterfield	8,014	8	0
Westwood and Wrights, Brierley Hill, Staffordshire	8,473	0	0
Clayton, Goodfellow, and Co., Limited, Blackburn	11,668	0	0

* Recommended for acceptance.

Centrifugal and other pumps, motors, strainers, etc.

Electric Construction Company, Limited, Wolverhampton*	£8,083	0	0
J. Cochrane, Barrhead, Glasgow	8,500	0	0
Gwynnes, Limited, London	8,575	0	0
Entwisle and Gass, Limited, Bolton	9,050 / 9,105	0	0
Vickers, Sons, and Maxim, Sheffield	9,071	0	0
Bruce Peebles and Co., Limited, Edinburgh	9,795	0	0
W. H. Allen, Son, and Co., Limited, Bedford	9,800	0	0
British Westinghouse Electric and Manufacturing Company, Limited, London	9,807	0	0
E. Scott and Mountain, Limited, Newcastle-on-Tyne	9,921	3	0
Johnson and Phillips, Limited, London	10,228	15	0
Electrical Company, Limited, London	10,319	10	0
A. Barclay, Sons, and Co., Limited, Kilmarnock	10,500	0	0
J. Thom, Patricroft, Lancs. (incomplete tender)	120	10	0
Mirrlees-Watson Company, Limited (incomplete tender)	652	0	0

* Recommended for acceptance, with sub-contractors as follows: Dryadale and Co., Glasgow, centrifugal pumps; Edward's Air-Pump Syndicate, London, air-pumps; F. Pearn and Co, Manchester, artesian well pump; J. Thompson, Wolverhampton, fixed strainers; H. Wallwork and Co., worm gearing.

For the supply of three electric car traversers—two for the New Cross car-sheds and one for the Camberwell car-shed.

C. and A. Musker (1901), Limited, Liverpool*	£1,456	10	0
Jessop and Appleby Bros., Limited, Leicester	1,534	6	6
Hurst, Nelson, and Co., Limited, Motherwell	1,646	8	0
Ransomes and Rapier, Limited, London	1,765 / 2,005	10	0
J. Hitchin and Son, Limited, Halifax	1,773 / 1,855	15	0
Dick, Kerr, and Co., Limited, London	1,828	4	0
Brush Electrical Engineering Company, Limited, Loughborough	1,850	0	0
Heenan and Froude, Limited, Worcester	1,872	3	0
R. W. Blackwell and Co., Limited, London	1,950	0	0
Cowans, Sheldon, and Co., Limited, Carlisle	1,955	0	0
J. Buchanan and Son, Liverpool	2,299	11	6
J. M. Henderson and Co., Aberdeen	2,405	0	0

* Recommended for acceptance.

Weston-super-Mare.—The Urban District Council have received the following tenders for the supply and fixing of a 5-h.p. motor engine for the town yard:

Oaks and Sons (accepted)	£43	5	0
Hillman and Sons	43	8	0
F. C. Stephen	45	10	0
Brush Electrical Engineering Company	50	10	0
Bryant and Sons	55	6	6
Star Engineering Company	62	11	6
Leaver and Fox	73	10	0

BUSINESS NOTES.

TRACTION.

Aberdeen.—A sum of £225,000 is to be borrowed for finishing the incomplete routes.

Bury, Rochdale, and Oldham.—The transfer of the company's undertaking was formally carried out last week.

Dover.—The Tramways Committee are to consider the question of constructing a light railway to join the tramways.

Blackpool.—Penny fares on the Promenade and Morton sections of the Corporation tramways have been decided upon by the General Purposes Committee.

Leith.—The sub-committee appointed by the Corporation to visit the tramways systems of other towns unanimously recommend the overhead principle. Preliminary arrangements are now being made for the work of conversion.

Lancashire and Yorkshire Railway.—It is reported that the company intend to erect a station in the near future between Marsh-lane and Seaforth on the electrified section of their railway.

Edinburgh.—The Lord Provost's Committee recommend that the application of the lessee company, referred to in our issue of the 7th inst., for a reduction of £50,000 in the capital sum, upon which rent is to be charged, be not entertained.

Huddersfield.—The receipts for the six months to the end of September total £37,371, and the total working expenses amount to £19,199. After allowing £12,390 for interest and redemption of debt, but making no allowance for depreciation, there is a net surplus of £5,781.

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Proposed Electric Railway.—The old scheme of an electric railway between Dundee and Stanley is again attracting attention in Perthshire. It may be remembered that some time back futile attempts were made to induce one of the railway companies to undertake the scheme.

Beckenham.—The Urban District Council having received an enquiry from the British Electric Traction Company as to whether the Council would be able to supply energy for the working of the Penge tramways, and upon what terms, the Council desire the company to state when they are likely to require the current.

Keighley.—The tramways were opened last week. Major Pringle, R.E., who inspected the system on behalf of the Board of Trade, expressed his entire satisfaction with it. The service was promptly opened to the public, and is being well patronised.

Yarmouth.—The Council have confirmed the recommendation of the Tramways Committee that notice be served upon the Gorleston Tramways Company requiring them to sell, and a committee has been appointed to negotiate with the company. The Board of Trade have approved the extension from St. Peter's-road to Queen's-road.

Perth.—The Council have ultimately arrived at a decision in regard to the tramways, which are to be electrified. Mr. Lambert, the electrical engineer, states that a more powerful engine will be introduced at the generating station, and that the Corporation will be able to provide power for the tramways under highly economical conditions.

Derby.—We are pleased to learn that the question of delay in the execution of works between the Corporation and Messrs. J. G. White and Co., Limited, has been amicably settled. It is understood that the work actually carried out was largely in excess of the contract requirements and involved numerous changes in the specifications. This naturally caused the time for completion originally specified to be exceeded.

Halifax.—The new double line of tramway connecting Bailiffe Bridge and Brighouse has been opened. When the proposed Bradford extension from Wyke to Bailiffe Bridge is carried out—as is hoped to be done before 12 months have passed—it will be possible to travel from Bradford to Brighouse, a distance of seven miles, entirely by electric tramcar, at a cost of 4d. The Lancashire and Yorkshire Railway have forwarded to the Sowerby District Council a protest against the suggestion that, in consideration of the Corporation extending the tramways to Sowerby, that authority should remit the district rate on such property for five years.

Leeds.—The accounts for the half-year from March 26 to Sept. 29 show receipts totalling £161,089. 5s. 10d., as against £151,367. 15s. for the corresponding six months last year, an increase of £9,721. 10s. 10d. The advance is attributed to better weather and the introduction of the split-turn system of working. There was an increase in the working expenses of £2,865, the total being £83,500, as against £80,635. The estimated gross profit was £77,585, and after the deduction of charges for depreciation, interest, and sinking fund, it is expected there will be a net profit of £39,293. 15s. 5d. This is an increase of £2,403. 9s. 5d. over the net profit in the corresponding half-year.

Bury.—A deputation from the Ramsbottom District Council attended upon the Tramways Committee last week with a view to the extension of the Tottington section. The matter is receiving the attention of the committee. The Bolton Corporation have intimated their consent to the Bury Corporation obtaining powers to lay tramways to the borough boundary at Ainsworth. As a consequence of this the Bolton Corporation have rescinded a resolution arrived at by them some time ago to themselves apply for powers to extend their Bury-road tramways. Another conference has been held in reference to the Heywood tramways, and although a final decision has yet to be arrived at, it is understood that further progress with the negotiations was made.

Heywood.—At the meeting of the Town Council, a desultory discussion ensued as to the negotiations with Bury and Rochdale. The Chairman of the Electricity and Tramways Committee, replying to the criticisms that had appeared in the local Press to the effect that the dust destructor ought to be used for driving the tramways, stated that the refuse at Heywood was much inferior to that at some of the towns where the destructor was employed for this purpose, so that he did not think there would be any advantage in connecting the destructor with the electrical works. He mentioned that the borough electrical engineer had told him there were times when the heat generated by the destructor was so low that it would not work even a small mortar mill. The borough and electrical engineers have prepared a report on the matter, which agrees with the views expressed by the chairman.

Bournemouth.—The arbitration proceedings to determine the costs to be paid by the Corporation for the undertaking of the Poole and District Electric Traction Company were resumed last week. The amount claimed by the company is £420,589, and the following are the valuations of the experts. For the company: Mr. Sellon, £420,589; Mr. More, £458,525; Mr. Hammond, £483,778; Mr. Dickenson, £59,237; and Mr. Conachy, £377,732. For the Corporation: Mr. Waller, £70,400; Mr. E. M. Lacey, £66,174; Mr. F. W. Lacey, £55,379; and Mr. Baker, £58,947. Mr. J. B. Hamilton, tramway manager at Leeds, who was called on behalf of the Corporation, estimated the value at £70,659. The evidence on both sides having been concluded, Mr. Lloyd, K.C., addressed the arbitrators on behalf of the Corporation, and characterised the company's claim as "a grossly exaggerated and extravagant" one.

Leamington.—At the meeting of the Town Council the Tramways Committee reported that they had received a letter from the engineer of the British Electric Traction Company enclosing a set of plans in duplicate showing a single line of tramway, with occasional passing places, throughout the borough, proposed to be laid by the tramway company, and stating that such plans cancel those showing a double line submitted on Aug. 5, 1903. The committee recommended that such plans be disapproved for the following (amongst other) reasons: (1) that 4in. by 5in. sett paving was shown in certain streets, whereas the tramway company had agreed to lay wood paving throughout the borough; (2) that the type of pole approved by the Council for use in Victoria-terrace and The Parade could not be used if a single track were laid; and (3) that for an efficient electric tram service the proposed single track would be unsuitable. The report was adopted.

Croydon.—The Corporation have decided to include the following further extensions of the tramway system in their Bill: (*a*) an extension of the tramways system from Lower Addiscombe-road along Morland-road, Woodside, and Portland-road to near Norwood Junction Station. (*b*) An extension from Thornton Heath terminus to the Gloucester public-house, Whitehorse-road (agreed to by the Council on Oct. 27, 1902. This to be a single line with turn-outs. (*c*) An extension from High-street, South Norwood, along South Norwood-hill to its junction with Church-road. This to be a single line with turn-outs. The following provisions are also to be inserted: (*a*) borrowing powers for extending the Thornton Heath and Purley depôts, and for the provision of new cars; (*b*) power to run omnibuses. The Corporation have decided to oppose the application of the British Electric Traction Company for an extension of three years in which to complete the Mitcham Light Railway. A depôt is to be constructed in Morland-road.

Bradford.—The question of the trams passing under the railway bridge at Eccleshill was discussed at Monday's meeting of the Tramways Committee. The Board of Trade inspector objected to the limited distance between the upper deck of the cars and the bridge. It appears, however, that the Corporation have a number of cars, including those taken over from the Mid-Yorks Tramways Company, which allow of the necessary clearance, so these will be utilised for the Greengates route. At a meeting of the Tramways Committee on Monday a report on the year's working was adopted. We have already published particulars of the accounts. Reference is made to some minor extensions which have been made, and it is considered that practically every part of the city is well served, so far as tramways are concerned. In pursuance of the policy of undertaking the electrical equipment of sections without the aid of contractors, the committee are pleased to state that this work has again been executed by the department with very satisfactory results. The route length of the tramways worked by the Corporation now totals 53 miles. Roughly speaking, the committee maintain two-thirds of the surface of these streets with granite paving.

Belfast.—At Monday's meeting of the Tramways Committee it was reported that the London County Council had granted permission to Mr. A. Young to act as valuer, on the understanding that the Belfast Corporation would take up the minimum amount of his time and that he should receive no fee. The advisability of having the overhead telephone wires removed so that they might not interfere with the electric traction wires was discussed, and it was decided to give notice to the National Telephone Company in the terms of their agreement with the Corporation, this notice to expire in May next. It was also decided that an endeavour should be made to effect an arrangement on similar lines with the postal authorities. The tramways manager (Mr. A. Nance) intimated that he would require the assistance of an architect in making the necessary alterations at the car depôts, but he believed this work could be done for a less sum than had been anticipated. Alderman Wm. M'Cormick moved, and Councillor Thompson seconded, that Messrs. Graeme Watt and Tulloch should be appointed architects for this and other work. It was resolved that the work in connection with the tramway depôts should be carried out by the Corporation's own staff. A letter was received from the Belfast and County Down Railway Company, stating that their engineer was prepared to consult with the city surveyor in regard to the proposed raising of the bridge at Bridge End. It was agreed that Mr. Nance's office should be connected with the telephone exchange.

Cardiff.—The annual report of the tramways manager (Mr. Arthur Ellis) was before the committee last week. This shows that the total income from all sources amounted to £108 442. The working expenses totalled £68,474. 4s. 2d., leaving a gross profit on the undertaking of £39 964. 7s. 11d. The surplus income was dealt with as follows: interest on loans and repayment of principal, £33,601. 9s. 5d.; estimated profit allocated to relief of rates, £642; payment out of revenue for construction of Fair Oak-road loop, £403. 0s. 4d.; leaving a surplus balance for disposal amounting to £5,317. 18s. 2d. The expenditure on claims account amounted to £1,185. 10s. 3d., leaving a surplus of £1,361. 6s. 11d., which, added to the total amount brought forward last year, made a total insurance fund of £2,950. 10s. 9d. The actual net surplus balance for the year was really £7,724. 5s. 5d., and he recommended that £9,137. 0s. 4d. should go towards the creation of a reserve fund to meet the heavy payments that would come upon the department in future for the maintenance and renewals, particularly of the permanent way. Considerable discussion took place on this recommendation, Mr. Ellis pointing out that all repairs and renewals to the overhead wires and cars, etc., were paid for out of revenue, and there was practically no depreciation in those respects, but some years hence the permanent way would have to be renewed, and it was advisable to have a reserve fund for this purpose. Some of the members could not quite see how there could be no depreciation in the cars, overhead wires, etc., and Mr. Ellis explained that so far as the overhead equipment was concerned, as soon as a piece of wire was worn it was replaced by a new piece, and in the course of time all overhead wires would be renewed in that way out of revenue. In the same way the cars were renewed as each portion of them became worn out. Councillor Crossman thought Mr. Ellis's remarks constituted a strong argument in favour of the establishment of a works department. Mr. Ellis pointed out that the loan charges were increasing, and the revenue

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was stationary as they were carrying as many passengers as they could expect to do, the whole of the population of Cardiff being carried in the cars nearly three times a week. The time had come, therefore, to consider the question of raising the fares on some of the routes. This matter, however, is to be considered at a special meeting to be held in November. Mr. Ellis's recommendation in regard to the creation of a reserve fund was adopted.

London County Council.—The Council have arranged with Messrs. J. G. White and Co., Limited, for a reduction by £1,569 of the contract price of £95,000 for the reconstruction of the Kennington-Streatham section, as after the contract had been prepared it was decided to suspend the tram traffic, thus saving the contractors from providing a temporary track. The Highways Committee of the Stoke Newington Borough Council recommend that the Council assent to the overhead system for the tramways on the Moorgate-street to Manor House route, having regard to the material difficulties and expense in connection with the conduit system. The same committee further reported that, pursuant to reference, they had reconsidered their recommendation with respect to the application of the County Council to the Board of Trade to sanction the use of a centre conduit slot, 1in. in width, in lieu of a slot ⅜in. in width on certain of the County Council tramways, including those in the Stoke Newington-road, High-street, and Stamford-hill. The committee instructed the borough surveyor to inspect the Bournemouth tramways constructed on the side or rail slot principle, and having heard his report, directed a communication to be addressed to the Board of Trade to the following effect: "That the Council was unable to approve of the proposal of the London County Council for a 1in. slot in the centre of the track in lieu of the ⅜in. slot previously proposed, and was, moreover, of opinion that it was desirable that one of the rails should be adapted for a slot for the plough in lieu of putting the same in the centre of the track as suggested. This system had been successfully worked in other places, and it must be apparent that the fewer rails there were in the road the less the public disadvantage. That the Council also desired to draw attention to the undesirability of putting the covers of the insulator boxes level with the surface of the road. It was proposed to place four of these covers across the track at every 15ft., but by placing the same under the paving a better surface to the road could be maintained. The Council have rejected as grandmotherly legislation a proposal that all cars, buses, etc., plying for hire should be compelled to exhibit a list of fares outside the vehicle; and on the ground that they had already made sufficient concessions, the Council also rejected the following proposition: "That it be referred to the Highways Committee to consider and report upon the practicability of granting to clerks and all women workers using the Council's tramcars before 9 a.m. the privilege of travelling at the reduced fare now enjoyed by all working-men up to 8 a.m."

LIGHTING AND GENERAL.

Bishop Stortford.—Application is to be made for an electric lighting provisional order.

Dudley.—The profit on the municipal electrical undertaking for the past year amounts to £650.

Bermondsey.—The treasurer's accounts of the electric undertaking shows a credit balance of £512.

Hornsey.—The Borough Council have decided to supply current to depôts and schools at a uniform charge of 4d. per unit.

Removal.—Mr. A. S. E. Ackermann, A.C.G.I., A.M.I.C.E., has moved into larger offices at 25, Victoria-street, Westminster.

Croydon.—An extension of mains in Melfort-road, suggested by the borough electrical engineer, is to be carried out at a cost of £560.

Leek.—The Urban District Council are raising £600 as part of a loan of £1,800 sanctioned in respect of the electricity department.

Wolverhampton.—The Town Council have approved extensions of lighting mains at an estimated cost of £220 and £645 respectively.

Leeds.—The Lighting Committee have decided to recommend the Council to extend the supply of current for lighting purposes to Kirkstall.

Whitby.—The Urban District Council proposes to promote a Bill which includes power to wire private premises for electric light and to let out electric apparatus.

Greenock.—The units of electricity generated during the month of September amounted to 139,856, as compared with 113,272 in the corresponding month of last year.

Cheshunt.—Consequent upon an enquiry by the Board of Trade, the Council have decided to inform that authority of the steps they are taking to carry out their electricity supply order.

Stamford.—A committee has been appointed to report upon the cost of electric lighting and heating at the union house. It is stated that at present the cost at the house is about 2d. per unit.

Sale of Plant.—Particulars of various sales of plant, including an electric lighting plant suitable for country residence, a 50-b.h.p. Tangye gas-engine, and 1-h.p. motor, appear in another column.

Ipswich.—The Council have entered into an agreement with the General Electric Company, Limited, to supply motor installations for use within the borough upon terms for a period of seven years from the 19th inst.

Margam.—The District Council on Monday, after discussing the draft agreement with the South Wales Electrical Power Company, resolved to eliminate clause 11 giving the company power to provide energy for collieries and works.

London County Council.—On Tuesday it was reported that the period for the repayment of the loan of £1,415,000 to St. Marylebone has been fixed at 38 years. The tramway offices of Camberwell are to be wired and fitted at a cost of £350.

Wireless Station.—The wireless telegraphy station at Ushant is now open for business, the charge being 7½d. per word in addition to the ordinary telegraphic rate. All telegrams must bear after the address the word "Radiotelegramme."

South London Electric Supply Corporation.—The company reports having sold during the first nine months of the current year 6,590,572 units, as against 2,788,400 units for the corresponding period of last year, showing a gross revenue of £51,009 as against £27,065.

Pembroke.—The new electric generating station at the dockyard is approaching completion. The present contract is for five miles of trenches, and in each trench two, three, or more ducts are laid. Each contains three cables, giving a total of 40 or 50 miles of electric cable.

Stratford.—The Town Council have resolved to enter into negotiations with the Birmingham Installation Company with a view to an arrangement with them, subject to the sanction of the Board of Trade, to transfer to them upon terms to be agreed upon the Council's powers under the electric lighting provisional order.

Dunfermline.—The Town Council have decided to engage Mr. William Brooks Sayers, M.I.E.E., Glasgow, to furnish an independent report as to the Council's position with regard to electric supply, and the best course to pursue, whether under agreement with the Fife Electric Power Company or independently of that company.

Holyhead.—The Urban District Council have referred back to committee a recommendation that £60 be expended on the electric works house to place it in a fit condition as residence for the electric engineer. The work of connecting Holyhead with the telephonic trunk is to be proceeded with at once, private persons having become guarantors for £101. 15s.

Marconi Wireless Telegraphy.—A contract has been awarded for the dismantling of the present Marconi wireless telegraphy station at Table Head, Cape Breton, and for the removal of the towers four miles inland. The construction work will be completed by Jan. 1 next. The station will be the most powerful yet erected by the Marconi Company.

Stock Exchange.—The Stock Exchange Committee have ordered Metropolitan Railway £3,611,558 3½ per cent. preference stock, £1,110,715 3½ per cent. "A" preference stock, £3,601,278 3½ per cent. debenture stock, and £335,214 3½ per cent. "A" debenture stock, in lieu of the preference and debenture stocks now quoted to be quoted in the official list.

Montrose.—At the last Town Council meeting a motion for the appointment of a committee to reconsider how the Corporation might acquire the whole of the electric lighting plant in the burgh found no seconder. It was contended that the negotiations would take some time, and it was in the ratepayers' interest to purchase the plant. The company had made £11,000 of profit.

Caversham.—The Urban District Council last week decided in favour of taking steps to obtain a provisional order authorising the Council to supply electricity for any public or private purposes within the district. No actual move has yet been made, because the attendance at the meeting was so small that the members would not take the responsibility of incurring the expense.

Eastern Telegraph Co.—After payment of interest on the debenture stock, dividend on the preference stock, and the interim dividend of £1. 5s. per cent. on the ordinary stock, there remains a balance available sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent. (both tax free) on the ordinary stock, making a total distribution of 7 per cent. for the year ended March 31.

Willans and Robinson, Limited.—According to a statement by Mr. Mark Robinson at the recent general meeting, the above firm proposes to take up the manufacture on a large scale of the Diesel engine. We are informed that this move is being made under a manufacturing arrangement with the Diesel Engine Company, Limited, of London, with whom the selling rights remain and who will deal with all enquiries.

Geltsdale.—The Postmaster-General's offer to provide and maintain a double-wire circuit fitted with four telephones between the waterworks engineer's office, Fisher-street, Carlisle, and the attendants' cottages at Cumwhintom, Castlecarrock, and Binney Bank, for an annual rental payable in advance of £141 under an agreement for 10 years, has been accepted. Messrs. Mansergh are to have the work between Carlisle and Castlecarrock put in hand at once.

Callender's Cable and Construction Co.—The directors have decided to pay an interim dividend of 5s. per share, being at the rate of 10 per cent. per annum, on the ordinary shares of this company. The ordinary share register will be closed from the 20th to 31st inst., both days inclusive, for the purpose of preparation of such dividend, and the warrants will be payable on Nov. 1. Sir J. Fortescue Flannery, M.P., has been elected a director in place of Lieut.-Colonel G. A. Elliot, deceased.

Islington.—At to-night meeting it will be proposed (1) that the salary of Mr. Percy E. Rycroft, the assistant engineer and works manager at the electric lighting station, be increased to £250 per annum as from the 25th inst.; (2) that increased siding accommodation be obtained at the electric lighting station from the Great Northern Railway Company, the company having intimated that for an annual payment of £5 they will construct an additional siding; (3) that £368 be expended upon extension of mains.

Woolwich.—We understand that at a meeting of the Woolwich Non Political Ratepayers' Association last week the following resolution was carried: "That in the opinion of this association the immediate extension of the electric lighting and power works at Shooter's Hill, Eltham, and Lee Green is desirable both from a business and economic point of view, and this association trusts that the Borough Council will decide to adopt the scheme submitted by the Electricity Committee on Sept. 29, with a view of carrying on the same."

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Perth.—The electric light has been introduced into St. Paul's Established Church. There are 113 16-c.p. lamps, the gallery being lighted by electric standards, and the body of the church by electroliers. Messrs. M'Leish, Morrison, and Co., Mill-street, Perth, were the contractors. The work was carried out according to specifications drawn up by Mr. Lambert, the electrical engineer, while the fittings have been supplied by the Ediswan Company.

Huddersfield.—The borough electrical engineer's last report shows that at the beginning of October there was a total of consumers amounting to 1,974, as against 1,954 in September, an increase of 20, whilst there were 135,468 lamps connected, being an increase of 1,255 over the number in September. The total length of mains on Oct. 1 was: primary, 88,485 yards; secondary, 63,864 yards. In connection with the proposed supply to Golcar, it has been decided to apply for sanction to borrow £4,300. Mr. A. V. Anderson has been appointed junior assistant at a salary of £78 per annum.

Oriental Telephone and Electric Co.—The directors have declared the following dividends: (1) an interim dividend of 3 per cent. on the 6 per cent cumulative preference shares for the current year (less income tax) payable to those shareholders whose names are on the share registers of the company at this date; (2) an interim dividend of 3 per cent. on the ordinary shares for the current year (free of income tax) payable to those shareholders whose names are on the share registers of the company at this date. The warrants in both cases will be posted on 31st inst. The share transfer books are closed until 31st inst., inclusive.

Electric Lighting Shares.—With the coming of the dark winter days and the consequent calling of the public's attention to electric lighting companies, the usual improvement in this class of investment may be regarded as probable. Moreover, the best class shares in this section return a 4½ to 5 percentage to their proprietors, and the management of electric lighting concerns has now reached such a pitch of excellence in so many instances that investors can confide their money safely to the shares. If the market is not particularly free, it is a very steady one, and dealings are at all times easy in a reasonable amount of shares.—*Westminster Gazette.*

Hydro-Electric Plant.—Don José Luis Gomez Navarro is to appropriate 10 cubic metres per second of water from the River Segura at the point called Rio Muerto, for the production of electric power, to be used for industrial purposes in Murcia and other towns. The *Gacetas* containing the foregoing notice may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays 10 a.m. to 1 p.m.). Snr. Andres Lifebore has obtained from the Mexican Government permission to utilise the water of the Amacuzas, in the Tetecala district, State of Morelos. The maximum to be taken is 80 cubic metres per second.

Dartmouth.—At the end of 1903 the Urban Electric Supply Company, Limited, had connected to their mains 225 consumers with a total of 6,610 8-c.p. lamps. The corresponding figures on Sept. 30, 1904, were 366 and 9,473. The average of 318 8-c.p. lamps per month is 50 per cent. above the estimated number at the beginning of the year, while there are still 20 consumers waiting to be connected, equalling some 760 8-c.p. lamps, which will make over 10,000 at the end of the year. The works last year generated 112,192 units, out of which 73,650 were sold. This year up to Sept. 30 they have generated 109,470 units and sold 77,187. There being still three months to complete the year's working, it is hoped that over 150,000 units will have passed out of the dynamos.

Walsall.—The Electricity Committee in their last report give the total number of consumers supplied on Sept. 30 as 366. During the past month the total units generated at the station was 123,753. The total output from the main generators was 119,857 units. The total units from the transformers was 93,617 (estimated). The total units registered on the meters was 88,416. The machinery was run for 685 hours. The wages paid amounted to £123. An offer of the Reason Manufacturing Company, Limited, has been accepted, who will take back the old demand indicators, which, owing to the change in the method of charging consumers, will not now be required, and allow a credit of 10s. on the large size and 7s. 6d. on the small size, on the condition that the committee purchase some of their ordinary meters at 47s.

Tonbridge.—At the last meeting of the ratepayers' association Admiral Pattisson said he hoped the electric light was making a move in the right direction, and he thought they should do all they could to support the Council in carrying out that undertaking. He had seen that several members of the Council had run down certain lights and the undertaking generally. It was a mistake. It was their duty to support it all they could—the school had done so and they ought to do so. It would pay sooner or later, and it ought to have their help. Several members spoke in a similar strain, and a written question put by another member was read as follows: "Is it good form for some members of the District Council to continue to deprecate and hamper the progress of the electric light now that it is the property of the ratepayers?"

Salford.—The abstract of last year's accounts of the Electricity Committee show receipts for current, rent of meters, etc., of £67,287, out of a total revenue of £68,767. The expenditure amounted to £25,907, leaving a balance to credit of profit and loss amounting to £42,860. The generation of electricity cost £15,141. After liquidating a deficiency of £2,394 on last year's account, and paying £31,086 in interest and redemption of loans, etc., the committee placed £8,000 of the gross profit to credit of a depreciation and renewals fund, and the balance—£1,380—was transferred to the district fund in relief of the rates. The expenditure on capital account to March 31 last was £48,233, and the income £42,627, showing a debit balance of £5,606. The total liabilities amount to £521,537, and the assets to £563,693, showing a balance of assets over liabilities amounting to £42,155.

Hammersmith.—Application is to be made to the London County Council for a loan of £18,482 for electrical machinery. The probable expenditure of the additional plant which the Council has recently agreed to provide comprises the following items: Three boilers (including brickwork, feed-water heater, forced-draught apparatus, economiser, pumps, piping, etc.)—total estimated expenditure for completed extensions, £12,100; total amount of contracts accepted to date, £4 899; estimated value of contracts yet to be settled, £7,201; estimated payments on account of extensions to March 31, 1905, £3,600. Two 1,500-kw. turbo-alternators (including condensers, etc.)—£20,000 (£18,482; £1,517; £10,500). Ash conveyor, tank, battery, chimney, flues, extension of condensing main, buildings, etc.—£5,900 (£2,067; £3 832; £2,054). Clerk of works and sundries—£2,000 (—; £2,000; £500). Feed pump, superheater, etc., already installed (transferred to capital account from last year's revenue account)—(£1,828). Totals—£40,000 (£25,449; £14,551; £18,482).

King's Lynn.—The electrical engineer in his last report stated that since the last meeting applications had been received for a supply to 339 additional lamps of 8 c p. or equivalent, making a total of 19,686, and that there were now 480 connections to private consumers, being an increase of four. The following statement was submitted: Units generated—July, 1904, 25,436 (1903, 18,149); total units sold to private consumers (light and power), 21,484 (8,638); units sold at power rates, 15,643 (4,919); cost of fuel, stores, repairs, and wages at station, £116. 18s. 10d. (£100. 19s. 11d.); cost per unit generated, 1·1034d. (1·3355d.); wages of lamplighters and outside staff, £18. 16s. 9d. (£19. 15s. 5d.). Units generated, August, 1904, 29,974 (1903, 22,977); total units sold to private consumers (light and power), 15,998 (11,663); units sold at power rates, 9,729 (4,793); cost of fuel, stores, repairs, and wages at station, £120. 0s. 10d. (£93. 11s. 1d.); cost per unit generated, 0·9611d. (0·9771d.); wages of lamplighters and outside staff, £21. 3s. 5d. (£17. 16s. 5d.).

Liverpool.—On Wednesday the Electric Power and Lighting Committee passed a vote of thanks to Mr. Richard Dart for his services as chairman during the past municipal year. Mr. Dart, in responding, said, according to the *Liverpool Courier*, that the number of consumers of electricity in the city had increased from 4,790 to 5,345. The total amount of energy supplied for lighting and power showed an increase of 20 per cent. over last year, and 12½ per cent. increase on the electrical energy supplied for tramways, the increase on the total output being 15 per cent. The new power station at Lister-drive would commence work in the course of a few weeks, and additional plant was being provided for sub-stations. Consequent upon active building operations five miles of new streets had been lighted, and the work of lighting passages, commenced in 1896, had now been completed, 2,664 lamps having been fixed at a first cost of £1,300. The annual additional charge would be £4,500; 5,435 gas-meters had been tested, and 578 rejected; 2,936 electricity meters tested, and 1,079 rejected. The average illuminating power of the gas had been 20·83 candles, the parliamentary power being 20 candles. The city was at present lighted by 18,312 lamps—electric and gas.

Bedford.—An enquiry has been held into the Town Council's application for sanction to borrow £44,950 for purposes of electric lighting. Mr. Hedley Baxter, the town clerk, said the estimated population of the borough was 37,100, the last census showing a population of 35,144. The rateable value was £197,614, and the loans on the district fund £19,006. He understood there was to be no opposition to this application. In 1898 an application was made to the Local Government Board for sanction to a loan of £41,000, which was granted. At that time the number of consumers connected with the mains was 376, and the number on March 31 this year was 1,140, or an increase in six years of 773. The number of inhabited houses in the borough was 7,350. During the last two years there had been a profit on the electric works undertaking for the first time; they had now turned the corner. The profit for the year ending March 31, 1903, was £23. 11s. 8d., and for the year ending March 31, 1904, the profit was £744. 11s. 6d. The electrical engineer (Mr. W. R. Phillips) gave details of the proposed expenditure. He also stated that everybody had under-estimated the demand. It had been contemplated that there would be 150 increase in the consumers; but they had spent £7,730 on house connections alone, instead of £1,500.

Electrical Mining Plant.—Messrs. Scott and Mountain, Limited, of the Close Works, Newcastle-on-Tyne, have just secured a contract from the Alquife Mines and Railway Company for a complete electrical plant for their mines in the South of Spain, which installation is of considerable interest on account of water power being used. The Alquife Mining Company have secured the water rights of the Rio Alcazer, and from this river they are able to get, under the worst conditions, from 3,000 h.p. to 4,000 h.p. with a fall of 280ft. The electrical plant consists of a 300-h.p. double Pelton wheel, with a special form of governor, the turbine being fitted with a heavy flywheel and directly coupled to one of Messrs. Scott and Mountain's three-phase alternating-current generators of 250 kw. capacity. This generator delivers three-phase current at an E.M.F. of 500 volts to a transformer, where it is transformed to 5,500 volts, and conveyed from the power station to the mine, a distance of nearly 10,000 yards, by bare overhead wires. At the mine the current is again transformed down to 500 volts by means of step-down transformers for the power motors, and to 250 volts for the lighting of the private houses, workshops, and offices. At the mine there will be installed two motors of 100 h.p. each for driving the briquetting machinery, and six 15-h.p. motors for driving the elevators, etc.; also nine 5-h.p. motors for driving the feeding gear from the kilns, hoists, workshops, etc. About 275 incandescent lamps will also be installed throughout the workshops, offices, etc.

London Gazette.—The partnership between George Becker and Otto Böhndel, carrying on business as agents for electrical fittings at 29, Cock-lane, Snow-hill, London, under the style of Schoen Bros., has

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been dissolved by mutual consent. The partnership between George Arthur Smith and George Herbert Huntsworth, carrying on business as electrical engineers at 180, Regent-road, Liverpool, under the style of Smith and Huntsworth, has been dissolved by mutual consent. The partnership which has for some time past been carried on by Albert Clulee Hands and George Hands under the firm of Hands Bros., at 30 and 34, Snow-hill, London, in the trade of electrical engineers, manufacturers of electrical fittings, etc., has been dissolved by mutual consent. A general meeting of the London Telegraph and Steam-Gauge Electric Company, Limited, will be held at 4, Romford-road, Stratford, Essex, on Nov. 21, 1904, at 4 p.m., for the purpose of having an account laid before them, showing the manner in which the winding-up has been conducted and the property of the company disposed of. The creditors of the Bath Electric Manufacturing Company, Limited, are required to send their names and addresses and particulars of their debts or claims to Mr. Augustus C. Comley, Albion-chambers, Bristol, liquidator. The Electrical Bleaching Company, Limited, has been wound up voluntarily, and Mr. William Barrett Winnicott. Queen-street, Nottingham, accountant, appointed liquidator. The first meeting in the estate of James Marsden, 39 and 40, Woodcock-street, Birmingham, electric fittings manufacturer, will be held on Oct. 26, at 11 a.m., at 174, Corporation-street, Birmingham. The last day for receiving proofs in the estate of Thomas Hyom, electric light fitter, etc., 139, Fawcett-road, Southsea, is Nov. 1, 1904.

Lichfield.—At the last City Council meeting a report was adopted giving the history of the Council's electric lighting order. In this report the Electric Lighting Committee said they had had before them several proposals for working the electric lighting order which the Council obtained in 1901. At first it had been considered that the best course to be adopted would be by arrangement with a company or firm whereby the Corporation should borrow to the extent of £10,000 to put down an electric lighting station with mains thereto, and then lease the undertaking to a company or firm for a term of years, upon conditions which should include under an ample guarantee and satisfactory security a provision that such company or firm should repay the principal and interest, including all sinking fund charges during the term, thereby preventing any burden on the rates, and at the end of such term the whole of the undertaking and works should become the property of the Corporation. The parliamentary agents, however, advised that in their opinion the Board of Trade would not consent to such a proposal, as they would regard it as being practically a transfer of the order, and that the only way to carry such an agreement into effect would be for the Corporation to apply at once for a further order extending the time for carrying out the original order and providing for its transfer to a company or firm which would have to be specifically named in the further order. The committee consequently resolved not to apply for the further order, but to await the future development of the matter, seeing that two notices had been served upon the Corporation by firms intimating their intention to apply for electric lighting powers in the city. Mr. Geo. Ashmall has been appointed the secretary to the Electric Lighting Committee at the annual salary of £25, exclusive of parliamentary, litigious, conveyancing, and other legal work, and out-of-pocket payments.

Dublin.—The adjourned enquiry was held on Tuesday into the applications made by the Corporation for sanction to borrow £21,000 in connection with the scheme for lighting the city by means of electricity. Mr. Ignatius O'Brien, K.C., and Mr. Philip White, who appeared in support of the application, said, as reported in the *Dublin Mail*, that the necessity for the loan arose from the absolutely unexpected success of the electric lighting scheme. The existing electric light plant at the Pigeon House consisted of a generating plant of four separate units. These units consisted of plant capable of producing two lots of 500 kw. and two of 1,000 kw.—a total of 3,000 kw. The estimate was 1,000 kw., but the works were so constructed that they could be increased fives upon demand. Mr. Hammond estimated that something more than 2,000 kw. could be safely produced without risk out of the existing works, but the margin which he estimated for was only 200 kw., or 10 per cent. The existing boilers were capable of producing 2,500 kw., placing no undue stress on the installation. That was a material figure. The capacity of the cables was 2,800 kw. But the demand had entirely exceeded the most sanguine hopes of the original projectors of the scheme, and as they were under obligation to supply electric light to every person occupying premises within the area in a street where a circuit ran who demanded it, under a penalty of £2 a day, it was clear that the works would have to be extended. It was not a question of speculation, but one of fact. There was an almost certain increase of demand to face, and it was absurd to say that they had either to run the existing installation, taking the risk of one of the units breaking down, or to ask sanction for the erection of a new 400-kw. set. It seemed to him that as a matter of business it was wise to go on with the extension. Mr. F. J. Allen, secretary to the Lighting Committee, was examined as to the progress made by electric lighting in the city since the committee began to enter into agreements for the supply of light to the citizens. He stated that the number of agreements in existence at March 31, 1903, was 322. Since then three had been cut off, leaving 319 still working. The new agreements entered into from March 31, 1903, to Oct. 13, 1904, were 580, of which two had been since cut off, and 35 of which were only extensions of alterations. The new agreements entered into showed a steady progress month by month. The total consumers connected to the system on Oct. 13, 1904, was 816, and consumers whose agreements were completed but who were awaiting connection were 45. The total 8-c.p. lamps on the system at March 31, 1903, were 33,000, and from that date to Oct. 13, 1904, after allowance of 58 which had been subsequently cut off, there had been 46,042 installed. The number at present on supply was 79,042, and awaiting connection 6,440. The total demand for 8-c.p. lamps for which the Corporation were liable was 85,482. Mr. Mark Ruddle, resident engineer at the Pigeon House, stated that from his experience he was of opinion that it was necessary to add to the generating plant for the purpose of immediately coping with the demand. The boilers had been immensely improved.

Port Elizabeth. — The *British and South African Gazette* authoritatively announces the settlement of the difference of opinion between Port Elizabeth's borough and consulting engineers as to the most suitable system of electricity supply for the municipality, and that commercial benefits will accrue within the next six or eight weeks. The whole difficulty has arisen out of the fact that insufficient data were originally placed before the consulting engineers in London—Messrs. Robert Hammond and Son. As we have previously announced, the plans of Mr. R. Pape, the borough electrical engineer, provided for direct current on the low-tension system. These plans, together with maps of the town and district, were submitted to Messrs. Hammond and Son for their approval, but were returned with a strong objection to the low-tension system, and an urgent expression of opinion in favour of a high-tension scheme, on the ground that the site of the generating station was not sufficiently central for the successful working of the former. After consultation with Mr. Pape, who arrived in England a week or two ago, Messrs. Hammond and Son have cancelled their objection to the low-tension scheme, and are now engaged with Mr. Pape in drawing up specifications, etc., preparatory to calling for tenders. The report continues as follows: Details of the plant which will be required, and on which an expenditure of £90,000 is at present authorised, are not yet public property, but we are fortunately able to give our readers some hitherto unpublished particulars. The earliest indents will be for three sets of 400-kw. steam-turbine generators, of about 1,800 h.p. total, delivery of which will be spread over a period of 12 months. The first will be required practically at once, and will meet the earliest demands for power. The second will be held in reserve, but it is calculated that the demand for current will double itself in 12 months, so that by the time the third set arrives the first two sets will be working to their full capacity. Even after the erection of these three generators is completed, considerable extensions are expected to prove necessary at an early date. In addition to this heavy plant, large orders are to be given out for cables, lamps, standards, switchboards, meters, fuse boxes, and the many other items of equipment required to complete the full municipal light and power scheme. Arc lamps will be erected in the main streets, but in the lesser thoroughfares the lately-introduced Nernst lamps will be utilised. Apart from the important and immediate orders which the municipal authorities are about to place, the installation of an electricity supply system at Port Elizabeth has a more general commercial significance. A considerable demand for current for industrial purposes is anticipated, and as the local price for gas is 8*s.* 9d. per 1,000 cubic feet, it is probable that electricity will quickly step into favour as a means of domestic lighting and heating. This means that a new trade in electrical fittings and supplies will be created at Port Elizabeth, and a new source of custom provided for manufacturers of lamps, ornamental brackets, insulated wire, etc. It is, by the way, an extraordinary fact that while makers of metal fittings and electric cables and wire are pushing their goods in the South African market, it is an extremely rare circumstance to find any evidence of a desire on the part of makers of electric lamps to secure Colonial trade. In the home market quite a variety of types of the ordinary incandescent lamp for domestic use are receiving constant and wide advertisement, yet brands which are almost household words in Europe and America are only heard of by accident in South Africa. Amongst other orders mentioned, we note that at Kimberley the burgesses have approved the agreement under which the De Beers Consolidated Mines Company will supply current within the municipality. In addition to the electrical works now in hand at Middelburg, Transvaal, the Town Council has before it a scheme for the electric lighting of the cantonments, which will involve the purchase of additional mains, fittings, lamps, etc. Orders consequent upon the decision of the King Electric Power Company, Limited, to extend the present lighting plant and system at Kingwilliamstown, have yet to be placed. At Vryheid the Local Board has two tenders for the electric lighting of the town under consideration. The Johannesburg telephone system is soon to be taken in hand, and when the new exchange is built about 10,000 connections will be available. The instrument to be employed is the Ericsson. Messrs. Harris, Lee, and Co. have secured the concession for the lighting of Bethlehem in the Orange River Colony. The installation involves orders for boilers, engines, dynamos, cables, etc., to a considerable value.

Leeds Hospitals.—The Seacroft and Killingbeck Hospitals were recently opened by the Lord Mayor, the ceremony marking the completion of an undertaking which has been carried out at a cost of £266,000. There are 42 acres of buildings, self-contained and independent as a little town, with generating station, administrative buildings, and school. Mr. E. T. Hall, F.R.I.B.A., was the architect, and Messrs. Arnold and Son were the contractors. The whole of the engineering works were included in the architect's general specification. Messrs. Shepherd and Courtney, Leeds, were the consulting and supervising engineers for the electric plant and installation, and Mr. E. G. Hillier, Manchester, for the boilers and steam-piping. Messrs. Clayton, Son, and Co., Limited, Leeds, were contractors for the engineering works, plant, etc., consisting of three high-pressure Lancashire boilers 28ft. by 7ft. 6in., and three low-pressure boilers 30ft. by 7ft., all complete with Messrs. Hopkinson's mountings, valves, etc. There is a Green's economiser, consisting of 144 pipes, six pipes wide, built in two groups. Messrs. Dargue, Griffiths, and Co., Limited, Liverpool and London, made the connections, etc., consisting of steam-pipes for boilers, electric light, pumps, kitchen, heating, hot-water supply, laundry, etc. The boiler steam mains and connections, consisting of duplicated 6in. cast-iron pipes jointed with Taylor's corrugated copper rings, are taken to two cast-iron steam-separators 15in. bore 3ft. deep below the 6in. branches fitted with inside diaphragm plate and reflex water gauges.

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The separators are drained by means of a ⅜in. Sentinel steam-trap with valves and by-pass arrangements; duplicated 5in. cast mains are taken across the engine-house with 2½in. bore copper pipes from each main connected to the 2½in. engine stop valves. Cast-iron pipe connections are taken from three 6 × 4 × 6 Worthington pumps for economiser and boiler feed. The whole of the condense from the steam mains, electric and laundry engines, calorifiers, kitchens, laundry, etc., is taken to the cast-iron hot-well fitted at the suction end with three filtering grids so that no water can pass except through the towelling. The well provides hot boiler feed during the day load. The Electric Construction Company, Wolverhampton, were the contractors for the generating sets, consisting of three 50-kw. and one 13k-w. Belliss-Morcom-E.C.C. sets. The dynamos are compounded. The main switchboard contains four dynamo panels, one meter panel, two feeder panels. Each dynamo panel is fitted with ampere and voltmeter, two-way voltmeter switch, shunt resistance switch, two single-pole fuses, one double-pole 200-ampere switch, one circuit breaker, and automatic reverse-current release switch. The meter panel contains two wattmeters for 450 and 150 amperes. The feeder panel contains four ampere-meters reading to 150 amperes, four single-pole fuses, four single-pole switches, four circuit breakers, with automatic overload release, for 150 amperes normal maximum. Messrs. J. H. Taylor and Co., Huddersfield, were the contractors for the feeder distributors, wiring, telephones, fire-alarms, etc. The feeders and distributors, amounting to upwards of 3½ miles of British Insulated and Helsby concentric, lead-sheathed and armoured cables, have been run partly in stone troughing filled in solid with pitch, and partly on multi-step cast-iron brackets in the subways. The feeder, distributor, junction, and service boxes, amounting to upwards of 100, are cast-iron boxes filled in solid with pitch, designed specially by the consulting engineers, and supplied by the British Insulated and Helsby Cables. The wiring is carried out on the double-pole distributing fuse-board system for 2,800 lights, on 2,400 switches. The wires are laid in American whitewood casings of the architect's special rounded section, and looped from terminal to terminal. The casings are multi-grooved—one groove, one circuit. The fittings in the wards are steel-bronzed, plain tube pendants, with loose non-rotating joints. The telephone exchange is arranged for 100 lines. The cables and wires are insulated with pure and vulcanised rubber, enclosed in lead sheathing, partly run underground in wood troughing filled in solid with pitch, and partly in the subways, the connections being made by means of about three dozen connecting cast-iron watertight boxes. The fire-alarm installations, consisting of about 30 bells, are fixed in the various buildings occupied by the staff. The bells are rung simultaneously by means of switches in the gate porter's lodge. The wires are vulcanised rubber, lead-sheathed, and run in wood troughing filled solid with pitch, and laid underground, local batteries being supplied for ringing the bells, the circuit being closed by means of relays. The electric goods lift was supplied and erected by the Leeds Hydraulic and Engineering Company, Limited. Amongst the minor electrical plants we note a 12-h.p. motor in the laundry by Messrs. Dargue, Griffiths, and Co., Limited, electrically-driven bakery plant by Messrs. Morley and Co., Halifax, and a number of electrically-driven labour-saving appliances in the kitchen. Other contractors were: (1) Laundry, 16-h.p. engines by John Fowler and Co., Limited, Leeds, and other machinery by Messrs. Bradfords and W. Summerscales and Sons, Limited; (2) kitchens, the latter firm and Messrs. W. Moorwood and Son and Co.; (3) sanitary engineering and plumbing, H. Braithwaite and Co., Leeds; (4) pipe covering, the non-conductor amounting to 61,000ft. super, supplied by Messrs. J. S. Miller and Co., Leeds, asbestos for high-pressure work and the special covering "Unradium" for low-pressure work. There are eight miles of drains, 26 miles of steam, water, and other pipes, and 46½ miles of electric light and telephone wires, and 80,000ft. of electric light wood casings, etc. It is said that there will not be a penny extra on the contract.

PROVISIONAL PATENTS, 1904.

OCT. 10.

21684. Improvements in alternating-current electric motors. Union Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 9, 1903, being date of application in Germany.) (Complete specification.)

21694. Improvements in or in connection with electric motor controllers. Henry Vincent James, 3, Brown-street, Market-street, Manchester.

21722. Improvements in rail joints and electrical bonds connected therewith. Richard Heber Radford, 15, St. James-row, Sheffield.

21726. An improved system of suspending conductor wires for the distribution of electrical energy. Albert Enoch Cooper, 118, Abbey-street, Rugby.

21729. Improved swivelling coupling for electric cables. Edwin Burbidge Phillips and Thomas Creswell Parkin, 22, Southampton-buildings, Chancery-lane, London.

21780. Improvements in automatic thermal and magnetic circuit breakers. Robert Starke, 195, Upper Thames-street, London.

21784. Improvements in the method of and apparatus for automatically opening or breaking at predetermined times an electric circuit or circuits. Percy F. Corkhill, 6, Lord-street, Liverpool.

21795. An improved dynamic-electric clutch. Robert von Lieben and Eugen Reisz, 46, Lincoln's-inn-fields, London. (Complete specification.)

21796. Improvements in and relating to controllers for electric motors. Alexander Churchward, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 10, 1903, being date of application in United States.) (Complete specification.)

OCT. 11.

21819. Improvements in automatically-operated telephonic exchanges for a small number of lines. Albert Morrison Bullard, 55, Chancery-lane, London. (Complete specification.)

21846. Improvements in electric switches. Thomas Ames Cameron, 615, F. St., North-West, Washington, D.C., United States. (Complete specification.)

21848. Telegraph recorder. Willis Joseph Roussel and Alphonse King, 615, F. St., North-West, Washington, D.C., United States. (Complete specification.)

21889. Electric alternating-current machines. Karl Arvid Lindström, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 16, 1903, being date of application in Sweden. (Complete specification.)

21892. Improvements in electric arc lamps. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

21894. Improvements in regenerative dry batteries. William Hackett Gregory, 53, Chancery-lane, London. (Complete specification.)

21895. Improvements in electric telegraphs. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21902. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, and Reginald Charles Clinker, 83, Cannon-street, London.

21903. Improvements in electricity meters. The British Thomson-Houston Company, Limited, and William John Lloyd, 83, Cannon-street, London.

21911. Improvements relating to electric batteries, electrolytic apparatus, or the like. Pascal Marino, 7, Southampton-buildings, Chancery-lane, London.

21913. Improvements in the manufacture of galvanic cells. Rudolf Ziegenberg, 18, Buckingham-street, Strand, London. (Complete specification.)

OCT. 12.

21966. Improvements in electric heat alarms. Robert William Bill and Sidney Bill, 9, Headingley-road, Handsworth.

21995. Improvements in and relating to intercommunication telephone systems. Isidore Bernard Birnbaum and Herbert George White, 322, High Holborn, London.

22000. Improvements in electric motors. Paul Jigouzo, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 21, 1903, being date of application in France.) (Complete specification.)

22003. Improvements in conduits for electric cables or conductors. Thomas Easton Devonshire, 47, Lincoln's-inn-fields, London.

OCT. 13.

22022. Improvements in the means of operating switches or points of tramways and overhead cables in connection therewith. Philip Reader, 2, Church-gate, Nottingham.

OCT. 14.

22085. A wireless telegraphy receiver capable of recording or printing only waves of a given strength. Francis Patrick Reid, 37, West Nile-street, Glasgow.

22100. Improvements in or relating to certain parts of electrical circuit breakers and automatic switches. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

22113. Improvements in apparatus for automatically operating the points of electric tramways. William Redfern Evans, 55, Market-street, Manchester.

22156. Improvements in commutators for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22157. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22164. Improvements in or relating to apparatus for use in the distribution of alternating electric current. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

22171. Improvements in connection with electric switchboards to protect persons from injury. The Elektrizitäts Akt.-Ges. vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 31, 1903, being date of application in Germany.) (Complete specification.)

22173. Improvements relating to electric heating. Francis Edward Spon, 22, Southampton-buildings, Chancery-lane, London.

OCT. 15.

22236. Improvements in electric lamp fittings. Albert John Bonnella, 9, Warwick-court, Gray's-inn, London.

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22206. Electromagnetic press. Sir Benjamin Scott (Knight), Edwin Herbert Quarrington, and Tom Hill Hodgkinson, James-street, Carlisle.

22210. An improvement in or in connection with dry voltaic cells and primary batteries. Clarence Metcalfe Stead, 30, Park-row, Leeds.

22213. An improved electric wire terminal clip. George Robinson Cartmel, Palatine-chambers, Market-street, Halifax.

22246. Improvements in and relating to the distribution of electricity for electric traction. Charles Gibbs, 70, Chancery-lane, London.

22247. Improvements relating to electric lamps. Armistead Keith Baylor, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 3, 1904.

1903.

15077. Automatic switchboards for telephone and like exchanges. Hanson. (Date applied for under International Convention, July 7, 1902.)

22953. Dynamo-electric machines. Martin, Lowson, and Sayers.

22440. Telephone systems. Fairweather. (Kellogg Switchboard and Supply Company.)

23110. Electric potential governors. Boyden.

23478. Electrical transmissions of energy through space. Artom. (Date applied for under International Convention, Aug. 23, 1903.)

25525. Electric starting switches for electric motors and the like. British Thomson-Houston Company, Limited. (General Electric Company.)

25663. Telephone systems. Falk, Stadelmann, and Co., Limited, and Thurnauer.

26488. Electrical ignition apparatus for internal-combustion engines and the like. Napier.

26533. Electric heaters. Krause.

26553. Apparatus for electrically igniting miners' safety lamps. Best, Best, and Best.

26557. Electric arc lamps. Crompton and Co., Limited, and Hodgson.

27350. Electric gas or vapour lamps. Le Tall. (Potter.)

28748. Trolley wheels or collectors for electric currents. Estler and Jack.

1904.

653. Casings for dynamo-electric machines. Saarbrücker Elektricitäts Akt.-Ges. and Emmerich.

2899. Electric signalling systems for railways. Struble. (Date applied for under International Convention, Feb. 13, 1903.)

3540. Alternating-current integrating and indicating watt-meters. Conrad. (Date applied for under International Convention, Feb. 20, 1903.)

3365. Storage batteries or accumulators. Fairweather. (Vesta Storage Battery Company.)

15226. Method of selecting electrical impulses. Troy. (Date applied for under International Convention, July 11, 1903.)

16396. Method of producing zinc from sulphate solutions by electrolysis. Abel. (Siemens und Halske Akt.-Ges.)

17236. Post for electric conductors, lamps, trolley lines, and the like. Weller.

17483. Receiving system for wireless communications. Harrison. (Date applied for under International Convention, Aug. 27, 1903.)

17792. Manufacture of incandescent electric lamps. Canello. (Date applied for under International Convention, Sept. 12, 1903.)

18949. Safety guard for conductor or live rails of electric railways. Sale.

19245. Automatic signalling for electric railways or tramways. Wilson and Marshall.

19611. Controlling apparatus for electric motors. Klinkenberg.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-6
—— 5 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	–	2⅜-3¼
—— 4 per cent. Mortgage Debenture Stock	100	..	87-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,751 ..	2	..	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	94-97
—— 4½ per cent. 2nd Debenture Stock	100	–	70-75
Callender's Cable, Debentures	100	–	101-105
—— Ordinary	5	–	9¼-10¼
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	5	–	1¼-2
—— 5 per cent. Debentures	100	–	90-95
Edison and Swan United, "A" Shares, 1-99,251	5	–	⅜-½
—— "A" Shares, 01-017,139	5	–	1-2
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78-83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1-1¼
—— 7 per cent. Cumulative Pref.	2	–	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	96-99
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10¼-11¼
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	108-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	19-20
—— 4 per cent. Debentures	100	–	99-102
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	36-39
—— 5 per cent. Bonds	100	–	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	–	103-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	102-105
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 ..	5	–	7⅛-8
—— Nos. 80,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	106-109
Charing Cross and Strand, Nos. 1-70,000	5	–	8¼-9
—— 70,001-80,000	5	..	8-8¼
—— 4½ per cent. Cum. Pref.	5	–	5¼-5½
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 40,001-80,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	103-106
Chelsea Electricity Supply	5	–	6¼-7
—— 4½ per cent. Debentures	100	–	108-111
City of London, Ordinary	10	–	10¼-10⅝
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	103-106
County of London Electric Supply, Ordinary	10	–	8¼-9¼
—— 6 per cent. Cum. Pref.	10	–	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	102-105
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6¼-6⅝
—— 6 per cent. Cum. Pref.	5	–	6¼-6⅝
—— 4½ per cent. First Mort. Deb.	100	–	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	101-104
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7⅛-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	101-105
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	100-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10¼
London Electric, Ordinary	3	–	1⅜-2¼
—— 6 per cent. Pref.	5	–	5¼-5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red..	100	–	96-99
Metropolitan Ordinary	10	–	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	–	86-89
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb..	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-103
Notting Hill Electric Lighting	10	–	14¼-15¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) ..	100	–	99-102
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310.....	5	–	6¼-6¾
—— 4 per cent. Debenture Stock	100	–	99-102
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	98-101
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2⅜-3¼
—— 4 per cent. Debenture Stock	100	–	98-101
South London, Ordinary		–	4¼-4⅜
South Metropolitan Electric Light and Power Co., Ord...	1	..	⅜-1
—— 7 per cent. Cum. Pref.	1	..	1¼-1½
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108
—— Ditto, June, 1904		..	—
St. James's and Pall Mall, Ordinary, 101-80,000	5	–	14-15
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	88-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4⅜-5
Westminster, Ordinary	5	–	12¼-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6-6½
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅛-5⅜
—— Ord.	5	..	6⅜-6⅞
—— Permanent 5 per cent. Debenture Stock, 1888 ..	100	–	139-142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	103-105
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..	1	..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	¾-1
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11⅝
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000.....	5	–	3⅜-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-101
British Columbia Electric Railway Co., Ord. Def.	100	–	99-102
—— Ord Pref.	100	–	100-103
—— Non. Cum. 5 per cent. Pref.	10	–	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	–	104-105 p.e
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10⅜-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	115-118
—— 4½ per cent. 2nd Deb. Stock	100	–	94-97

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Name.	Amount paid. £		Last price. £
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5		3¼-4¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5½-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5½-5¾
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	102-105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	–	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7¼-7¾
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways ,Nos. 1-480,000	1	–	1½-1¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4¾-5 xd
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14¼
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-50,000	5		3¼-4
—— 4 per cent. Debenture Stock	100	–	88-91
Kidderminster and District Lighting and Traction, Pref.	5	–	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10¼-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103-106
Madras Elec. Trams. (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¼-1
—— 4½ per cent. Deb. Stock, Red.	100	..	101-102
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	5	–	¼
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Egd.)	100	–	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12-12½
—— 5 per cent. Cum. Pref.	10	–	9¾-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	–	102-106
Potteries Electric Traction, Ordinary 30,001-40,000	10	–	8-9
—— 5 per cent. Cum. Pref., 1-30,000	10	–	8¼-8½
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company —— £250,000 Ordinary	1		1
—— £101,152 6 per cent. Preference			
—— £528,093 4½ per cent. Debenture Stock	10	c. –	

Electric Railways.—

Central London, Ordinary	100	–	89 92
—— 4 per cent. Pref.	100	–	100-102
—— " deferred	100	–	79-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	107-110
City and South London, Consolidated Ordinary	100	–	47-49
—— 4 per cent. Debenture Stock	100	–	106-109
—— 5 per cent. Pref. Stock '31	100	–	122-125
—— " " " '36	100	–	117-120
—— " " " '01	100	–	113-117
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10½
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	–	98-98¼
Waterloo and City, Ordinary	100	–	86-89

Telephones.—

National Telephone, Preferred	100	–	104-106
—— Deferred Stock	100	–	92-94
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5¾
—— 5½ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	104-106
—— 4 per cent. Prov. Cert.	–	..	67-69
Oriental Telephone and Electric Company	1	–	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 8	1,320	1,140	+ 179	+30,453h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	—	—	—	—	—	8	8	,, 15	14,160	3,201,586	336,049	1·03	10·11	1,770	5 04
Barking Corporation	,, 15	41	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 16	1,015	1,091	– 76	– 240	23·53	23½	March 31	56,0 3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Tramways	,, 15	5,456	5,131	+ 325	—	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 14	869	816	+ 53	+ 2,877	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·59
Blackpool Corporation	,, 13	658	528	+ 140	+ 5,619	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	Sep. 5	1,463	1,368	+ 95	– 40	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7 05
Bolton Corporation	Oct. 15	1.704	1,803	– 99	—	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 12	1,009	999	+ 10	+ 1,901	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 15	4,457	3,606	+ 851	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 16	939	894	+ 45	+ 3,165h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 14	4,818	5,048	– 230	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 15	1,043	805	+ 238	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 16	325	361	– 36	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·81	1,570	7·57
Cardiff Corporation	,, 15	1,922	1,962	– 40	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 15	182	192	– 10	—	—	—	Dec. 31g	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 15	6,780	6,443	+ 337	— h	6	6	,, 31	362,471	44,953,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 16	2,516	2,761	– 225	– 1,337h	6½	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	Sep. 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Oct. 13	479	492	– 13	– 2 475	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 14	223	224	– 1	—	7·23	7·23	March 31a	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 15	202	208	– 6	—	4½	4½	,, 31	11,255	2,871,332	280,901	0·91	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 14	131	121	+ 10	— h	7	6½	Dec. 31g	6,234	688,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 14	4,015	4,023	– 8	—	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 14	932	869	+ 63											
Dundee City Tramways	,, 12	921	939	– 18	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 15	644	588	+ 56	+ 1,470	10·77	10·75	March 31	34,312	12,950,259	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 15	14,563	14,081	+ 482	+16,012h	143	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	Sep. 21	342	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	Oct. 5	2,830	2,795	+ 34	+ 3,416	33	30½	March 31	68,283	16,322,054	1,387,885	1·0	11·79	2,019	8·77
Huddersfield Corporation	,, 15	1,269	1,201	+ 68	+ 2,758	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 15	3,344	2,559	+ 784	+ 8,394	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 15	390	343	+ 47	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 12	123	148	– 20	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 12	215	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 15	5,613	5,137	+ 476	+10,520	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	Sep. 3	1,506	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 8	10,724	10,474	+ 250	+12,330	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 16	1,453	1,594	– 141	– 1,061h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 8	13,047	10,556	+2,491	+72,931	46½	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 8	174	206	– 34	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 13	131	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 15	12.149	11,455	+ 694	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 14	1,733	1,164	+ 569	+ 7,375h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 8	120	98	+ 22	+ 1,103	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 15	3,565	3,501	+ 63	—	45	38½	,, 25	185,027	39,715,120	4,059,807	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	,, 15	487	462	+ 25	—	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	29	,, 31	91,448	18,204,426	1,828,193	1·15	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 13	444	457	– 13	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 15	97	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 16	4,571	4,840	– 269	+ 2,659	34½	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 13	940	974	– 34	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 12	285	247	+ 39	+ 1,275	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 14	488	349	+ 139	+ 6,954	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 2	1,216	1,218	– 2	+ 390	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	,, 1	312	—	—	—	3½	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 15	710	657	+ 53	+ 1,376	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 13	1,083	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 12	711	443	+ 268	—	7½	—	,, 31g	20,873	4,263,066	417,335	—	12·006	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
j Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

The Royal Sanitary Institute.—His Majesty has been graciously pleased to confer the title "Royal" upon the Sanitary Institute, and to signify his pleasure that the institute be known as the Royal Sanitary Institute.

Rontgen Society.—This institution will open its session on the 3rd prox., when the presidential address will be delivered. The following dates for general meetings have been provisionally arranged: Dec. 1, Jan. 6, Feb. 3, March 2, April 6, May 4 (exhibition evening), June 1, and July 6 (annual meeting).

Faraday House.—Judgment was given in the action Eason *versus* the Syndicate of Electrical Engineers, Limited, on Tuesday, in favour of the defendants, with costs. This was an action in reference to ancient lights at the back of the new Faraday House in Southampton-row, and we are glad to note that the Electrical Standardising Institution has been successful in resisting it.

Electrolysis of Water-Mains.—The report of the Metropolitan Water and Sewerage Board of Boston, U.S.A., after commenting upon the large degree of electrolysis sustained by the water and drainage mains, observes that an insulating joint with a connection made of rubber gasket ½in. thick, placed between two flanges, has been found useful in preventing the flow of electricity from adjoining pipes.

High-Voltage Experiments.—Some time ago a considerable sum was contributed in America to enable Mr. R. W. Mershon to take up certain high-voltage experimental work, the results of which he will describe in a paper. The preparations for this work, which will be carried out on the American side of the Niagara Falls, are practically completed, and the tests will be commenced very shortly. It is proposed to take measurements on an experimental line up to at least 100,000 volts, and possibly as high as 200,000 volts.

Electric Fire-Alarms for Theatres.—We are pleased to see that the May-Oatway fire-alarms recently installed in the Theatre Royal, Edinburgh, have already proved of service. There was a fire in the theatre on Tuesday last during a rehearsal, and the Edinburgh fire brigade was called automatically to the spot by the electric fire-alarm. In the meantime the theatre staff had succeeded in extinguishing the fire, but the prompt call to the brigade would have been of inestimable service had the fire proved too much for the theatre staff. We understand that this is the first fire in a theatre of the United Kingdom which has been so reported, but there are four Scotch theatres which have this safeguard. Owing to the refusal of the London fire brigade to have this automatic signalling in their stations, this form of protection is not used in any London theatre. We think, however, it is time that the County Council reconsidered their decision on this point.

Brighton Telephone Service.—The municipal telephone service was opened on Oct. 5 of last year, when the number of instruments connected was 12. On the anniversary of that date 1,448 instruments were working, in addition to which there were 21 junction lines. The construction of over 1,400 stations in 12 months compares favourably with any similar undertaking in the country, especially as the Council thought at one time that a 1,000-line exchange would suffice. All the subscribers in Brighton, Hove, Preston, and Kemp Town are connected directly with the central exchange, ensuring a quicker service than with a number of sub-stations. In another column we publish an approximate revenue account for the six months ending Sept. 30. From this it will be seen that after charging all working expenses, interest, and sinking fund, a balance of £98 remains. The revenue during this period averaged £411 per month. It is anticipated that the account for the year on March 31 next will show that the revenue has been sufficient to cover all expenses, including capital charges, and show a substantial balance. The committee and the engineer are to be congratulated upon such an excellent result.

London Traffic.—The chairman of the Highways Committee of the London County Council has returned from the United States, whither he proceeded a few months ago to study the traffic problem, a confirmed believer in the conduit system for the tramways of the Metropolis. He was greatly impressed with the conduit trams of New York, which run the entire length and breadth of Manhattan Island, and would have the arrangement duplicated here by a line from Shepherd's Bush to Stratford, running right through the City, and another from Highgate to Streatham. To this, and a shallow underground railway with similar ramifications, Mr. Baker looks for a solution of the traffic problem. Few, however, will expect to find the former included when the London Traffic Commission issues its recommendations. Two features in the New York tramway service attracted Mr. Baker's attention. Higher speeds prevail than in London, and there are no restrictions on overcrowding. Mr. Baker thinks that some revision in the latter respect may be necessary here. There would probably be little harm in allowing a certain degree of latitude, as is done in some of the provincial towns, but the desirability of unlimited overcrowding may well be questioned.

Tram Accident.—As one of the Brighton Corporation's cars was ascending Elm-grove the other day some leaves from the adjacent trees were crushed under one of the wheels, causing insulation. The car began to travel backwards, but an application of the slipper brake promptly checked the speed, with the result that at the foot of Elm-grove the car turned a curve without accident. Having reached level ground, the car was brought to a standstill. Meanwhile the passengers had taken alarm, and a number of them crowded on to the platforms. Apparently none of them attempted to jump off, but owing to the pressure of those behind five were thrust off, and in falling two of them were rather badly hurt. The moral of the accident is the same as can be drawn from practically every tram accident—*i.e.*, that it is safest for the passengers to remain in their seats. Our readers will perhaps remember an accident of a similar character a year or two ago at Glasgow, in which the injuries were considerably more than at Brighton. In this case the tram, after running down a hill backwards, finally broke into a shop. The construction of the car was so substantial, however, that not even the windows were broken. The passengers who sat still were also uninjured; but it is a difficult matter to educate the public in this respect.

The Tubes and Hygiene.—The *Lancet* considers that the tube railways adopted a mistaken policy in having one class of train only. Further, it charges the companies with providing inadequate ventilation. When the compartments, remarks our contemporary, are full, the characteristic sickening smell of human exhalation is most revolting to the passenger entering fresh from the outside air. This leads the *Lancet* to ask, Why, if the tunnels are well ventilated, as stated, cannot the train partake of this ventilation, instead of the doors being closed as soon as the train leaves the station? This question seems a reasonable one, and worthy of attention on the part of the companies. On the question of classes, our contemporary

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observes that in a one class compartment the cleanly-disposed are compelled to be wedged in amongst the indifferent, and it believes that many passengers, especially ladies, would willingly pay a higher fare to travel in a distinct compartment, not from social considerations, but in order to secure greater comfort and a better sanitary environment. Such an arrangement would, our contemporary predicts, amply pay the companies. This does not seem to quite accord with the experience of the steam lines. Probably the provision of, at any rate, one distinct car in each train would meet with considerable appreciation. It would, however, lengthen the period of stopping in each station, and thus delay everyone.

Salaries of American Locturers.—At the farewell banquet given in his honour by the physical science departments of the Brooklyn Institute of Arts and Sciences at New York, Sir William Ramsay had something to say upon the remuneration of those engaged in teaching science in America. In the course of his remarks Sir William stated that during his sojourn in the States he had been greatly impressed by the high power of organisation displayed by leading manufacturers and commercial men, but had also learned that men employed in a scientific capacity, especially those engaged in teaching the science, were receiving less than they would earn if they were engaged in industrial pursuits. "This condition of affairs," said Sir William, "unless remedied, and remedied soon, before long will lead to the lowering of the whole educational status, for it will inevitably react upon the training of professional and scientific men in this country. If trained by third-rate teachers—as they must be—it is unlikely that they will take the rank which they would have taken if their teachers had been men of first-rate ability." It was not necessary, Sir William added, that every professor should receive high emoluments, but he considered that those who filled the most important positions in the leading universities of the country should be well paid. He recommended that some of the donations from public benefactors, instead of being devoted to the erection of new buildings, should be used to increase the emoluments of existing chairs.

Association of Technical Teachers.—Meetings of teachers engaged in London polytechnics, technical institutes, and kindred foundations were held in the summer, at which the formation of an association of technical teachers was discussed, and the principal aims and objects agreed upon. The main objects comprise the advancement of technical education generally, the interchange of ideas or methods of teaching, and the safeguarding of professional interests. At a further meeting held at the Birkbeck College on Saturday, Mr. W. J. Lineham (Goldsmiths' Institute), who presided, remarked that the distinct interests of technical teachers rendered such an association necessary. It was proposed, he said, that the association should, in the first instance, be formed for the county of London, but ultimately it might become a national institution. Similar societies in Manchester and the West Riding of Yorkshire had, in fact, intimated their willingness to join a national movement. There are already organisations of teachers in elementary and secondary schools, and the promoters consider that a federated committee of the various associations would be of considerable assistance to the Board of Education. The following resolution was carried: "That this meeting hereby decides to form an association of science, technology, and art teachers engaged in the London polytechnics, technical institutes, and schools of art, such association to comprise both permanent staffs and evening teachers, other than those engaged in purely secondary work." An executive has been appointed to formulate the constitution, and to report to a general meeting in January.

Seats for Tramway Employes.—The report of the Highways Committee presented to the London County Council on Tuesday dealt with the question of providing seats for drivers and conductors. With reference to the former the committee have come to the conclusion that, having regard to the operations which a motorman has to perform in dealing with the controller, the electric and hand brakes, the foot-gong, and the sand pedal, it would be quite incompatible, either with the efficient working of the tramways or the safety of the public, that the motormen should be allowed to sit down while at their work. With reference to the provision of seats for conductors, the committee consider that, having regard to the large carrying capacity of the cars, to the number of short ½d. stages which are so extensively used by the public, and to the importance of the conductor being in a position to attend to intending passengers, and to assist persons in mounting and alighting from the cars, it would be very undesirable that this practice should be adopted. The committee point out that the men have already serious difficulty in collecting all the fares between the different stages. As an experiment the committee gave instructions some time ago that conductors should be allowed to rest against the end of the cars when not engaged. This was found to be unsatisfactory, as the conductors failed to notice many people who were waiting for cars at stopping-points. In the course of the discussion that ensued, Sir William Collins, speaking as a hospital surgeon, stated that the provision of seats would make an immense difference to the health as well as the comfort of the men. No decision has yet been arrived at.

Inspection of Electrical Equipment.—A paper on "Maintenance and Inspection of Electrical Equipment" was presented by Mr. J. Lindall, of the Boston Elevated Railway, to a meeting of the American Street Railway Association at St. Louis. An abstract of the paper appears in the *Electrical Review* of New York. After suggesting that the practice of supplying railroad literature to motormen and conductors should be extended to inspectors and repair men, the author emphasies the necessity of inspection of electrical equipment being systematic. Mr. Lindall remarks that the question of how often to inspect depends entirely upon the equipment and conditions of operation, but as the primary object is to prevent failure, the cost of inspection should be weighed against the direct loss in wages of trainmen while handling crippled cars, and the loss of patronage due to interrupted service. Under the system employed by the Boston Elevated Railway, surface lines, trolleys, switches, controllers, and motors are inspected after three days' service. Some of the cars which operate under particularly heavy work are inspected daily. In addition to this inspection, there is a monthly inspection which consists of opening up motors and cleaning and lubricating all the parts. Controllers are taken apart yearly, and thoroughly cleaned and painted. The wires are also inspected yearly for insulation weakness. The system employed on the elevated roads does not differ materially from that used on the surface roads. The equipment is inspected twice a week, and the controlling mechanism is tested. The best system of inspection, concludes the author, is one that is frequent enough to take care of the equipment properly with the least inconvenience to the service.

Electro-Therapeutics.—An animated discussion on the treatment of cancer occurred at the recent Dermatological Congress at Berlin. Prof. von. Petersen

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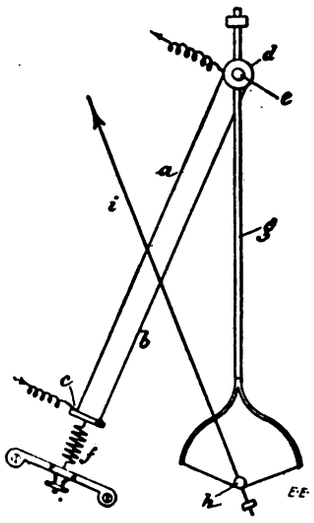
spoke on the subject of non-surgical treatment, and came to the following conclusions: (1) that epithelioma is curable without operation only in its initial stage; (2) that the best results are obtainable by "Finsenlicht," inasmuch as this treatment has no deleterious effects, though, unfortunately, it is very expensive; (3) that Röntgen rays are often productive of good results, but they must be employed with great caution; (4) radium rays give positive results, but are accompanied by dangers still greater than those arising from the use of Röntgen rays; (5) small surface epithelioma can be healed by continued bandaging with a solution of from 5 to 15 per cent. of soda. Prof. von Bergmann maintained that every kind of epithelioma can be permanently healed by means of surgery, whereas only a portion of the cases are healed by treatment by light. He admitted that when severe complications already existed the surgeon could not cure the patient. But in those cases the Röntgen rays also failed. Hitherto, he said, no cancer which has proved impossible to operate for had been healed by the Röntgen rays. It was true that in perfectly hopeless cases the pain of the patients could be alleviated by Röntgen and radium rays, but this simply meant the prolongation of the life of the patient and not his cure. Dr. Leredde, of Paris, stated that a clever doctor could always avoid causing harmful effects when using radium in cases of cancer. He had obtained good results from the use of radium. The president of the congress pointed out that a careful distinction must be drawn between the different kinds of epithelioma. Deep-rooted cancer, he thought ought to be operated upon immediately if an operation were possible, but superficial epithelioma should be treated by Röntgen rays.

Shoreditch Electrical Exhibition. — To commemorate the exhibition undertaken by the Shoreditch Borough Council, the exhibitors gave a dinner and smoking concert to a large assembly of guests on Monday at the Great Eastern Hotel, the Mayor, Councillor H. B. Bird, J.P., being in the chair. From all indications this exhibition has been a decided success. No fewer than 24,000 visitors inspected it, and Mr. C. Newton Russell, the borough electrical engineer, expressed his belief that the seed thus sown would fall on fruitful ground. In the course of his excellent speech in reply to the toast in his honour, he specially associated his staff with his own efforts in organising the exhibition, and predicted that its benefits would be particularly apparent in a great accession to the number of small power users. Monday's pleasant function demonstrated that Mr. Russell's talents are not confined to matters electrical, his rendering of "The Bandeleiro" being much appreciated. In regard to the excellent dinner provided, the novel menu seems to merit preservation as a memento of the compiler's genius: "Crême à la Russell; anti-sulphuric; boiled cable in bitumen sauce; cut-outs on shorts; contractor cutlets with earths; exhibitor's delight; L.C.C. regulations; hot bearings; hashed specifications; armature salad; welded joints; boiled shear-legs; baked field coils; casual enquiry; units; balancers." After this the company were regaled with an entertaining vocal and instrumental programme, and conviviality was the order, notwithstanding the efforts of one gentleman with bellicose tendencies to introduce Mars. When the organising secretary, Mr. C. S. Syer, gave "The Death of Nelson," this gentleman sighed for the resuscitation of the naval hero for the edification of the Russian Baltic Fleet. This in no wise detracted from the harmony, which reigned supreme throughout the evening. Messrs. H. F. Joel, Marryatt, and A. W. Penrose were responsible for some felicitous remarks in proposing the various toasts.

Hot-Wire Measuring Instruments.—A description appears in the *Electrical World* of New York of the Whitney Electrical Instrument Company's new design of voltmeters and ammeters of the hot-wire type. The principle on which these instruments operate is novel, and it is claimed that they constitute a distinct advance in the art of measuring apparatus of this class. The underlying principle is illustrated in the accompanying diagram. A wire, *a-b*, of high resistance, low temperature coefficient, and non-oxidisable metal, is secured at one end to a plate, *c*, passed around a pulley, *d*, secured to a shaft, *e*, and its free end brought back again and mechanically, though not electrically, attached to the same plate, *c*. Plate *c* is kept under stress by the spring, *f*, which constantly tends to pull it in a direction at right angles with the axis of the shaft, *e*, and is so guided that it can be moved in that one direction only. To the shaft, *e*, is likewise an arm, *g*, bifurcated at one end and counterweighted at the other. Between the extremities of the bifurcated ends of the arm, *g*, is another shaft, *h*, on which there is a small pulley, and to which is attached the needle, *i*, that gives the desired indications. A fine silk fibre is attached at one end to one of the arms of *g*, then passes around the pulley and the shaft *h*, and finally has its other extremity secured to the other arm. The arms are springy, and serve to keep the silk fibre



taut. The current to be measured flows through the wire *a*, only, entering and leaving as indicated by the arrows. Evidently, when *a* is heated by the passage of current, it expands, which, as *a* and *b* were originally under the same tension, makes *a*'s tension relatively less than that of *b*, and equilibrium can be restored only when the pulley, *d*, rotates sufficiently to again equalise the strain. The rotation of *d*, of course, carries *g* with it, and *g*, in moving, causes the silk fibre to rotate the shaft which carries the needle. If the temperature of the air surrounding the instrument changes, *a* and *b* are affected alike, and their resulting equal expansion simply results in a movement of the plate, *c*, back or forth in its path without any tendency to rotate the pulley. The advantages claimed for this design include perfect compensation and very limited tension on the wire. The new instruments being normally worked at a lower temperature than former types, there is a margin of safety such that an overload sufficient to cause the indicating needle to swing over 120deg. beyond the extreme normal limit of the scale when the cap is removed may be carried continuously without even affecting the calibration. The zero adjustment used is also novel. The entire moving system, shown in the diagram, is mounted on a single base plate free to rotate over a small angle around a heavy shaft

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secured to it immediately below and in line with shaft *h*, around which the needle swings. By means of a lever secured to this base plate and projecting slightly beyond the cap that covers the mechanism, the position of the needle relative to the scale may be altered at will without interfering with the wire in any way. While already nearly dead-beat in their action the instruments are provided with an auxiliary damping device, consisting of an aluminium disc secured to the shaft to which the needle is attached and swinging between the jaws of a small permanent magnet.

Electrolytic Oxidation of Hydrocarbons.—At a meeting of the Faraday Society on Tuesday, Messrs. H. D. Law and F. M. Perkin presented a paper on the electrolytic oxidation of hydrocarbons of the benzene series. The paper dealt with the methyl group, comprising toluene, ortho-xylene, meta-xylene, and para-xylene, mesitylene, and pseudo-cumene. The authors had repeated Renard's experiment in regard to toluene with somewhat different results, particulars of which will be communicated in a future paper. The oxidation of the xylenes brought out points of considerable interest. It was found that with ordinary oxidising agents the three xylenes behave very differently. Thus ortho-xylene, when subjected to the oxidising action of chromic acid, is completely decomposed with carbonic acid and water, whereas both meta- and para-xylene yield the corresponding dicarboxylic acids. Dilute nitric acid converts ortho-xylene into ortho-toluic acid, and para-xylene into para-toluic acid, but has no effect upon meta-xylene. Potassium permanganate, on the other hand, yields the corresponding dicarboxylic acids. The electrolysis was carried out in a rectangular glass battery jar of about 1,200 cubic centimetres capacity, which was placed in a vessel through which cold water was caused to slowly flow. The cathode compartments consisted of two narrow porous cells, which were placed against opposite sides of the battery jar, and contained cathodes of sheet lead. The electrolyte in the cathode compartment is either acid of the same concentration as that employed in the anode cell, or a 15 per cent. solution of sodium sulphate. When sulphuric acid is employed, it is necessary to refill the cells every 24 hours or so, owing to the depletion of the electrolyte through the migration of the SO_4'' ions. In the centre of the anode cell is placed a glass stirrer, worked by a water-turbine or electromotor, and on either side of it two platinum gauze or sheet platinum electrodes, each having half a square decimetre of surface; or two gauze electrodes of one square decimetre surface are fixed about 1 cm. from each of the porous cells, this latter arrangement having the advantage of lowering the E.M.F. A current density of from one to two amperes per square decimetre is usually employed. A great difference of action is exhibited by slight modifications in the mode of conducting the electrolysis.

Electrical Extraction of Nitrogen from the Air.—A paper on this subject, of which an abstract appears in *Electrochemical Industry*, was presented by Mr. J. S. Edstrom to Section C of the International Electrical Congress. The author, having indicated the necessity of making provision against the exhaustion of the Chili saltpetre mines, deals with other means of producing compounds of nitrogen. The nitrogen in the air is the source which has most naturally been turned to in seeking to produce a commercially useful article. Having reviewed the work of other experimenters, the author describes the process of Messrs. C. Birkeland and S. Eyde, of Christiania, which is based on a compound with oxygen. This process is founded on the fact that the current in the arc, and with it the arc itself, can be deflected by a magnetic field, the deflection being at a right angle to the lines of force. If the horizontal electrodes are connected to a generator in series with a suitable inductance coil, and a strong magnetic field is applied near the electrodes in horizontal direction and at a right angle to the direction of the electrodes, the arc between the electrodes will momentarily be carried upward or downward. It will then be broken, while simultaneously a new straight arc is formed between the electrodes, which is

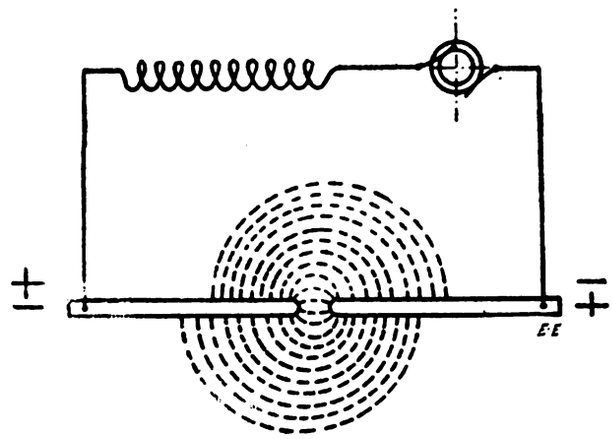

FIG. 1.

again carried outwards, etc. The speed of the formation, motion, and breaking of the arcs is so rapid that the arc can be formed several thousand times a second. In the practical form of the ovens only some hundred arcs per second are used. If the magnetic field is excited by a direct current, and the generator delivers direct current for the arc, a continual series of arcs will be formed moving radially with a speed corresponding to the strength of the magnetic field. The striking points of the arc along the surface of the electrodes are also moving away from the points at

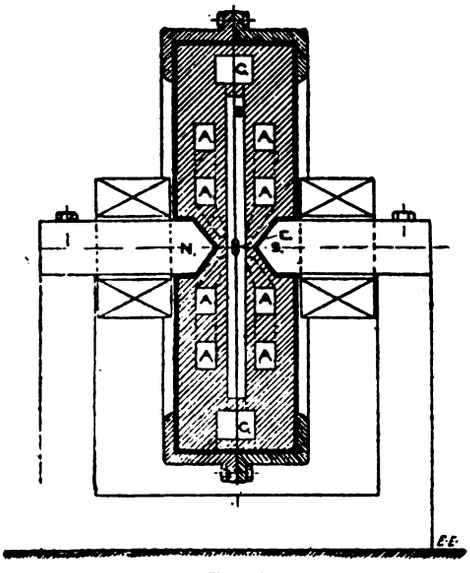

FIG. 2.

the same speed. Thus, the phenomena appear to the eye like a disc of arcs in the shape of almost a complete semi-circuit. The movement of the arc near the electrodes is usually more rapid at the negative than at the positive electrodes, shifting the centre of the circular disc somewhat to one side of a line joining the electrodes. If the magnetic field is excited by alternating current, and the arc is fed by direct current, the arcs will vibrate between opposite sides of the electrodes. This will also be the case if the arc is fed by alternating current and the magnetic field by direct current, in which

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case the phenomena will appear as indicated in Fig. 1. In Fig. 2 is shown the electric oven complete in a vertical section at right angles to the electrodes. The air that is to pass the oven is forced through the channels, A, and thence into the arc chambers of the oven, B, around and in the neighbourhood of the electrodes, E. Having passed this space from the centre, and coming into intimate contact with the disc of arcs, the air passes out into the channel, C, leaving the oven mixed with a certain percentage of oxidised nitrogen. The advantage of this apparatus is that the economical efficiency increases with the amount of energy employed at the electrodes. In spite of the relatively large current which can be employed in this type of oven, the electrodes exhibit marked durability.

Tests on a Transformer having High Electrostatic Capacity.—In a contribution to the *Elektrotechnische Zeitschrift*, L. Lichtenstein deals with some tests carried out on a high-tension alternate-current transformer built by the Siemens-Schuckert Company, and having a primary consisting of 2 × 30 turns of ·066 square inch section copper strip with a resistance of ·0096 ohm per limb, and a secondary winding of 2 × 30,000 turns of ·01in. diameter copper wire giving a resistance of about 12,150 ohms per limb. The low-tension primary coils were permanently coupled in parallel, whilst the high-tension secondary ones could be coupled either in parallel

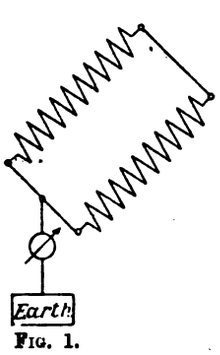

Fig. 1.

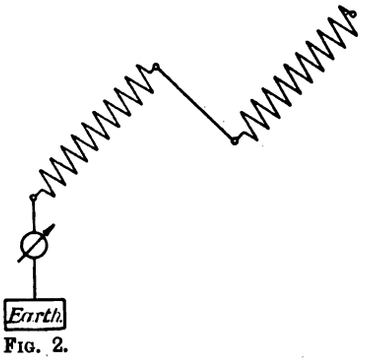

Fig. 2.

or in series. In this way the ratio of transformation could be made either 1 : 1,000 or 1 : 2,000, and as the primary was designed for about 100 volts at 50 ⁓, a secondary voltage of 200,000 could be attained. The secondary current with the limbs in series was ·05 ampere, so that the normal output of the transformer was 10 kw. It was noticed that on test with open secondary circuit, the primary current, at constant primary voltage, reached a different value according to whether the high-tension secondary limbs were connected in parallel or in series. A series of further tests was therefore carried out, and showed that there were also differences of primary current according to whether one pole of the secondary was earthed or both poles were insulated. The following table shows the results of the various tests :

Primary voltage.	Primary current.	Secondary voltage.	Secondary current.	Primary power factor.	Arrangement of the secondary as in
45·2	8·78	45,200	·00844	·858	Fig. 1*
45	13·38	90,000	·0133	·686	Fig. 2†
45	8·65	90,000	·00496	·852	Fig. 3*
45·2	10·4	45,200	—	·614	Figs. 4A and 4B*

* Primary coil lagging. † Primary coil leading.

It will be seen that merely changing the secondary coupling affected the primary current to the extent of about 50 per cent. The explanation is to be found in the fact that the great number of turns in the secondary gives the latter an appreciable capacity. This causes a charging current to be set up whose value depends on the coupling up, and these currents react on the primary current as shown in the table. The correctness of this explanation was confirmed by direct measurement of the charging current by means of a standard voltmeter (dynamometer) calibrated as a milliampere-meter, and having an internal resistance of 10,000 ohms. Since the charging current, as in the case of a cable on open circuit, is different at different points, the milliampere-meter had to be inserted at the point of maximum current. This point, when the two limbs are in series and both poles insulated, is in the middle of the winding—*i.e.*, midway between the two limbs (Fig. 3). When one pole is earthed the point of maximum current is in this earth connection (Fig. 2). This is also the case when the two limbs are in

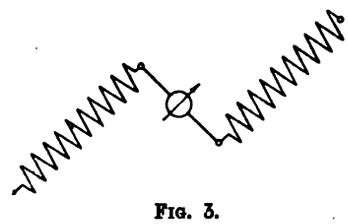
Fig. 3.

parallel with one pole earthed (Fig. 1). With the limbs in parallel but insulated at both poles the point of maximum current occurs midway along the winding of each limb, but in this case it was not possible to obtain direct measurements of the secondary currents. The primary current was, however, found to be the same whether the secondary limbs were connected or not (Figs. 4A and 4B). The various current measurements obtained are shown in the fourth column of the table. The seventh column shows that the primary current is a leading one in the case of the Fig. 2 connection, so that the capacity of the winding was sufficient to actually reverse the phase relation of the primary current. This question of the leading or lagging nature of the primary current was determined by successive measurements of the current at constant primary volts : (1) with a choking coil in parallel with the primary, (2) with the choking coil alone, and (3) with the transformer alone. By applying the vector diagram for the three currents it was easy to determine definitely whether the primary current was a leading or a lagging one. In conclusion, the writer proceeds to compare the test results with calculated results on the assumption of uniformly distributed capacity per unit length of secondary winding and for a sine wave of E.M.F. He shows that the maximum secondary currents measured by the ammeters in the arrangements indicated by Figs. 1, 2, 3, and 4 respectively should be in the ratio of 2 : 4 : 1 : ·5, whilst the actual measurements for Figs. 1, 2, and 3 gave currents in the

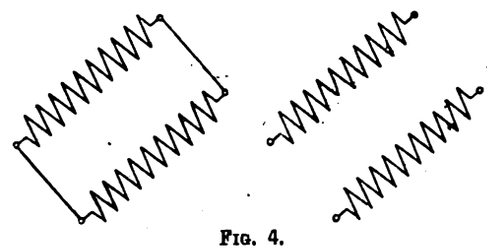
Fig. 4.

ratio of 1·7 : 2·68 : 1. This is as good an arrangement as could be expected considering that the assumptions made do not accurately represent the conditions. The whole capacity of the winding calculated from the currents and voltage measured with the Fig. 2 arrangement is about ·001 microfarad. It is clear that such a transformer might easily lead to resonance effects, for even with open secondary circuit all the components of a resonant circuit are present, the secondary leakage flux forming the self-induction and the capacity being the capacity of the winding itself. The comparatively frequent occurrence of voltage rises when making insulation tests may perhaps be explained in this way.

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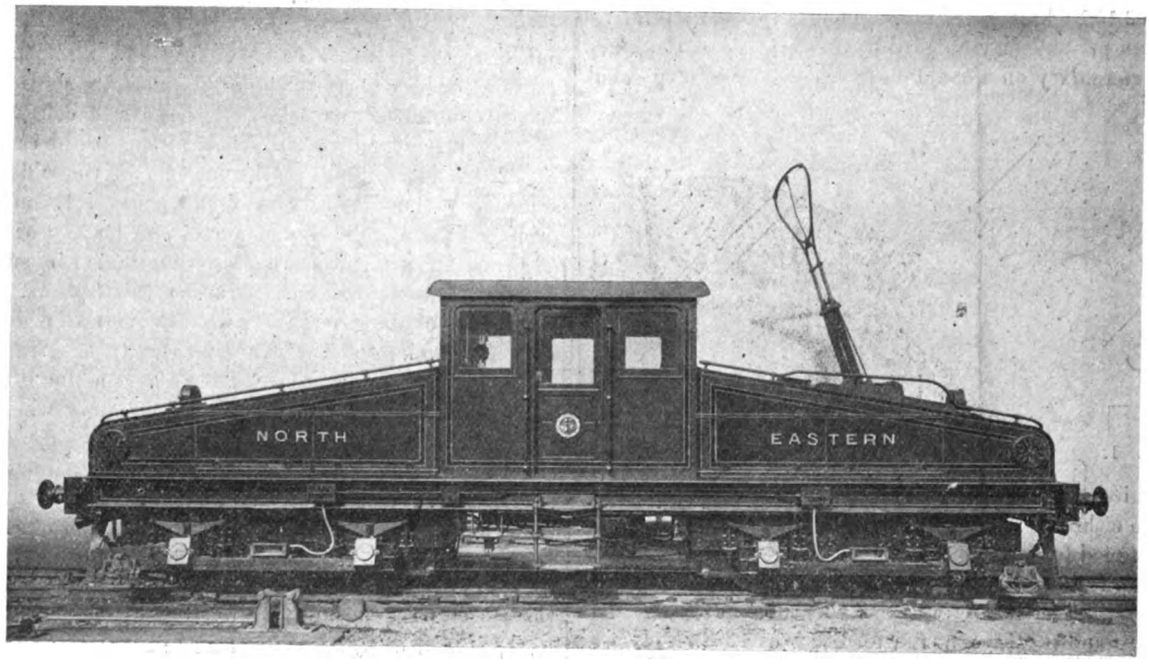
ELECTRIC GOODS LOCOMOTIVES FOR THE NORTH-EASTERN RAILWAY COMPANY.

Through the courtesy of the British Thomson-Houston Company, we are able to give the following details of the heavy electric goods locomotives they have supplied to the North-Eastern Railway Company. These locomotives are for use on the electrified sections of the company's lines round Newcastle-on-Tyne, and are constructed to haul heavy loads. For instance, according to the specification of the consulting engineer to the railway, Mr. C. H. Merz, each locomotive is capable of handling a 300-ton train on the level and of hauling it at a speed of 14 miles per hour. When working on grades under all conditions of weather, the locomotives are also capable of starting a 150-ton train up a grade of 1 in 27, and of running up this grade at a speed of nine to ten miles per hour. From this it will be seen that these locomotives, which weigh about 50 tons, are quite capable of handling the heavy goods traffic such as is found on the lines round Newcastle-on-Tyne. We are pleased to state that the whole of these locomotives were made in England. Thus the trucks and cabs were built by the Brush Electrical Engineering Company at Loughborough, and the electrical apparatus, with the Sprague Thomson-Houston multiple-unit system of control, were supplied by the British Thomson-Houston Company from Rugby. From actual trials we understand that the locomotives are able to exceed considerably the demands of the specification.



Side View of the N.E.R. Electric 50-ton Goods Locomotive made by the British Thomson-Houston Company.

As will be seen from the two illustrations given herewith, the locomotives are of the double-bogie type with a central cab and sloping ends. The four motors are of the G.E.-55 type with two-turn armatures and 3 28 to 1 gear ratio, one being mounted on each of the four axles. The control adopted is the Sprague-Thomson-Houston multiple-unit system, and is similar to that used on the passenger trains. The following are the leading dimensions: gauge, 4ft. 8½in.; length over central cab, 9ft. 0½in.; length over headstocks, 35ft.; length over buffers, 37ft. 11in.; pivotal centres of trucks, 20ft. 6in.; wheel base of each truck, 6ft. 6in.; width over cab, 7ft. 6½in.; width over side soles, 7ft. 10⅝in.; width over all, 8ft. 8in; height from rails to top of cab, 11ft. 9in; height from rails to top of floor, 4ft. 3¾in.; diameter of wheels, 3ft.; diameter of axles at centre, 6⅜in.; diameter of axles at wheel seats, 7 28; diameter of axles at journals, 6in.; length of journals, 10in.

The trucks are of the steel-plate frame type, in accordance with English railway practice, strengthened with steel angles and gussets with swinging bolster built up with steel sections and steel castings. The bolster is supported on two nests of coil springs of circular section, and is provided with cast-steel wearing plates, cast-steel centre, and side bearing plates. The side frames are supported on the axle boxes by laminated springs of heavy design. The axle boxes are of cast steel, machined to work in the horn plates, which are also of steel and machined, being riveted to the side frames, which are cut out to receive them. The axle boxes are provided with wings to take the shoe beams, and are fitted with heavy brasses babbitted. Ample provision is made for lubrication and exclusion of dust. The brake gear is of specially heavy design, as it plays an important part in the work that the locomotive has to handle, which is chiefly on heavy grades. Blocks are fitted to each side of each wheel, and all gear is heavy enough to stand operation by air pressure. The wheels are of the cast-steel disc type, balanced, and fitted with rolled-steel tyres 5½in. wide by 2½in. deep on tread, held in place by retaining rings and also by eight set screws. The motors are carried on the transoms by means of cast-steel brackets, in which the nose on the motor rests, being held there by a forged strap. The shoe beams are of oak, and bolted to the axle boxes, the shoes being hung outside the wheel base as shown on the drawings. All holes are drilled, edges of plates planed, and rivets hand riveted.

The underframe is constructed of steel sections, and ballasted with cast-iron blocks to bring up the weight desired. Each side sole is formed by a girder 12in. by 6in. by 54lb., and of I section. There are two centre longitudinals, each 8in. by 3½in. by ⅝in., of channel section, these four longitudinals being connected at their ends by headstocks 15in. by 4in. by ½in., of channel section. To the front of these is bolted oak headstocks 15¾in by 8in. The whole frame is firmly riveted together with steel angles and gussets, all holes being drilled and edges of plates machined. The underframe bolster is formed by two girders, each 6in. by 5in. by ½in., of I section, held together on the top by a plate 3ft. wide and ⅜in. thick, on the lower side being a plate 17in. wide by ⅜in. thick. Between the bolsters evenly spaced there are five cross girders, each 8in. by 3½in. by ⅝in, of channel section, backed with a plate 15in. wide by ⅜in. thick. On the top of the frame is a floor of fireproof wood 1⅞in. thick, fixed transversely, with a top or lining floor of ⅞in. thickness laid longitudinally. The draw gear, side couplings, and buffers are of the standard English pattern.

The centre cab is constructed of ⅛in. steel plate and angles, and is separate to the sloping ends, which are also constructed in a similar manner, all three portions being bolted to the underframe. The cab is provided with two side windows on each side, the one at the driving corners being arranged to lower. A sliding door is fitted on each

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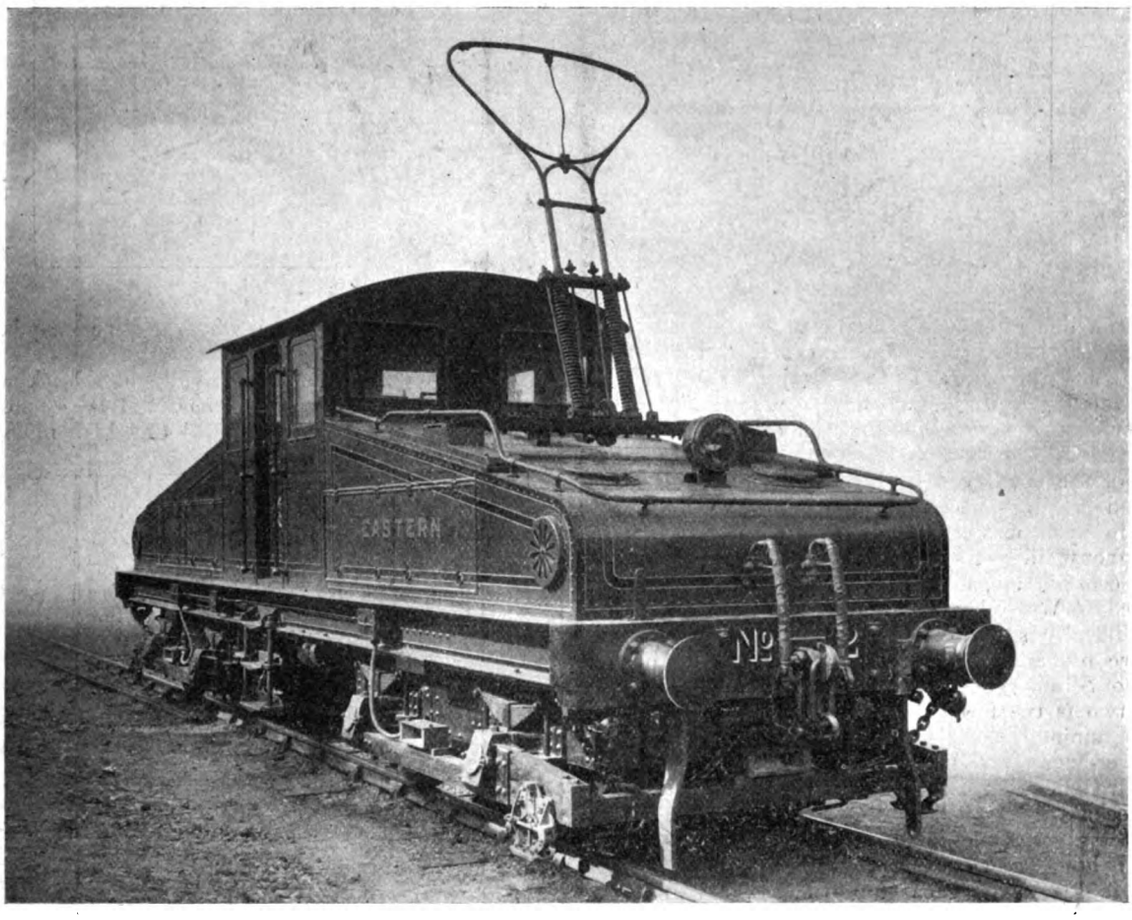
side, of ash, glazed at the top and panelled at the bottom, bearing on the outside the arms of the company in transfer. The doorways are 2ft. 4in. wide and 6ft. in the clear. At the ends of the cab are two windows arranged to slide transversely. Arrangements are made for driving the locomotive from each end of the cab, and it is therefore fitted complete in duplicate with master controller, air brake, sand and whistle valves. In the centre of the cab is fitted a cast-iron column to carry the hand brake gear; on each side is a panel for the control and pump circuit accessories, with a main panel at one end for main and control switches, etc. Air gauges and ammeters are also fixed in each driving position. Under the sloping ends are fixed the contactors, reversers, and rheostats; the apparatus for each two-motor equipment being fitted in its own end of the cab, the four-motor equipment being thus split up into two equipments as far as possible as regards location. The contactors are supported from an angle-iron framing built on the floor of the cab, the reversers and resistances being bolted to the floor, but raised above it so that the cable runways may run underneath them. The air brake is of the quick-acting pattern, air being supplied by a B.T.H. electrically-driven compressor of the C P. 14 type, which is hung underneath the frame. This compressor will compress against a pressure of 90lb. per square inch with a cylinder displacement of 20 cubic feet per minute. The air reservoirs are fixed in the ends of the sloping cabs, as also are the sand hoppers, the sand being carried by flexible tubes to the fixed pipes on the trucks, the air operating pipes being connected to the same at the base of the hoppers.

The lighting is effected by a shaded lamp fixed in each driving corner, with three lights in each of the sloping ends and a headlight on each end. All lamps are of 32 c.p., and are arranged for working six in series on a 600-volt circuit. Two portable lights are also provided.

As the locomotives have to operate over sections fitted both with overhead line and third rail, a sliding bow trolley has been provided of special design, automatically reversing itself according to the direction of travel of the locomotive, and also capable of being reversed and lowered when not in use from the cab by a hand-wheel actuating a worm and wheel device. All the cables used are asbestos-covered, and are run either in wood troughing lined with uralite or in steel tubing. Besides being fitted with the nine-wire coupler at each end for the control circuit, 'bus or main-line and pump-line couplers are also provided, so that two locomotives can be coupled together if necessary, and operated by one man for dealing with heavier loads.

The more extended trials in daily work of these locomotives will afford most valuable information to other railway companies contemplating the electrification of their lines.



End View of the Locomotive, showing the Slippers for Collecting Current from the Third Rails, and also the Bow Trolley.

THE LACKAWANNA AND WYOMING VALLEY RAILWAY.

At the present time, when schemes for railway electrification are rife all over the country, the doings of others in this respect become of more than ordinary interest, particularly when they are surrounded by adverse conditions such as are not usually met with. The recently completed third-rail line of the Lackawanna and Wyoming Valley Rapid Transit Company is one that has been carried out under conditions of competition that are certainly above the average. No less than five steam lines are in operation between the cities of Scranton and Wilkesbarre, the termini of the new electric line, and yet so immensely superior has electric passenger and goods traction proved itself that, although the opening of the main section only took place in December, 1903, results have already been obtained that fully justify what would appear at first sight a decidedly risky project.

The two cities of Scranton and Wilkesbarre are situated in a thickly-populated mining district of Pennsylvania, about 20 miles apart, and their population is respectively 150,000 and 75,000, suburbs included. In the immediate territory are several thriving cities, town, and villages, varying in size from Pittston, with 25,000, and Carbondale, with 15,500 inhabitants, down to some with a popu'ation

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of from 7,000 to 1,000, all more or less dependent upon the two larger cities for commerce and pleasure. The steam main lines running between Scranton and Wilkesbarre had given little attention to the commercial needs of these intervening places, excepting so far as the mining interests were concerned, and did not touch at them; so for this reason an electric line intersecting all the mining towns of any importance and passing through the centre of Pittston, the principal city, became a feasible project. The essential idea of the line is to provide a high-speed service, and as it was evident that more than the usual amount of difficulty would have to be encountered consequent upon the rugged nature of the country and the great number of railway and road crossings necessary, owing to their large experience in such matters, arrangements were made with Westinghouse interests to carry on the work, and the design, construction, and equipment of the property was entrusted to Westinghouse, Church, Kerr, and Co. With much difficulty suitable rights-of-way were obtained, and extensive properties secured for termini in the business centres of Scranton and Wilkesbarre. The more important of the two is the former, which covers about 98 acres of land, containing the passenger station, the goods station, the power-house, and the car-sheds and repair shop, all built of red brick with sills, lintels, etc., of moulded concrete blocks.

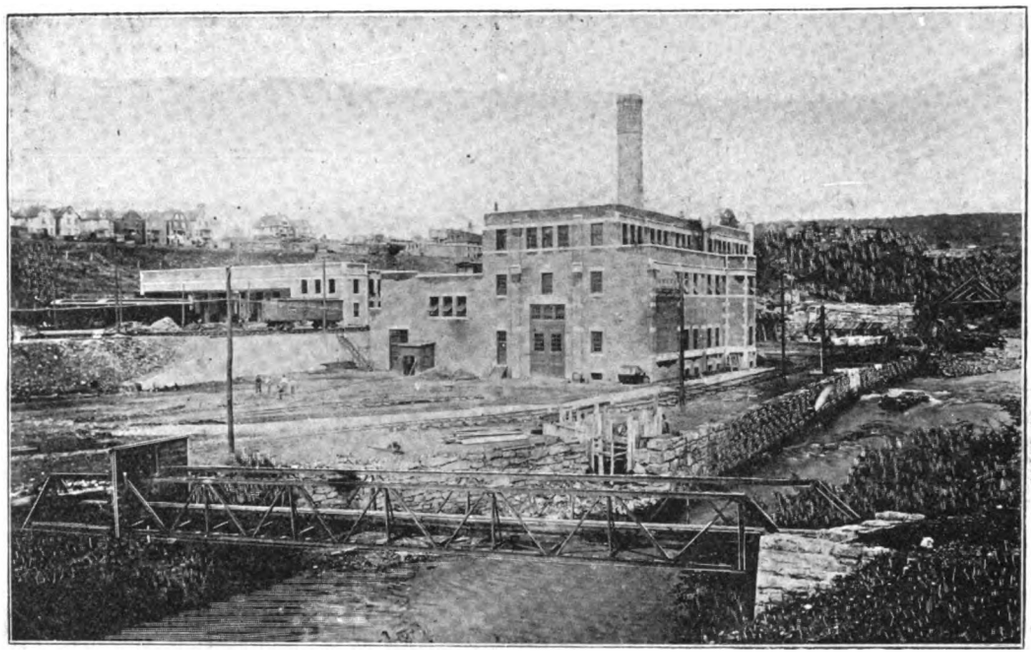

FIG. 1.—Power House, Lackawanna and Wyoming Valley Railway.

The passenger station is E-shaped, 83ft. long and 27ft. deep. It has a basement and two storeys, and is arranged with 11ft. loggias on each side, which provide covered passage-ways from the street to the platform in the rear. The waiting-rooms are well found, with mosaic floors and dark oak panelling, and the whole building is amply lighted electrically. The goods station, placed about 30ft. away from the passenger station, is one storey high and of rectangular shape, measuring 100ft. by 50ft., with an office extension at one end. The whole construction is upon the lines of heavy mill work, and is so designed as to afford every facility for the rapid handling of freight of all descriptions.

The car-house, situated at one extreme end of the yard, has a frontage of 146ft., a depth of 177ft. and a height of 28ft. 6in. clear. It is divided into three bays by brick walls running the entire length of the building; and each bay contains three tracks, each of which can accommodate three cars. While all can be used for the storage of cars, two are designed for that purpose exclusively, and the third is provided with all arrangements to facilitate repairs, which are accomplished in a specially-equipped extension. This latter bay is provided with two 15-ton travelling cranes and a compressed-air supply for operating pneumatic tools and for cleaning purposes. The repair shop runs the full length of the building, and is divided into a blacksmiths' shop, a machine shop, an armature repair room, and oil, sand, salt, and tool rooms. Contiguous are sundry offices, waiting-rooms, and lavatories, and the whole building, which is thoroughly fireproof, is lighted by electricity and heated by hot water, both furnished from the adjacent power-house. Close by in a private street are six small houses for motormen or other employés whose presence may be needed promptly in case of emergency.

The power-house (Fig. 1) is divided by a brick wall into separate boiler and engine rooms, and is rectangular in shape, 90ft. wide, 133ft. deep, and 42ft. high in the clear.

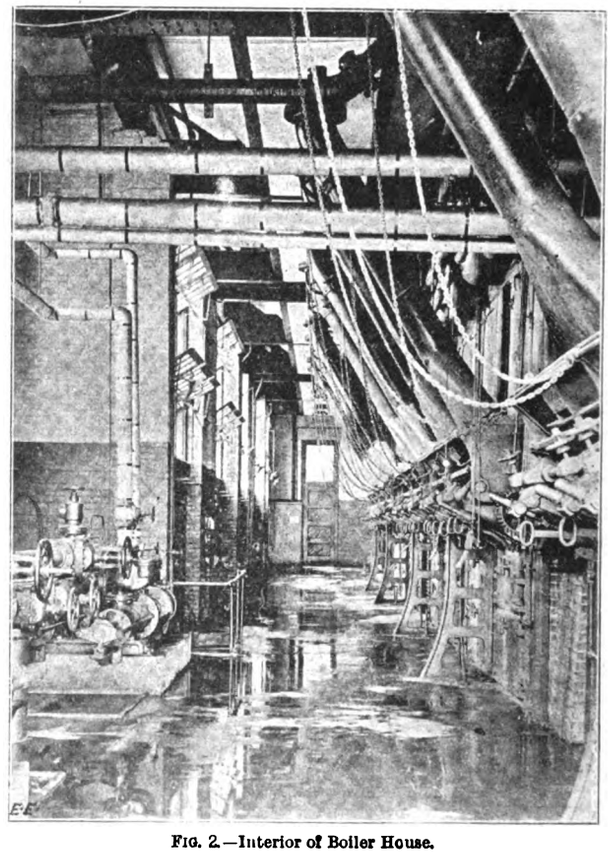

FIG. 2.—Interior of Boiler House.

It has been designed in every detail to allow of easy and cheap extension. The boiler-room (Fig. 2) is arranged to accommodate seven 400-h.p. water-tube boilers of the Babcock and Wilcox type, five of which are already installed. Each is equipped with a Roney mechanical stoker, specially adapted to burn with minimum labour the

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various grades of coal which the locality provides. Coaling is effected by trucks running on a trestle-supported track at the side of the building, and falling through chutes into a conveyor, the coal is automatically distributed into the bunkers above the boilers. From here it falls, as usual, by gravity into the stoker hoppers, the quantity being controlled by gates. The ashes are collected by a truck running on a track underneath the boilers, being directed into it by hoppers.

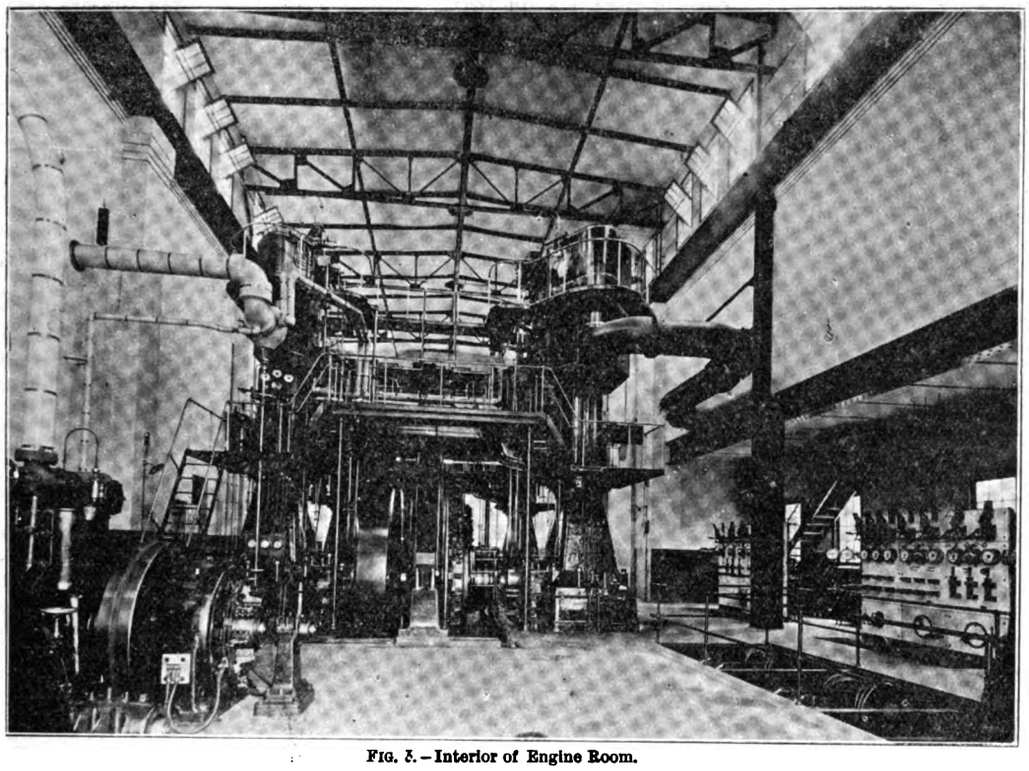

FIG. 3.—Interior of Engine Room.

by the blast from two blowers installed in the basement. The boiler-room auxiliary plant consists of two Worthington compound pumps connected in duplicate to several sources besides the hot-well. From whichever of these the feed is taken, it is passed through a specially designed horizontal, closed feed-water heater, where it attains a suitable temperature.

The steam-piping throughout is of standard full weight wrought-iron pipe fitted with extra heavy flanges, standard gate valves with outside yoke and screw, and covered with the best magnesia compound. It is arranged in a system of interconnected manifolds, with valves so placed as to make isolation of any part for repairs possible without interfering with the running of the plant. Draining is automatically effected by the Holly gravity return system,

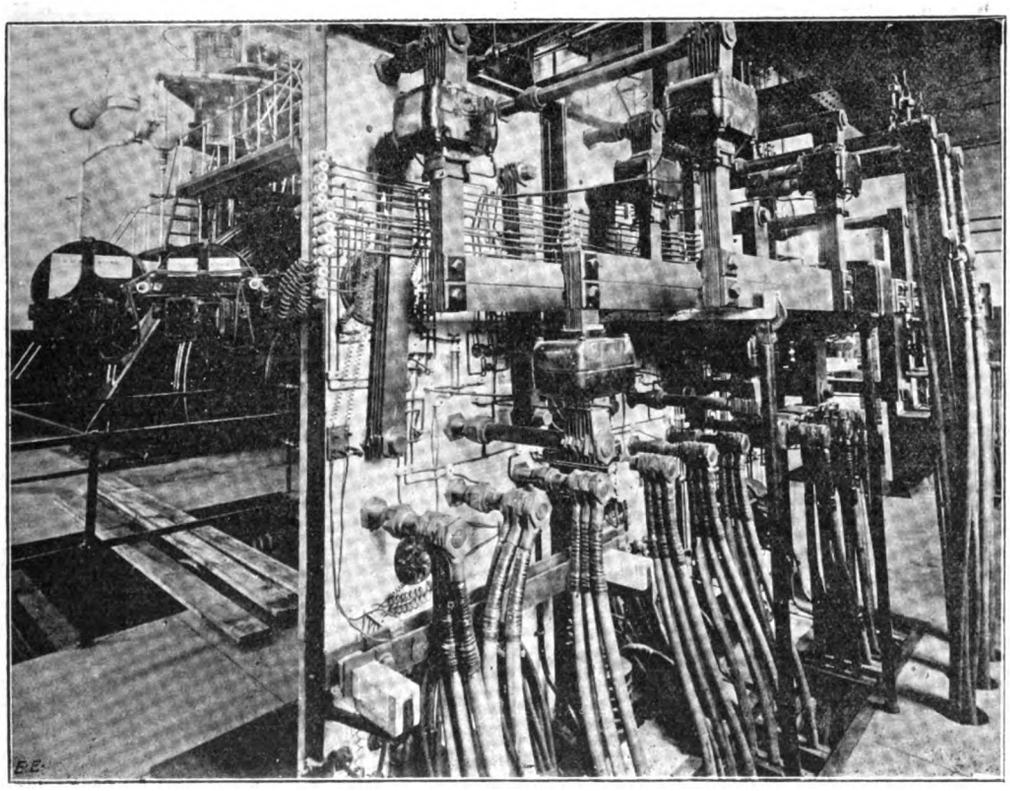

FIG. 4.—Back of Alternating-Current Switchboard.

The chimney is of the well-known Alphons Custodis construction, and is 118ft. high, 9ft. 10in. internal diameter, and rests on a concrete foundation. Access to its interior is possible through a door in its base, and an iron ladder runs from the ground to the top, both inside and out. Its draught may be supplemented, if necessary,

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and the wastefulness of steam-traps and their accompanying pipework thus avoided.

Coming now to the engine-room, an interior view of which is shown in Fig. 3, the two main engines already installed will, when occasion arises, be supplemented by a third, the bed for which is already in. Each of the present engines is of the Westinghouse vertical cross-compound type, with Corliss valve gear, and when supplied with 160lb. pressure steam and condensing will indicate 2,000 h.p., with a capacity for 60 per cent. overload at higher pressures. The oiling system is entirely automatic, and provides for the collection, filtering, and distribution of the oil. Each engine is coupled to a Westinghouse double-current generator of 1,250 kw. capacity supplying three-phase alternating current with a pressure of 390 volts and direct current at 650 volts. The exciter is at 125 volts pressure, and is derived from independently driven dynamos. A switchboard is provided for each side of the system, the one containing the controlling and measuring gear for the direct-current supply, which is used locally, and the other for the alternating current before its connection with the step-up transformers, where it is raised to a pressure of 22,000 volts and sent out to the line. There is no wood-work in connection with these switchboards, the whole being of marble, 3in. thick, set in steel. Fig. 4 shows the arrangement at the back of the alternating-current switch-board.

The high-tension transmission line is carried on 30ft. to 35ft. cedar poles spaced 100ft. apart, and consists of three No. 4 B. & S. hard-drawn bare copper wires arranged in a triangular manner and supported on umbrella type glass insulators. It is 14 miles in length, the far end being taken to the sub-station at Hancock, where the current is transformed and converted into direct. This is carried out in a fireproof room and tower separate from the main buildings, which are equipped for passenger and goods service along very similar lines as the main stations.

Between Scranton and Wilkesbarre the permanent way is double tracked, with cross-overs, and is carried out in the heaviest class of construction. The rails are of 90lb. A.S.C.E. section, fixed to 7ft. by 8in. long leaf yellow-pine sleepers, spaced 2,640 to the mile, which in turn are bedded on ballast and broken stone of a minimum depth of 10in. Under the fishplates two 4/0 protected bonds are placed, and every 500ft. the track is cross-connected by bonds of 250,000cm. The third rail, of 75lb. A.S.C.E. section, is placed in the centre of the track, and is bonded with two 400,000cm. foot bonds. It is broken at the stations, approach blocks being provided to make and break the circuit, and continuity is maintained by the aid of two 300,000cm. cables run underground on the solid system. The whole right-of-way, which varies from 60ft. to 150ft. in width, is protected by a wire fence. Speed being the primary consideration, much trouble has been taken to make the line as straight and level as possible with the result that there is only one 12-degree curve, and one grade greater than 1½ in 100. The natural and artificial difficulties of the country, as stated, have been very great, in places necessitating long cuttings through hard material, largely solid rock. One case that occurred at Pittston, where there is a 1,000ft. cutting, 25ft. deep, through rock and hard pan, is typical of these difficulties; and here, in addition, the Erie Railway had to be maintained in operation on one side, and a road carried across by means of a temporary bridge, while the water from two collieries and one washery, and the surface drainage from a very large area, had to be diverted by means of timber flumes. Such difficulties have almost proved the rule more than the exception, and might be extended into a formidable list. Roads, railways, and houses have been moved, in some cases considerable distances, and bridges and viaducts have been necessitated in great numbers. Of these, the one at the approach to Wilkesbarre, a viaduct 554ft. in length, has embraced the greatest engineering difficulties, as at this point the line is carried over the road, the Wilkesbarre Traction Company's

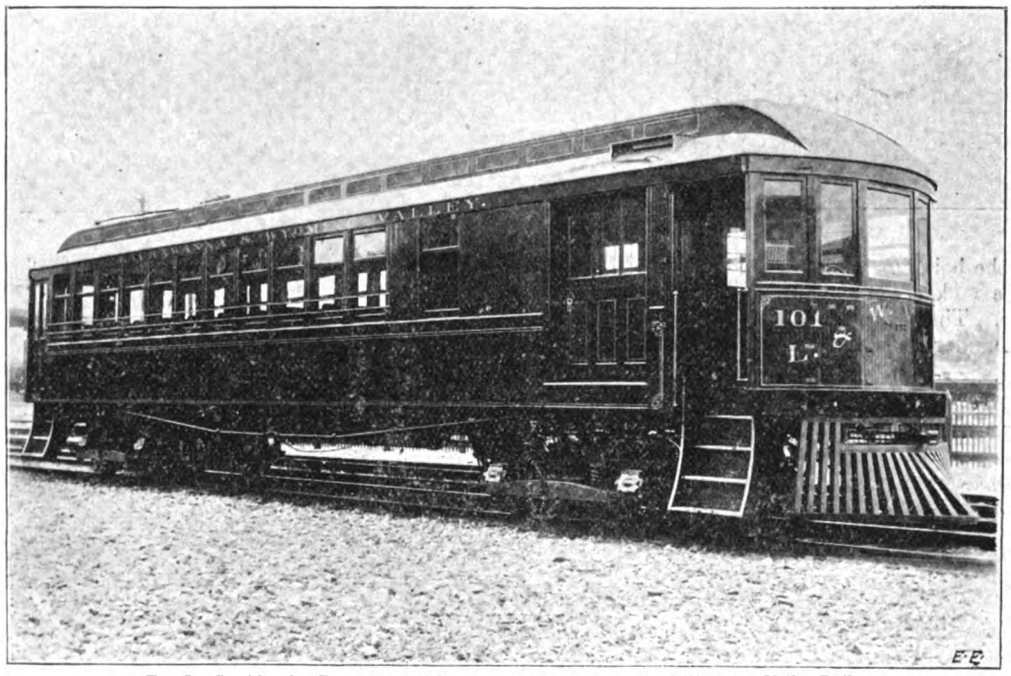

FIG. 5.—Combination Passenger and Baggage Car. Lackawanna and Wyoming Valley Railway.

trolley line, several tracks of the Lehigh Valley Railway, and the Central Railroad of New Jersey. The road and the tramcar line have been moved 30ft., and an embankment has been built across the old highway to bring the line to the viaduct. The Wilkesbarre terminus is the southern extremity of the line, and, as in the case of Scranton, provides ample accommodation for both passenger and goods traffic.

The rolling-stock comprises 10 regular passenger cars, three combination passenger and luggage cars (Fig. 5), four freight cars, and one for construction and repair work. They are all of the same dimensions, 42ft. long over end panels and 52ft. over platform, and were built by the American Car and Foundry Company to special designs. The trucks were made at the Baldwin Locomotive Works, and are of the M.C.B. swing-motion equalised bolster type; the motors are 150 h.p. of the single-reduction Westinghouse make, being attached to the rear truck by the aid of Gibbs cradle suspension. The passenger cars contain seating accommodation for 59, and are divided up into two compartments, one being for smokers. As the cars traverse loops at each terminus there is only one motorman's cab, and the backs of the seats are stationary. The construction and repair car has movable sides, and is equipped with two single-reduction 75-h.p. Westinghouse motors, which will enable it to make fast runs in emergency and perform

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snow-plough and other heavy work. In addition to this there is a 50-ton steam locomotive, that is looked upon as a stand-by in the event of a serious failure of the current. All cars are fitted with trolley poles for use in the yards, and Westinghouse automatic air-brakes are installed, as well as vertical hand-wheel brakes. The wheels are in all cases cast steel, with steel tyres and axles, except the construction car, which has chilled cast-iron wheels. At present a 20-minute schedule of running trains is inaugurated, which will be shortened as rapidly as the passenger traffic may demand.

We are indebted to the Westinghouse Company for the above particulars.

NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(Continued from page 593.)

The solenoid-control switch is an extension of this pattern, but with more perfect automatic action. This type of switch is shown in Fig. 4. This figure shows a slate on which are mounted a large solenoid switch, above this the ordinary multiple-step switch, the lever of which is connected at one end to a plunger which works in a dash-pot, while the centre is connected to a plunger of a second solenoid. Down the right-hand side are also shown a number of subsidiary solenoid switches. The method of working this switch is very simple, and the whole arrangements are carried out so as to attain a perfectly automatic reliable switch. The main solenoid is wound with many turns of fine wire, and this is energised by a current taken from the mains and controlled by a small tumbler switch capable of dealing, say, with one ampere. As soon as the circuit is made through the main solenoid switch by closing the tumbler switch, the switch is closed and the current is supplied to the shunt of the motor, and also to the armature through the whole of the external armature resistance, which is mounted at the back of the slate, the main solenoid switch acting as the main switch for the motor, although in the complete equipment a double-pole main switch ought also to be included. Upon closing this main switch a small current is supplied to the upper solenoid, and the plunger is attracted and so rises slowly upwards. The speed at which the plunger, and consequently the contact lever, moves is regulated by the dash-pot in two ways; in the first place, the viscosity of the fluid in the dash-pot can be varied, and, in the second, the end of the plunger forms a small piston, in which there is an opening to allow the fluid to escape from one side of the piston to the other. The size of this opening can be altered at will, and, of course, the speed of the lever will increase as the opening is made larger. For each individual switch the correct speed is found, and is usually set once for all; but if it is necessary to alter this, it can be done, only as the dashpot has to be opened out and the piston removed, there is little fear of the switch being tampered with by any than authorised persons. When the lever has risen to the second contact, the top smaller solenoid is energised, and its switch closed. This acts in exactly the same manner as the switches in the starter just described, and opens a path to the armature through a shorter length of resistance. The contact lever now moves on to the third contact, and the second auxiliary solenoid is energised, and the connected switch closes, a further amount of resistance being cut out. There is no difference between this solenoid switch and the previous one, except that whereas in the former case, when all the switches were closed, all the various lengths of resistance were connected with the armature circuit through any switch. In this case, as soon as the second solenoid is closed, the circuit is opened through the first auxiliary solenoid, and this becomes demagnetised, and the switch it controls at once opens, so that the only path through the armature is that offered by the last closed solenoid switch. When the final auxiliary solenoid switch, generally known as the master switch, is closed, the armature is directly connected across the mains.

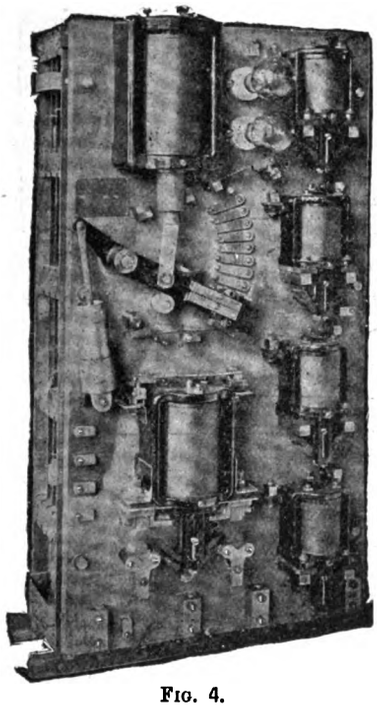

FIG. 4.

The Sturtevant Engineering Company, Limited, who are the makers of this switch, have fully considered all the possible points of improvements; it will be noted that only a small shunted current sufficient to energise the various solenoids is dealt with at the contacts, so that very little arcing or burning will occur here. Again, during the operation of starting the motor this current has to energise the various solenoids, and therefore has work to do, but when the motor is under weigh all that the shunted current has to do is to keep the main and master solenoidal switches closed, and for this a smaller current will suffice. This result is attained by arranging two or three lamps in series in such a manner that the circuit is only closed through them when the master switch is closed. Again, the makers acknowledge the importance of dealing with the current due to the self-induction of the shunt, and consequently additional lamps are inserted so as to be in circuit at the periods of make and break. In starting the motor through this switch the lamps are seen to incandesce, and the main switch closes, then the lever gradually moves upwards the various auxiliary solenoidal switches, closing and opening again in rotation. When the motor is stopped the lever gradually drops down to the off position, and as it leaves the last contact breaking the shunt connection the lamps will be seen to momentarily incandesce to a great degree, showing the high value of the induced E.M.F. The auxiliary small switch required to energise the main solenoid need not be placed on the switch base, but can, and is generally, placed some distance away near the machine driven by the motor. In the case of the failure of the current, the main and master solenoids will become de-energised, and their switches will then open. It is impossible to then again start the motor until the contact lever has descended to its off position, so that the solenoids themselves act as a most efficient no-volt release. It is not customary to make this piece of apparatus complete with an overload preventer. If this is required, it should be in the form of a secondary piece of apparatus—viz., a maximum type circuit breaker.

The switch described above is for larger sizes of motors. For the smaller sizes the switch consists of the main solenoidal-controlled switch and the solenoidal-controlled contact lever fitted with the necessary steps. All the auxiliary solenoids are then omitted, and the main current is dealt with at the multiple-step switch in the more ordinary manner. For large sizes it is better to deal here only with the shunted current necessary to energise the auxiliary solenoids.

A simple form of switch is shown in Fig. 5 This switch was designed by Mr. Gibbings when chief electrical engineer at Bradford. This town is one where there are a very large number of motors let out by the Corporation on hire, and Mr. Gibbings found that a very large percentage

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of the breakdowns to motors which occurred in the town were due solely to defective starting switches, and he therefore set to work to design a switch which should answer ordinary requirements, be simple in its action, and low in cost. The switch is now made by Mr. Bertram Thomas, of Manchester, and consists of the ordinary movable lever and multiple steps, but the lever is moved by compressed air. The lever is connected to a plunger which works in an air-cylinder. The operator presses the handle inwards, and turns it so as to lock it on to the lever. This also releases a spring, which causes the lever to move over the contacts at a fixed speed, the actual rate being controlled by the amount of air which is allowed to escape. The air opening being adjustable, when the opening is completely closed the lever will retain its position for long periods, thus showing the good fit which the piston makes in the cylinder. The switch is also fitted with a no-volt release and automatic overload preventer. Recently the makers have further improved the switch by arranging for quick break between the different contacts, and they thus minimise to a great extent all sparking and burning.

There are several good makes of ratchet-type switches, and in Fig. 6 is shown the ratchet attachment of the switch made by Bray, Markham, and Reiss. This attachment is mounted at the back of the slate, the corresponding position at the front being occupied by the ordinary multiple switch. The action of starting the motor by this switch is as follows: The operating handle is first moved in one direction, carrying with it a single-pole switch which is held in the on position by means of a trigger which engages with the keeper of the no-load magnet. At the moment of making contact the ratchet wheel and the contact arm will have turned into such a position that the lever is on the first contact. The handle is now turned in the opposite direction until the pawl comes into contact with a tooth; it is impossible to take more than one tooth at a time, as the ratchet wheel is shrouded for a great proportion of its circumference. Stops are shown on the face between which only the handle must be moved; if the operator moves the handle beyond these limits, or should he desire to leave some resistance in circuit with the armature, and so leave loose of the handle before all the resistance is cut out, the handle will come back to the off position and a projection on the pawl lever will cause the single-pole switch to open. This is an important point, as it prevents most effectually any portion of the resistance being left in circuit under any circumstance. The switch is fitted with overload and no-volt releases, and also with a magnetic blow-out. As the break always occurs at one point, the single-pole switch, the point of sparking is localised, and the addition of the magnetic blow-out prevents any serious burning occurring.

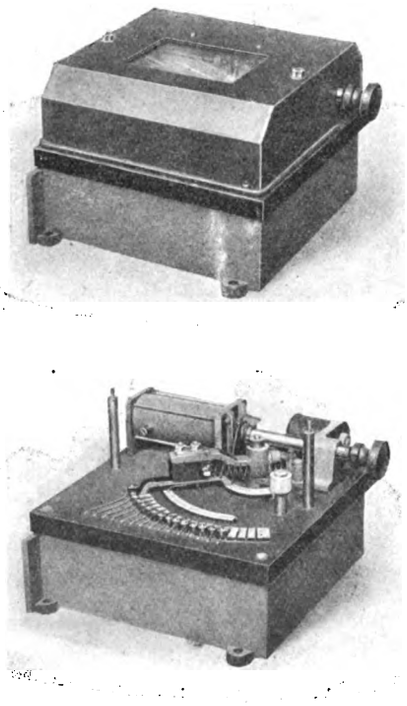

FIG. 5.

Liquid resistance starting switches are of great benefit in many classes of works, especially where the motors and controlling apparatus are exposed to the action of the atmosphere, but with shunt-wound direct-current motors they have the disadvantage that there is yet no good switch on the market which will fulfil all the requirements of the metallic resistance switch. The usual liquid starting switch consists essentially of an iron tank filled partially with an electrolyte, and into which an iron or copper plate is lowered when the motor is started, the resistance being decreased as more and more of the movable plate is immersed; the final contact should be between metal and metal. The one great disadvantage is that the solution cannot be plain water, owing to its low conductivity, and, therefore, an acid or alakaline solution must be used; generally a weak acid solution is chosen. The passage of the current sets up electrolysis, and acid fumes are given off which attack any metal work. The majority of the metal work can be painted with acid-resisting paint, but the points of contact cannot be, and hence there is liability of undue wear here. In the best forms of liquid switches no contacts are made directly over the tank, but rather at the side, and the movable plate is operated by means of worm gear to permit of the motion of the plate being slow.

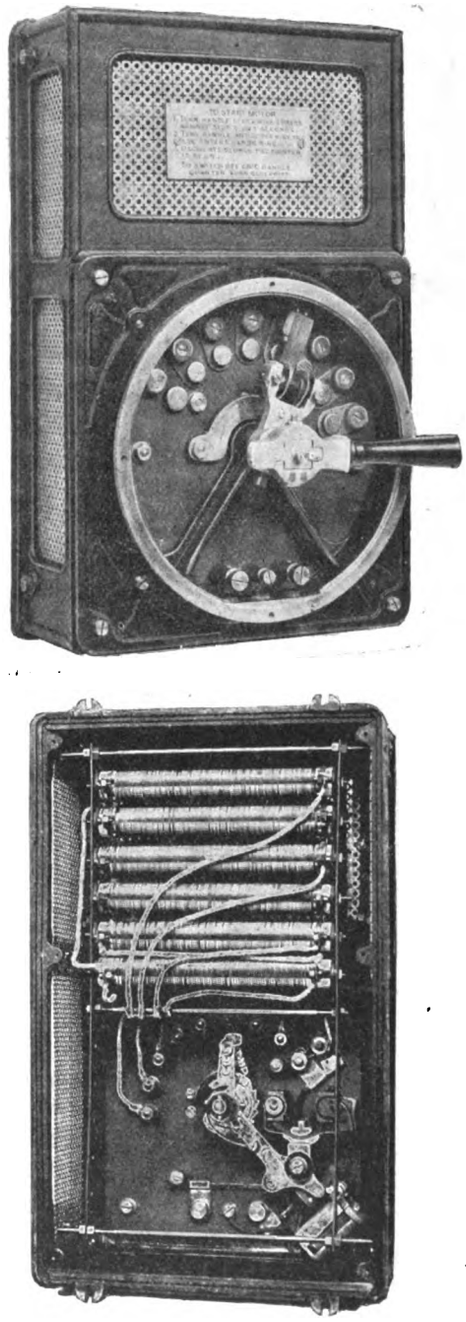

FIG. 6.

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Owing to the rough treatment which liquid starters will stand, they are of great service, and as they are subjected to usage that the metallic switches could not survive for any length of time, the corrosive action of the acid fumes is only a minor matter. When this type of starting switch is used, it should be in conjunction with the maximum and no-volt circuit breakers before mentioned. These circuit breakers, though of delicate construction, can be mounted in iron boxes and made perfectly watertight, the handle for setting them should they open coming through the sides of the cases, and they will, therefore, be protected against much rough usage; in addition to which these necessary parts of the equipment need not be fixed in such exposed positions as the starting switches themselves, but may be placed some little distance from the motor under cover. The writer lately examined some electrical plant at one of the large shipyards where liquid starters were used, each motor being further supplied with maximum and no-volt circuit breakers mounted in iron cases, and he found that the arrangement worked very satisfactorily, and that there had not been the slightest trouble with any of the plant since erection, although at a neighbouring yard, where only liquid switches were used without circuit breakers, the fields being directly connected across the mains in the more ordinary manner, the breakdowns to the motors are far from being uncommon.

(To be continued.)

NOTE ON A SUGGESTED NEW SOURCE OF ALUMINIUM.*

BY BUENA POOL, B.SC.

In bringing the following results before British electrochemists, I should like at once to point out that they are to be found in full detail in the *Geological Magazine* for 1903 in the work of Mr. Holland and Messrs. Warth. The suggestion particularly to be brought out by this paper is the practical utilisation of the results. As is well known, practically all the aluminium produced at the present day is made from bauxite, of which the British Isles possesses but scanty deposits. It appears, however, that in India we possess a vast treasure-house and store of aluminium in a formation which is spread over the surface of thousands of square miles of country waiting for the spade of the prospector. The laterite deposits of India have long been a puzzle to geologists. They occur spread over vast areas as a purely superficial deposit of depths varying from a few feet to a few hundreds of feet, chiefly over the Deccan trap area of Central India. Until recently laterite, in consequence of its appearance and consistency, was loosely classed as a clay; recent careful investigations and analyses seem to show, however, that it is much more closely analogous to bauxite, the aluminium being present in the hydrated form and not as silicate.

Laterites vary pretty considerably in composition; they fall naturally into two groups—the "high-level" and the "low-level" laterites High-level laterites, as the name indicates, are found at higher elevations on the Deccan traps of Central India; the low-level laterites, on the other hand, are found along the coasts. The western coast-line of India, from Ratnigiri southwards, consists of a laterite formation up to the thickness of 200ft., and on the eastern coast-line laterite occurs everywhere. But this is a much less massive formation than the rock of the western coast, being at most only about 20ft. thick. Low-level laterites differ from the high-level laterites of the interior in structure and composition; they are less hydrous and more concretionary; they contain more silica in rounded grains and less alumina. They are apparently detrital in origin, being formed by water action from the high-level laterites Drs. H. and F. J. Warth† have made a series of analyses of Indian laterites. They find that in chemical composition Indian laterites fall into four distinct classes:

I. The deposit found at Kodikanal, which stands alone. It is a pure gibbsite ($Al_2O_3 + 3H_2O$); after ignition it contains nearly 95 per cent. of aluminium oxide. It forms a deposit of 1ft. in thickness, consisting of loose crusts and plates, over an area of at least several acres, lying between the surface soil and the charnockite rocks. Kodikanal is a small summer resort on the Palni Hills in the Madura district of the Madras Presidency (lat. 10° 13′ 21″; long. 77° 31′ 38″ E).

II. Laterites (from districts which are not specified) with pisolitic structure; they are bauxites, very rich in alumina, and with very little iron, closely resembling wocheinite. Analyses of four specimens are given in Table A.

TABLE A.

—	Kh.	Pl.	Sr.	Rw.
H_2O	26·47	24·00	28·10	26·94
SiO_2	·93	1·79	2·01	2·35
TiO_2	1·04	3·30	6·49	6·61
CaO	·36	·04	·45	·15
MgO	—	·02	—	—
Fe_2O_3	4·09	6·21	5·48	6·53
Al_2O_3	67·88	64·64	58·23	57·50
	100·77	100·00	100·76	100·08
Molecules of Water for One Molecule of Alumina.				
—	2·23	2·11	2·75	2·67

They contain little iron, very little silica, and a rather large amount of titanium dioxide, probably as ilmenite.

III. The third group includes specimens such as have usually been called high-level laterites. These are practically bauxites which have been formed from highly ferruginous igneous rocks; they belong mostly to the area of the Deccan traps. It is found that the amount of iron in the laterite bears a close relationship to the amount in the underlying rock. This bears out the theory that they are derived from them. Analyses of six such specimens are given in Table B; with the exception of two specimens with admixed quartz sand they show very little silica. The resemblance of these analyses to those of ordinary bauxite is obvious and striking. A general property of these high-level laterites is their infusibility before the blow-pipe. This serves to distinguish them from the low-level or detrital laterites forming the next group.

TABLE B.

—	Marwara.	Makab.	Sartara.	Nilgiris.	Karad.	Satara.
H_2O	26·82	24·99	23·88	20 70	11·82	14·39
Quartz, SiO_2.	—	—	—	—	1·77	—
SiO_2	3·90	·72	·37	3·14	4 23	·90
TiO_2	·38	·42	4·45	—	·10	1·59
CaO	·35	—	·86	—	·52	·64
MgO	—	—	—	—	trace.	·20
Fe_2O_3	13·75	23·41	26·61	37·88	51·25	56·01
Al_2O_3	54·80	50 46	43·83	38·28	30·86	26·27
	100·00	100·00	100·00	100·00	100·00	100·00
Molecules of Water for One Molecule of Alumina.						
—	2·80	2·83	3·11	3·09	2·19	3·13

IV. Low-level laterites. Free silica, and probably an even larger amount of clay, is present in all cases. Analyses of eight specimens from different localities are given in Table C. These analyses show that the amount of alumina in low-level laterites may vary from about 30 per cent. down to zero. The amount of free quartz also varies irregularly from about 40 per cent. to 4 or 5 per cent., depending on the locality, and clay (as kaolin) from 17·16 to 50·26 per cent. These laterites, as a rule, contain more iron than the high-level deposits; in places the iron content is so great that the laterite has been used by the natives as a source of iron. This effect is probably due to the sorting action of running water, which has floated away the lighter scales of gibbsite from the original high-level laterite, and so caused a relative increase of the heavier iron ore.

Mr. T. H. Holland,* director of the Geological Survey of India, has pointed out that this deposit only occurs in countries with tropical climate and an abundance of running

* Paper read before the Faraday Society, Oct. 25, 1904.

† *Geological Magazine*, vol. x., 1903, p. 154, "Composition of Indian Laterites."

* *Geological Magazine*, vol. x., 1903, p. 59, "On the Constitution, Origin, and Dehydration of Laterite."

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TABLE C.

—	Belgium district.		Jabalpur.	Dharwar.	Balaghat.	Birbhum.	Madras district.	
Colour when pulverised	Lavender.	Red.	Red.	Redd.-brown.	Brown.	Redd.-brown	Redd.-brown.	Brown.
H_2O	13·31	11·42	10·93	9·64	7·73	9·60	8·66	8·40
Free quartz, SiO_2	32·24	6·67	4·53	16·63	39·53	6·29	28·04	32·46
Combined SiO_2	9·94	13·35	23·32	14·79	7·96	17·49	14·07	13·33
TiO_2	·04	·25	·43	·02	·01	·04	·01	·01
CaO	nil	nil	—	·04	—	·03	—	·06
MgO	nil	nil	—	trace	—	—	—	—
Fe_2O_3	8·77	41·50	28·99	35·81	23·38	42·33	30·51	35·34
Al_2O_3	35·70	26·81	31·80	23·05	16·39	24·22	18·60	9·93
	100·00	100·00	100·00	100·00	100·00	100·00	99·89	99·53
The same with the clay calculated separately from the combined silica (kaolin = $Al_2Si_2O_7 + 2H_2O$).								
Free quartz, SiO_2	32·24	6·67	4·53	16·65	39·53	6·29	28·07	32·61
Clay as kaolin	21·42	28·77	50·26	31·88	17·16	37·69	30·33	(27·39)
Balance identical with bauxite. H_2O	10·33	7·41	3·93	5·20	5·34	4·35	4·45	4·42
Balance identical with bauxite. TiO_2	0·4	·25	·43	·02	·01	·04	·01	·01
Balance identical with bauxite. CaO	—	—	—	·04	—	·03	—	·06
Balance identical with bauxite. MgO	—	—	—	trace	—	—	—	—
Balance identical with bauxite. Fe_2O_3	8·77	41·50	28·99	35·61	23·38	42·33	30·55	35·51
Balance identical with bauxite. Al_2O_3	27·20	15·40	11·86	10·40	9·58	9·27	6·59	—
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

water. (The latter suggests the possibility of water power for the generation of the electricity necessary to work the ore.) Where precipitation is low, although the climate may be moist, a material known as "kunkar," is found, which, though otherwise similar to laterite, contains a great deal of lime. Laterite is apparently "kunkar" out of which the lime has been abstracted by the solvent action of running water. The colour of laterite varies according to the particular iron hydrate present; its consistency *in situ* is like putty. On exposure to the air, however, it hardens, owing to spontaneous dehydration, and becomes darker in colour as the ferric hydrate loses water. It is a very porous rock, being frequently traversed by cracks and small irregular tortuous tubes; in consequence of this it makes very poor and barren soil. Low-level laterites show no structure, but the high-level ones have a marked tendency towards a concretionary structure, while higher still the soft material often retains a perfect cast of the igneous rock from which it is formed. The junction of the laterite with the unchanged rock is sharp, sudden, and complete. Arguing from this and from its distribution and other characteristics Mr. Holland suggests that laterite may owe its origin to some bacterial agency which forms it *in situ* by attacking the silicates in igneous rocks. It would thus, by absorbing the silica and rendering it soluble, leave the iron and aluminium, which would become hydrated and left as the bauxite-like deposit which we find. This bauxite has all the characteristics to render it commercially valuable; its pureness, ready accessibility, widespread occurrence at all elevations, and association with flowing water point it out as an almost perfect source of aluminium.

VOLTAGE RISES ON THREE-PHASE CIRCUITS.*

It is well known that in single-phase installations employing concentric cables, incorrect switching in or out, or even the blowing of fuses, often causes a breakdown between the outer conductor and the lead covering. From tests made in connection with this matter, the rule "outer conductor to be switched in first and inner conductor to be switched out first" has resulted. In the case of three-phase installations also excessive voltage rises and the consequent breakdown of cables or machines may result if one phase, in a circuit consisting of the generator, the cable, and transformers on open circuit, is opened at the generator end and one of the other two phases at the transformer end. This arrangement is shown diagrammatically in Fig. 1. The generator with its terminals I., II., and III. is shown on the left, and the open-circuit transformer terminals, 1, 2, and 3, on the right. The cable lying between the two may be represented by the three capacities, C_1, C_2, and C_3. The switches or fuses are shown at *a*, *b*, *c*, *d*, *e*, *f*, and *b* is assumed to be open at the generator end, and *d* at the transformer end. The opening of *b* and *d* may in practice occur either through carelessness or through the blowing of fuses. With the conditions stated, the following circuit exists: from I., through *a*, the capacity C_2, *e*, the open-circuit transformer, 3—2, *f* and *c*, back to the generator terminal II. At the same time, the capacity C_3 is connected in parallel with the generator, and the capacity C_1 in parallel with the transformer. The arrangement is shown more simply in Fig. 2, and it will be seen that all the conditions for a resonance effect are present.

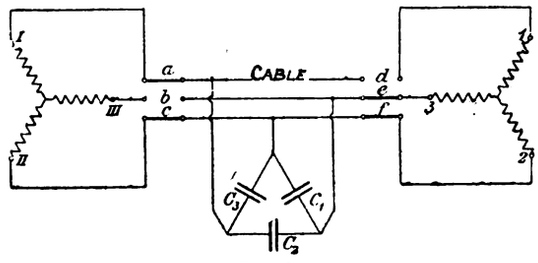

FIG 1.

Experiments were made in the laboratory of Messrs Felten and Guilleaume on an artificial circuit of this sort, composed of three mica condensers, $C_1 = C_2 = C_3 = 1$ microfarad, and an iron-cored choking coil having an ohmic

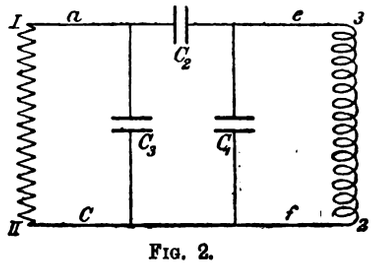

FIG. 2.

resistance of 164 ohms and an impedance of 1,310 ohms at 61 ∼ (coefficient of self-induction = 3·4 henrys), as determined by current, voltage, and watt measurements with a sine wave of E.M.F. With a generator voltage of 14 volts at 61 ∼ the following voltages across the several condensers were measured:

Across condenser $C_1 = 120$ volts.
" " $C_2 = 126$ volts.
" " $C_3 = 14$ volts.

These voltages were measured on an electrostatic voltmeter having negligible capacity compared with one microfarad. The self-induction of the generator was also negligible. It will be seen that condenser C_2 (or the cable) was subjected to a pressure nine times as great as that at

* Abridged translation of an article by P. Humann in *Elektrotechnische Zeitschrift*, Oct. 13, 1904.

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the generator terminals, which in practice might lead to disastrous results. The calculated capacity for complete resonance with the above self-induction at 61 ⁓ is two microfarads. An actual measurement was made with the choking coil connected simply in series with a condenser of two microfarads, and complete resonance was obtained, the voltage across the condenser being 126 again with 14 volts at the generator terminals.

At the first glance it is not quite clear why the connection of a one-microfarad condenser in series with a combination consisting of a choking coil of 3·4 henry and a condenser of one microfard, as shown in Fig. 2, should give resonance, when by calculation a condenser of one microfarad corresponds to a self-induction of 6·8 henrys for complete resonance at 61 ⁓. Considering the above combination of self-induction and capacity as simply an equivalent self-induction, however, its value works out at

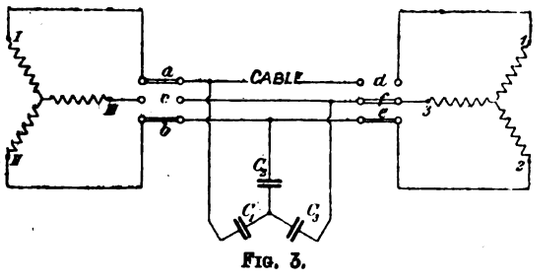

FIG. 3.

7·1 henrys from current voltage and watt measurements, which showed that impedance = 2,760 ohms, resistance = 438 ohms. Allowing for experimental errors, this value of 7·1 is a good check on the calculated value of 6·8. The impedance of 2,760 ohms also checks fairly with the value 2,600 calculated from the expression for the impedance of a parallel-connected choking coil and condenser—viz :

$$\text{Impedance} = \frac{\sqrt{R^2 + w^2 L^2}}{\sqrt{(1 - w^2 L C)^2 + w^2 C^2 R^2}}$$

where R = ohmic resistance;
L = self-induction;
C = capacity;
$w = 2\pi$ ⁓.

The impedance of such a combination, in fact, at first increases as the capacity is increased until the capacity reaches the correct value for current resonance; after that the impedance of the combination falls off as the capacity is further increased.

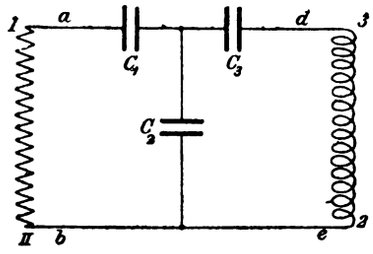

FIG. 4.

The substitution in the above experiment of three mesh-connected condensers for the three cables is not quite allowable, so a second experiment was made with the same three condensers, C_1, C_2, and C_3, of one microfarad each, star connected as shown in Fig. 3 and Fig. 4. The current path in this case is from I. through *a*, C_1, C_3, *f*, 3, 2, *e*, *b*, and back to II. In this way condenser C_3, with the self-induction 2—3, is connected in parallel with the condenser C_2. The self-induction was varied until decided resonance occurred—*i.e.*, until a large voltage increase above the generator voltage occurred across one or the other condenser. The following results were obtained with a generator voltage of 15 :

Voltage across C_1 = 35 volts
" " C_2 = 40 "
" " C_3 = 84 "
" " 3—2 = 128 "

showing nearly a six-fold voltage increase across C_3.

From a test made on the self-induction used above coupled in series with an adjustable condenser, the capacity C which gave complete resonance was obtained, and from this and the fact that for complete resonance $L = \frac{1}{w^2 C}$ the value of L was found to be 10·2 henrys. This value was also confirmed by means of direct measurement of volts and amperes in the self-induction alone at 61 ⁓. The writer shows by the ordinary rules for capacities and inductances in combination, neglecting ohmic resistance, that with L = 10·2 and $C_3 = 1$ the effective self-induction of the branch in Fig. 4 containing C_3 and 3—2 is 3·38 henrys. This branch is in parallel with $C_2 = 1$, and the effective self-induction of the whole is 6·72 henrys. This combination can now be considered as a simple self-induction of 6·72 henrys in series with a condenser C_1 of one microfarad. The theoretical value of the inductance to give resonance in series with a one-microfarad condenser at 61 ⁓ is $L = \frac{1}{w^2 C} = \frac{10^6}{w^2 \times 1}$ = about 6·8 henrys, which is a very good check on the above value of 6·72 calculated from the measured self-induction and capacities.

The above results show clearly that with either method of representing the capacities of three-phase cables, very considerable voltage rises may occur if one phase is opened at the generator end and another phase at the transformer end. As a safeguard high-voltage safety devices should always be installed, but care must be taken that they do not operate with too great a current, as otherwise the safety device itself may produce an excessive voltage rise. A resistance should be connected in series with the spark-gap. Further, it would perhaps be advisable to avoid fuses altogether in high-tension installations, and to replace them by automatic oil switches which cut all the phases in or out at the same instant.

BITUMEN: ITS CONSUMPTION IN THE UNITED KINGDOM AND ITS PRODUCTION IN TRINIDAD.

BY W. POLLARD DIGBY, F.S.S.

Of the properties of bitumen, either when laid by any paving company for the man in the street to walk on, or buried under the side walk forming an integral part of the insulation of electric light cables, and walked over by the man in the street, it is not necessary to write here. The *Proceedings* of the Faraday Society (*Electro-Chemist and Metallurgist*, vol. iii., pp. 322-335 and 398-401) contain Mr. D. A. Sutherland's paper on "Bitumen in Insulating Compositions," wherein the chemical properties of this singular natural product are discussed. It is now the object of the writer to show the volume and source of the United Kingdom's import of bitumen for the last 15 years.

At the onset one is faced by the question of what constitutes bitumen. Our imports of this nature are classed as "Asphalt or Bitumen." Mr. Sutherland's definition may again be quoted : "Natural bitumen is composed, as far as we have been able to learn, of saturated and unsaturated dicyclic, policyclic, or alicyclic hydro-carbons and their sulphur derivatives, with a small amount of nitrogenous constituents. Bitumen is a natural substance composed of such hydro-carbons and their derivatives, which melts on the application of heat to a viscous liquid; soft bitumen consisting of alicyclic hydro-carbons, which by heating or other natural causes becomes converted into hard bitumen. The line between the classes cannot be sharply drawn." Small wonder that the Board of Trade says, "Oh, asphalt or bitumen! It doesn't matter which you call it. Call it both if you like so far as Customs declarations are concerned."

Natural bitumen actually occurs in commercial quantities in Palestine, Venezula, California, Trinidad, Cuba, Barbadoes, Utah, Wyoming, Montana, Mexico, Peru, Columbia, Canada, and in smaller quantities in France, Italy, and Germany. Also in limestone (asphalt) at several places in Europe—chiefly at Val de Travers in Switzerland, and Limmer in Germany, as well as in the siliceous limestone, in sandstone, and in the shale formations.

But so far as the detailed trade returns of the United Kingdom are concerned, the sources known until 1894 were Germany, Holland, France, Italy, "other foreign countries,"

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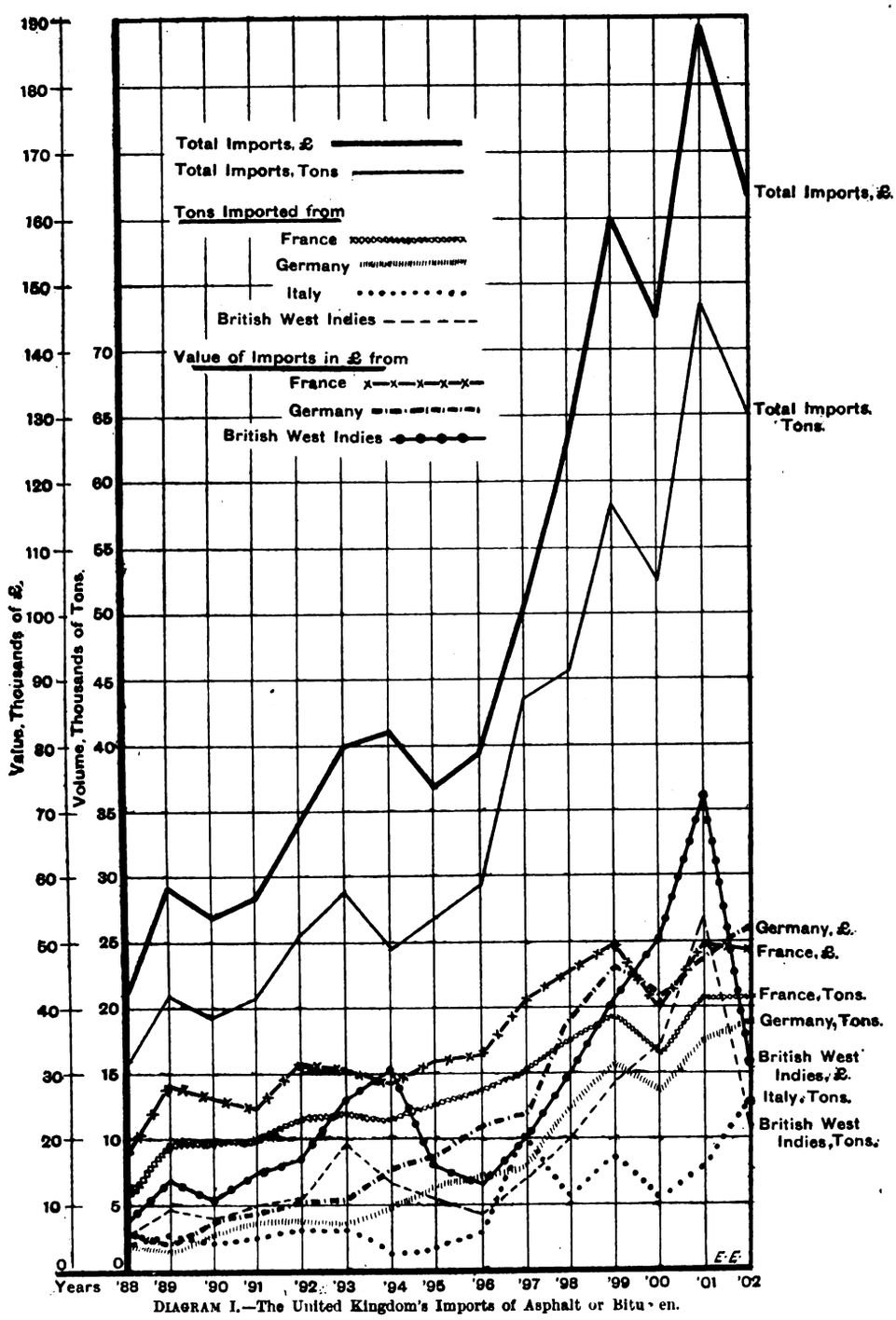

DIAGRAM I.—The United Kingdom's Imports of Asphalt or Bitumen.

and the British West Indies, when Holland disappeared from separate enumeration to reappear later. As the records of the imports from Holland are not continuous, the writer has reckoned it among the "other foreign countries. In Diagram No. 1 the total value and tonnage of the imports in any one of the 15 years enumerated may be seen, as also the tonnage respectively obtained from France, Germany, Italy, and the British West Indies. The value of the imports from France, Germany, and the British West Indies in each year is also shown. The fourfold rise in total tonnage and in total value from 1888 to 1902 is very striking. Of the individual countries, France is still ahead of Germany in tonnage, but since 1900 the respective values have been about equal. The relation between the two totals and the two British West Indies curves is interesting. In 1889 and 1893 a fall in the total values was accompanied by a reduction in the West Indian imports. In 1899 this was not the case, but the fall in the totals of 1901 is entirely due to the falling off in the imports of Colonial produce. As comparisons of individual years are apt to be fallacious, the writer has prepared the accompanying Table A.

The table shows the marked growth of the purchases of "asphalt or bitumen" by the United Kingdom from all sources. Relatively the greatest advance has been from

TABLE A.—Imports of Asphalt or Bitumen into the United Kingdom.

	Annual average for five years ending 1892.		Annual average for five years ending 1897.		Annual average for five years ending 1902.	
	Tons.	£.	Tons.	£.	Tons.	£.
Germany	2,721	7,861	6,075	18,748	15,466	45,920
Italy	2,262	5,138	4,134	6,480	5,718	16,527
France	7,281	25,979	12,789	33,026	18,699	46,900
Other foreign countries	1,730	4,387	1,059	3,338	627	3,249
British West Indies	4,475	13,031	6,643	21,075	17,925	45,084
Average annual consumption...	18,469	—	30,700	—	58,435	—
Average annual value.....	—	56,396	—	82,667	—	117,680
Percentage of total volume obtained within the Empire.	24·25	—	21·96	—	30·69	—
Percentage of total value purchased within the Empire ...	—	23·14	—	26·70	—	38·30

Germany and the British West Indies, while the increases from France and Italy have been proportionately less. It is unfortunate that no statistics exist whereby it is possible to compute the proportionate demands of the different

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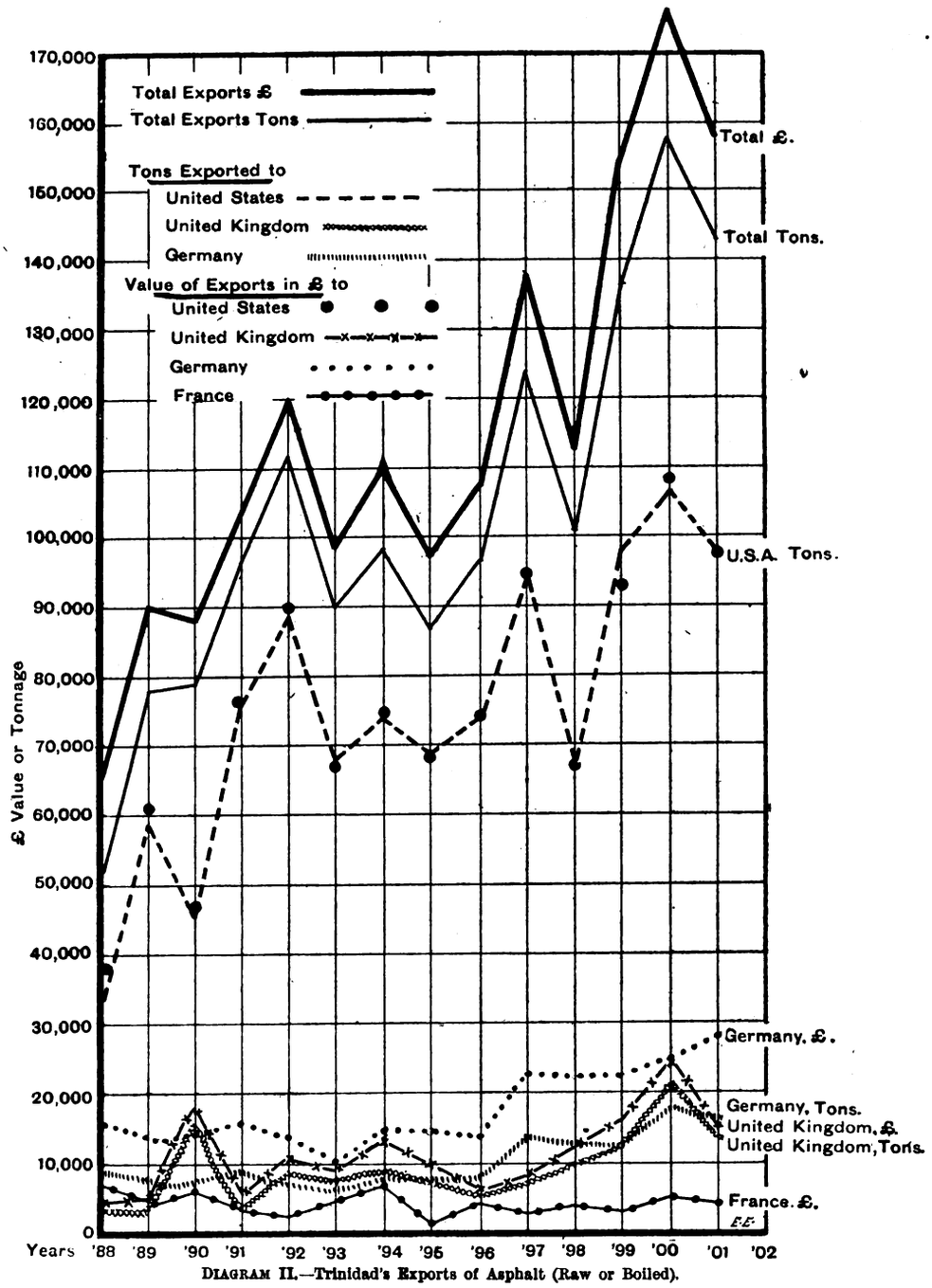

DIAGRAM II.—Trinidad's Exports of Asphalt (Raw or Boiled).

industries using this commodity. Architects for damp-courses, municipal engineers for street paving, and electrical engineers for cable insulation, are all interested in its supply. To the last-named bitumen spells "Trinidad bitumen," and it will therefore be of interest to examine how the output of this, the largest source of natural bitumen in the world, is distributed.

The yearly fluctuations of the Trinidad export trade in "asphalt, raw or boiled," are depicted in Diagram II., wherein the two upper curves denote respectively the value and tonnage. The chief purchaser is the United States, which accounts for about 60 per cent. of the output. In this case the price paid per ton has been practically £1 sterling for the 15 years under consideration, on which account only one curve representing the tonnage is shown in its entirety, while the various points on the value scale are denoted by small circles not connected by a separate curve, giving the values in each year. Separate curves are given for the value and volume of the exports to Germany. The margin between the two curves is probably due to Teutonic buying of high-grade or boiled—*i.e.*, partially refined—bitumen. Probably the resultant saving in freights is in its turn accountable for this. In the case of the United Kingdom the curves move in closer sympathy than the German curves, suggesting that this country purchases an intermediate grade, more expensive than the American while rather cheaper than the German. Only one curve is shown for France, whose purchases are relatively small and stationary both for value and volume. It will be noticed that Germany, which bulks so largely in the sources of British imports of "asphalt or bitumen," is the second largest purchaser of Trinidad asphalt.

TABLE B.—Exports of Asphalt (Raw or Boiled) from Trinidad.

	Annual average for five years ending 1892.		Annual average for five years ending 1897.		Annual average for four years ending 1901.	
	Tons.	£.	Tons.	£.	Tons.	£.
United Kingdom	7 374	9 339	7,293	9,849	14,630	17,047
United States.....	60,666	62,354	76,439	76,549	90,719	92,181
France.....	4,441	5,565	3,579	4,077	4,002	4,273
Germany.....	8,590	14,515	9,047	15,820	15,804	24,890
Other countries ...	2,166	2,957	2,967	4,506	7,408	10,401
Average annual export volume..	83,237	—	99,325	—	132,763	—
Average annual export value ...	—	94,730	—	110,801	—	128,792

The growth of exports to the United Kingdom, the United States, and Germany are evidences of the growing repute of the Trinidad product. Those who are concerned in the coal tax on British coal exports will be interested to learn that a revenue is raised by means of an export duty on the bitumen exported from Trinidad. The extent of the revenue so obtained and its proportion to the selling price are not stated in the detailed returns of the Colonial trade issued by the Colonial Office.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TECHNICAL EDUCATION.

A great deal has been written and spoken against the educational systems of this country. We regret to say that the great majority of those who decry the education which is now given have not taken the trouble either to acquire a real knowledge of the same or of the education which is given in Germany and the States, and which they recommend as superior. It is the usual practice of such speakers and writers to judge of the value of education by the expense incurred in the erection and the maintenance of the institutions for providing the same. The fact is ignored that an undue expenditure may be even destructive to the very purpose for which the institutions or colleges were intended, as it tends to divorce theory from practice. An educational department to do valuable work needs as careful organisation and supervision as a business house. In this respect the Department of Technology organised and maintained by the City and Guilds of London Institute is a typical example of what can be done by business men. An advanced copy of the report of this department for the session 1903-4 has just been forwarded to us by Sir Philip Magnus, and is worthy of the most careful perusal by all interested in the advancement of technical education. The aid given by the City and Guilds of London Institute has led to the formation of numerous classes throughout the length and breadth of the United Kingdom, and also in India and the Colonies. Thus in 1904 there were no less than 419 centres in which instruction on some of the sixty-six subjects of examination were given. The number of classes was 2,708, and there were 41,089 students in attendance. It is of further interest to note that of these hardly one-half sat in the examinations, and 11,293 passed with the required percentage of marks. This may seem to the uninitiated a small percentage of the total number of students, but it is a good indication of the fact that the examiners of the institute require an intelligent grasp of the subject from the students. Special stress is laid in the general report now before us on the change in the form of grants given by the Board of Education. A few years ago these grants were made on the results of examinations only, and the chief aim of a teacher was to give just sufficient information to the largest number of students possible to enable them to pass the examinations. Under the new regulations, grants are given for attendance of students at approved courses of instruction on subjects in which the teaching of science is closely associated with the application to particular trades and industries. This radical departure has already improved the strained financial conditions of many centres for giving technical education, and it enables the teacher to instruct with profit to his employers that class of student to whom an examination is distasteful. In other words, it enables instruction to be given for the sake of imparting knowledge, the ultimate end of which is not the passing of an examination. This encouragement offered by the Board of Education has already resulted in a large increase in the number of students attending registered classes of the City and Guilds of London Institute. We are pleased to note also that the number of candidates for examination from India and the Colonies is also regularly increasing. The report now before us is too long to reproduce verbatim in our columns; we are therefore compelled to give our readers the impressions which we gather from the same rather than the actual text. The report clearly shows to us that the council is under the control of business men, and is conducted on the same lines which a business man would adopt in the extension of a commercial undertaking. In the first place, every

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care is taken to secure the co-operation of the trade organisations associated with the various subjects taught. Again, the report shows that the selection of teachers is a matter on which the council have bestowed considerable forethought. Not only must these teachers be properly qualified before they can be registered, but they are also required to show proficiency in the art of teaching as well as in the subject to be taught. This is most important, as too many teachers are inclined to devote their energies rather to the acquisition of advanced knowledge than to the art of clearly instructing their students in the first principles of their subject. The encouragements offered to the students themselves are good, and it is gratifying to know that most of the private scholarships and exhibitions which are awarded are offered by the City guilds, who are thus fulfilling the obligations which have been handed down to them for centuries. Of the examiners' reports on the various subjects we propose to say little. They show, however, that the examiners are critical in their requirements, and that they give useful hints to the teachers as to the points on which students' replies give evidence of defects in the instruction given. In conclusion, we would add that the work of the department is a credit to all concerned, and of inestimable service to the country.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

XIII.—On Wasters.

My Dear Young 'Un,—You have completely explained the presence of the milk in the interior of the cocoanut in your reply to my last letter. You say, "I believe the reason that the foreman wouldn't put me on the marking-off table is because he bears a grudge against me for making a waster of a shaft I was cutting a key-way in." Just so. Your foreman evidently went home to tea that day down in the mouth, slapped all his children because they were noisy, and sent them to bed, because he knew that next day he would get a dressing down from the boss about that shaft. Did this occur to your imagination, my young friend? Apparently not, for you go on to say in bitterness, "They only expect an efficiency of 98 per cent. from an up-to-date dynamo, but a workman has to be absolutely perfect before they stop grumbling at him."

Now, what I am going to say to you may seem like kicking a man in the ribs when he is down. But as I am going to do it for your good, as the parent says when he spanks, I go into the matter with a light heart and a lusty muscle.

You practically state the proposition that of every 50 pieces of work you turn out, you are entitled to make a mess of one. Let us reduce that to absurdity. Of every 50 people you meet in conversation, you are entitled to smack one in the eye. Of every 50 meals you consume, you must be expected to take potassium ferrocyanide in one. There are certain functions in human life which, to be successful at all, must be perfect every time, and engineering shopwork is one of them. I suppose it must needs be that mistakes occur, but woe to that man by whom the mistake is perpetrated. He is strongly recommended to stick his head through the central aperture of a millstone and jump into the nearest canal.

An engineering firm is run upon a close-cut profit-and-loss system nowadays Just put yourself in the place of a managing director. He is competing with a dozen other firms for an order. He quotes a price less the usual something-or-other trade discount and so much more off for cash within the month. Out of that net price he pays wages, rent, insurance, depreciation, perhaps buys a necessary tool for the job, certainly has to purchase more or less raw material, and keeps himself in clothes and tobacco. If he doesn't collar the job he gets nothing, however carefully he estimates. If he doesn't quote lowest, he probably doesn't get a look-in. Now, how is that man to be expected to estimate for 2 per cent. of silly mistakes? And if he gets trapped and finds his profits swamped by some bungling fool of a workman, how can you expect him to maintain a calm seraphic smile? When you make a waster you rob him of a certain amount of jam from his bread, and he doesn't like it.

This sort of thing reacts on you. If you make a waster, you will probably not get the sack unless you become too rampantly uneconomical. This is because the average employer has a very poor idea of the average operative. He may hoof Box out, but Cox comes in and plays the goat more giddily than ever. You will simply be written down an ass—an atom of that great unreasoning mass of come-day go-day labour that can never be trusted, must be always watched, and requires to be bullied or coaxed like an overgrown lumpish baby. In the good old happy-go-lucky days, when British manufacturers could afford to make faces at foreign competitors, they were much more imperfect and much more comfortable. But certain Yanks and Germans have shown us that to take our ease, eat, drink, and be merry is only a 50-per-cent. affair. We are fighting a deadly war game in the West of Europe—though we aren't making as much noise about it as in the Far East—and military precision is the order of the day in those of our workshops which are going to pull through.

Of course, there are some fellows who couldn't help making wasters if they were chopping firewood. Out of nothing, nothing comes. They are not always idiotic. They are very often of the most polished order of beings—an ornament to any society. Only the trouble is, they are merely ornamental. Unfortunately, this is a world of much scrapping and scuffling; engineers were never noted for over-politeness, and our ideas are grossly materialistic. The best advice that can be offered to those jack-a-dandies who are too languid to do the amount of thinking requisite to avoid disaster, is to take up the profession of book-canvassing or flunkeying, where an oleaginous form of rhetoric and a *distingué* appearance may be used with some commercial benefit to themselves. As for those poor uncouth beggars who hover between insanity and unconsciousness, they had better take up a less dangerous form of existence than engineering. They would be safer in the middle of a large field digging up potatoes with a spud.

About the finest specimen of a human waster I ever came across was a gilded youth, who was catalogued as an "improver" at a works with which I was connected. I should not have mentioned him here—there was nothing about him to mention—but for one fact. He got a splendid testimonial from the firm, and the manner thereof was this. He had crowned a series of ingenious blunders by delaying the delivery of a machine for a fortnight owing to the thorough way in which he had wrecked an important casting. To have sacked him would have involved regrettable incidents with a big shareholder. Providentially he came across an alluring job and asked for a reference. The shop foreman was asked what sort of a testimonial he would suggest. The answer was instructive. "For Heaven's sake, sir, give him the condemndest good character that can be put on paper. Say he's the best man in the shops bar none. Lay it on thicker than sugar on a wedding cake. *Get rid of him by all means!*"

The waster with influence will get the very best testimonials. But the ordinary type merely gets the sack.—Yours,

The Old 'Un.

ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS.

The eighth general meeting of this association will be held at the Town Hall, Wakefield, on the 2nd and 3rd prox., when there will be a reception by the Mayor and the directors of the Wakefield and District Light Railways Company at 2.30. The executive committee will present their report, and Mr. H. England will deliver his presidential address. The following papers will be read and discussed: "Speed Allowance on Tramways and Light Railways," Mr. A. R. Fearnley, Sheffield; "Cost and Maintenance of Tramway Car Wheels and Rails," Mr. A. N. Banister, Norwich; "Systems of Ticket Checking," Mr. F. Coutts, Ayr; "Mr. Raworth's System of

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Regenerative Control," Mr. J. T. Hall, Devonport. The meeting will be adjourned at six o'clock precisely, and at 6.30 p.m. the members and friends will meet at the small banqueting hall of the town hall, where they will be entertained to dinner by the directors of the Wakefield and District Light Railways Company. On the following day, at two o'clock, the Wakefield tramways system will be inspected. For the convenience of those members who prefer staying in Leeds on the evening of the 2nd, the president has kindly promised to run a special car from Wakefield to Leeds on the evening of that day, and from Leeds to Wakefield on the morning of the 3rd.

THE ELECTRICAL CONTRACTORS' ASSOCIATION (INCORPORATED).

[COMMUNICATED]

The first annual general meeting of the association was held at Frascati's Restaurant, 32, Oxford-street, London, W., on Tuesday, Oct. 18, 1904, at 5 p m., for the purpose of considering the report of the Central Board, and the transaction of the ordinary general business of the association required to be dealt with at such meeting. There were present Mr. W. R. Rawlings, supported by Messrs. Hogan, Marryat, Berry, McDermott, Cross, Martin, Woodward, Usher, Wallis, Steinthal, Joseph, and a number of other gentlemen.

Mr. RAWLINGS, in opening the meeting, welcomed the representatives from Ireland, Scotland, and the provinces to London. The SECRETARY then read the minutes and notice of meeting, which were confirmed.

The PRESIDENT in his report recounted the earlier history of the association, the negotiation and agreement with the manufacturing houses, and urged members to act loyally to the agreement. He eulogised the work of the Joint Committee, and incidentally mentioned the establishment of a branch and the opposition to the Sheffield Corporation. He dwelt at some length on the reconstitution and the incorporation, together with the aspirations of the association, and explained the composition of the Central Board, sectional Boards, and local branches, and the responsibility of members in making the association a success.

The TREASURER then presented his financial statement, showing the deficit of £165. 10s 6d. This, he explained, was more apparent than real, as the subscriptions due on May 1 last had not been called in yet, and when they came to hand would pay all outstanding accounts and leave a balance in hand of about £100. The PRESIDENT spoke confirming this statement. Mr. MARTIN, of Glasgow, of Glasgow, moved the adoption of the balance-sheet as presented, and Mr. WALLIS, of Leeds, seconded it, motion being carried unanimously.

Mr. STEINTHAL then proposed that the subscriptions for members of all classes should be two guineas per annum, and that the entrance fee for members and fellows be two guineas, and the entrance fee for associates be one guinea. These to be fixed amounts. Mr. WOODWARD suggested the probability of there being a big balance in hand at the end of the year, and proposed, with the idea of introducing new blood, that the entrance fee be one guinea to all classes, and that subscriptions for all members, fellows, or associates be one guinea also. The PRESIDENT replied, pointing out the expenses to be met, such as the salary of the permanent secretary and other outgoings. Mr. Steinthal's motion was carried, with two dissentients

Mr. MCDERMOT then moved, "That this meeting accept the recommendation of the Central Board, and confirm the purchase of the *Electrical Contractor* for the sum of £200." Mr. BERRY seconded it, and the motion was carried unanimously.

Mr. BERRY proposed that the following gentlemen, Messrs. Cross, Steinthal, Hogan, and Marryatt, be elected honorary fellows. Mr. NOBLE seconded, and the motion was carried by acclamation. Mr. SHAW then moved that Messrs. Rawlings, Berry, and McDermot be elected honorary fellows. Mr. MARTIN seconded. Mr. JOSEPH moved an amendment to the effect that the three gentlemen be elected simply fellows. There was no seconding. The HON. SOLICITOR (Mr. R. Tweedie Smith) then explained the difference between fellow and honorary fellow and the difference in other grades. At this point there was some little misunderstanding on the part of Messrs. Woodward and Joseph, so Mr. MARTIN proposed, and Mr. STEINTHAL seconded, that Mr. R. Tweedie Smith be elected to the chair for the time being. The HON. SOLICITOR then explained at great length, and in exceedingly good temper, the position as explained by the articles of association. Mr. MARTIN then proposed that Messrs. Rawlings, Berry, McDermot, and Wright be elected honorary fellows. Mr. SHAW seconded it. The motion was put to the meeting, but as it was not unanimous, Messrs. Rawlings, Berry, and McDermot refused to accept the honour. With regard to Mr. Wright, Mr. Martin undertook to inform him of the motion, and no doubt he would signify his acceptance or not. Mr. BERRY then proposed that Mr. Woodward be elected a fellow, Mr. RAWLINGS seconded it, and Mr. CROSS supported. The motion was carried unanimously.

The following reports from the sectional Boards was then taken. For London, Mr. HOGAN spoke on the excellent progress of the association; and Mr. BERRY, continuing the same subject, eulogised the work of his predecessors, and gave a glowing description of the future prospects. For Manchester, Mr. MCDERMOT reported progress, gave details of the large fire in Manchester, and produced Press reports thereon stating that a large number of fires attributed to fusing did not arise from that cause at all, and that it behoved all branches of the association to investigate all fires attributed to electricity, to take strong and immediate action, and to see that the Press reports were correct, as sufficient harm to the industry had already been accomplished by false reports. For Glasgow, Mr. MARTIN reported, and expressed his gratification at the spirit he had seen displayed, and mentioned the association's opposition to the Glasgow Corporation, and to their conference with the consulting engineers of Glasgow and the favourable result thereof.

Mr. R. TWEEDIE SMITH then gave a very interesting address on the subject of municipal trading, defining the sphere thereof which concerned the public welfare, that no corporation should enter into competition with private enterprise where the latter was sufficient for the purposes concerned. He referred to the Stoke Corporation and to the stopping of the contracting department, and to the necessity of contractors co-operating by canvass. He referred to the efforts with respect to Newport and Ayr. He pointed out that the municipalities were indebted to the extent of £146,000,000, which had been devoted by them for purposes of municipal trading. He dwelt at some length on the Leeds and Battersea Corporations and the danger of Tammany of municipal life, and referred to the necessity of enthusiastic backing of the association's efforts to defeat the London County Council Bill shortly to be placed before Parliament. Mr. RAWLINGS supported these statements. Mr. WOODWARD moved that the association be instructed to oppose municipal trading in so far as it affected the electrical profession. Mr. WALLIS seconded, and the motion was carried unanimously.

The PRESIDENT then referred to the publications of the association — namely, "The Model Specification" and the debt-collecting letter. He then read a letter from the Manufacturers' Association giving notice to terminate the agreement on Dec. 31 next, and urged the members to act up to the spirit of the agreement, taking into account the monetary advantage accruing therefrom. Mr. BERRY proposed, and Mr. CROSS seconded, that the Central Board be instructed to enquire into the possibility of establishing a contractors' supply house or make some other arrangements in the event of the notice from the Manufacturing Association being confirmed.

Mr. BERRY commented on the sacrifice which members of the Central Board had to make for the benefit of the members of the association generally, and briefly explained the working of the Joint Committee.

Mr. NOBLE proposed a vote of thanks to the president and to Mr. R. Tweedie Smith, and Mr. EDEY seconded it.

This concluded the business of the meeting.

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A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITIES OF GAS-TURBINES.*

BY MR. R. M. NEILSON, ASSOCIATE MEMBER.

A prophecy expressed frequently in engineering circles at the present day is that turbines actuated by hot gases, other than steam, will eventually come to the front as prime movers. The idea of employing hot gases (other than steam) to drive a turbine is by no means new, but the success of the steam-turbine has recently brought the question into prominence. Although the subject is interesting and important, and although many minds seem to be considering it, there appears to be hardly any literature on the subject, except what is found in patent records.

There is no doubt that many persons speak of the advantages of gas-turbines without duly considering the difficulties to be encountered. There are probably many others who have valuable ideas on the subject, supported in some cases by experimental data, but who are apt to let their thoughts run in a groove, and to consider (rightly or wrongly) that the only possible solution of the gas-turbine problem lies in the particular direction in which they are working.

This paper is written with the object of expressing and comparing as concisely as possible the advantages and possibilities of gas-turbines worked on different cycles, and the difficulties to be overcome to make these turbines a success. A further and more important object is to draw opinions from other engineers who have studied the question, and especially from those who have conducted experiments. If these objects are attained, even in an imperfect manner, the author believes that a foundation of knowledge will be obtained and placed on record, which will be of considerable use to engineers who may be endeavouring or about to endeavour to produce practical machines.

Carnot's formula for the efficiency of an ideal heat-engine

$$E = \frac{T_1 - T_2}{T_1}$$

is well known, but its real meaning is sometimes forgotten; and it may not be out of place here to put in a reminder that, in Carnot's cycle, *all* the heat is put in at temperature T_1, and *all* the heat withdrawn at temperature T_2. An increase in the range of temperature does not necessarily cause a thermodynamic gain, and it is possible largely to increase the range of temperature (as, for example, by superheating steam before use in a steam-engine) without thermodynamically increasing the efficiency by more than a small percentage.

If we have a gas-engine (reciprocating or turbine) working on Carnot's cycle between the limits of temperature 1,600deg. C. (2,912deg. F.) and 17deg. C., its greatest possible efficiency will be

$$\frac{(1,600+273)-(17+273)}{1,600+273} = 0{\cdot}85.$$

If the gas-engine is an explosion motor with compression to 60lb. per square inch above atmosphere, combustion at constant volume, and expansion to atmospheric pressure, the greatest possible efficiency between the same limits of temperature is only 0·50; and if the engine work on the ordinary Otto cycle with the same compression and between the same limits of temperature, the greatest possible efficiency is only 0·37.

We must, therefore, strive not so much to get the maximum and minimum temperatures respectively as high and as low as possible, but to get the mean temperature at which heat is given to the gas and the mean temperature at which heat is withdrawn from it respectively as high and as low as possible. Of these two temperatures the lower one is usually by far the more important. An ideal gas-engine working on Carnot's cycle between the limits of temperature 2,000deg. C. (3,632deg. F.) absolute and 300deg. C. (572deg. F.) absolute will lose as much by an increase of 100deg. C. to the lower temperature as it will by a decrease of 500deg. C. from the higher temperature.

Coming now to discuss more particularly gas-turbines, there are four cycles on which it seems to the author that these could be worked with the possibility of good results. Two of these are what Mr. Dugald Clerk designates type 2 and type 3.* The author will call them respectively cycle I. and cycle II. The author has not considered it worth while to discuss the Carnot cycle at length, but a few remarks are made about it towards the end of the paper. A pressure-volume diagram of an engine working on cycle I. is shown in Fig. 1, and an entropy-temperature diagram in Fig 2 The working fluid is compressed adiabatically from A to B. Heat is then supplied by combustion at constant pressure from B to C. The gas then expands adiabatically from C to D. The fluid is then cooled at constant pressure from D to A. Reciprocating gas-engines have been worked on this cycle by Brayton and others, but have never come into common use. (The Diesel engine may be considered to belong to this class, although no decided constant pressure line is discernible

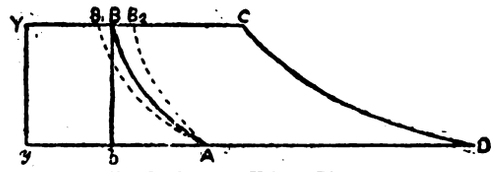

FIG. 1.—Pressure-Volume Diagram.

on indicator diagrams taken from the engine.) One great difficulty that has been experienced in working reciprocating engines on this cycle is that of getting complete combustion during the period B C without the charge occasionally firing back. If the air and fuel are brought into contact only on entering the cylinder, it is difficult to get good combustion during the period B C. If, on the other hand, the air and fuel are previously mixed together, it is difficult to prevent occasional firing back. Of course, the chamber in which the air and fuel are mixed may be made strong enough to stand explosions, but any back firing upsets the regular working of the engine, and is otherwise objectionable.

It has been proposed for gas-turbines to cause air and fuel to unite in a nozzle which thereafter diverges, with the idea that the air and fuel will combine on meeting each other, and the hot products of combustion then acquire a high velocity in the divergent nozzle, with which velocity they will enter the turbine buckets. The results of a

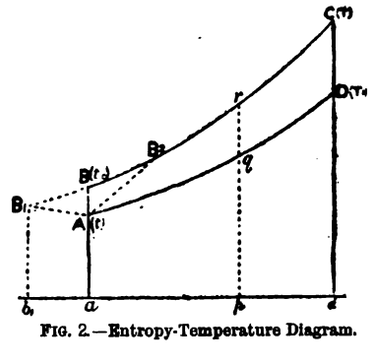

FIG. 2.—Entropy-Temperature Diagram.

trial of such a scheme would be interesting. The author doubts if the combustion would be quick enough to give a good efficiency. If, however, a combustion chamber of ample size were provided in which the burning gases could rest a short interval before passing to the turbine, better results could, in the author's opinion, be expected. The air and fuel would be separately pumped into the chamber from which the products of combustion would flow continuously and uniformly by one or more passages into the turbine.

At any rate the difficulties should not be as great with turbines working on this cycle as with reciprocating engines, as the latter have to receive the hot gases intermittently while the turbine receives a continuous flow. This is an important point as regards controlling the flame. With an engine of the Brayton type the fuel has to be ignited in the cylinder for every working stroke, and the supply of gas to the flame has to be cut off for every working stroke. With a turbine the fuel and air could be

* Paper read before the Institution of Mechanical Engineers.

* "The Gas and Oil Engine," by Dugald Clerk (Longmans and Co.), chapter iii.

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supplied at a constant velocity to the flame and a steady flame maintained without interruptions. This is important, because if a mixture of air and fuel be always supplied to the flame with a velocity greater than the velocity of propagation of the flame, there can, of course, be no firing back, and this result can be obtained without the use of a wire-gauze screen. The maintaining of this velocity of supply to the flame above the required minimum when starting and stopping the motor, and when running at low powers is, of course, a problem to be considered, and some consideration is given to it later on. The strength of the mixture of air and fuel should be kept constant. The power of the turbine can be varied by other means, which will be referred to later. It must be noted that if the air and fuel are compressed adiabatically to a sufficient extent, which depends on the nature of the fuel, combustion will occur immediately the two are brought into contact with each other. It is therefore necessary in such cases to keep the air and fuel apart until the instant when combustion is desired. It must also be noted that with a turbine there will be no hot waste gases mixed with the fresh air and gas to be compressed.

This cycle allows of a fairly high ideal efficiency being obtained with a moderate maximum temperature. Now, a moderate maximum temperature is of the utmost importance in the case of a turbine of the Parsons type. A Parsons turbine with steel blades could probably be designed without any great difficulty to stand a temperature of about 700deg. C. (1,292deg. F.) without any water jacketing or cooling devices of any sort (except for the bearings). With temperatures above this, the blades would need to be cooled. This would necessitate a radical alteration in design. The question of designing a turbine to stand high temperatures will be considered later on.

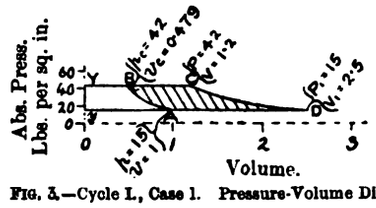

FIG. 3.—Cycle L, Case 1. Pressure-Volume Diagram.

It is only desired here to point out the great difficulties with a certain class of turbine are avoided by keeping the maximum temperature moderate. The cycle we are considering may therefore have great advantages for turbines.

It had better be stated here that the author has made several assumptions with regard to the working fluid or fluids. These assumptions are as follows: (1) That the specific heats of gases dealt with are constant at all temperatures and pressures, and are as follows: specific heat at constant pressure or $K p = 0{\cdot}238$; specific heat at constant volume or $K v = 0{\cdot}17$. (2) That weight per cubic foot of gases dealt with = 0·0777lb. at a pressure of 15lb. per square inch absolute and a temperature of 17deg. C. (3) That $\frac{P V}{T}$ = a constant for all pressures and temperatures. (4) That P V = a constant for isothermal expansion and compression at all temperatures and pressures. (5) That combustion produces no change of volume except that due to change of temperature.

Some of these assumptions will probably be appreciably inaccurate in certain cases, but it seemed advisable to sacrifice something for simplicity and uniformity. As regards the variability of the specific heats, it seemed advisable to assume constancy until more knowledge on the subject has been obtained and a scale of change (if any) has been agreed upon. Pressures have been reckoned in pounds per square inch, and temperatures have generally been reckoned on the Centigrade scale, although for convenience the corresponding readings on the Fahrenheit scale have also in some cases been given. The numbers on the diagrams representing pressure and temperature are all representative of absolute pressures in pounds per square inch, and temperatures on the absolute Centigrade scale.

Referring to Fig. 2, the heat absorbed by the fluid is represented in this figure by the area a B C d, and the heat abstracted or discarded by the area a A D d. The heat converted into work is represented by the area A B C D, and consequently, if E represents the ideal efficiency of an engine working on this cycle,

$$E = \frac{\text{area A B C D}}{\text{area } a \text{ B C } d}.$$

Now it can be proved* that

$$\frac{A B}{a B} = \frac{D C}{d C} = \frac{q r}{p r},$$

where $p q r$ is any ordinate cutting the lines a d, A D, and B C, which are all constant pressure lines. Therefore

$$E = \frac{A B}{a B} = \frac{D C}{d C} \quad . \quad . \quad . \quad (1)$$

Let t represent the temperature before compression.
Let t_c represent the temperature at the end of compression.
Let T represent the temperature at the end of combustion.
Let T_1 represent the temperature at the end of adiabatic expansion.

Then from equation (1) and referring to Fig. 2

$$E = \frac{t_c - t}{t_c} = \frac{T - T_1}{T}.$$

This can be proved quite well without an entropy-temperature diagram.† The diagram, however, shows the efficiency better. It is important to consider the amount of negative work done and the ratio of this to the total or

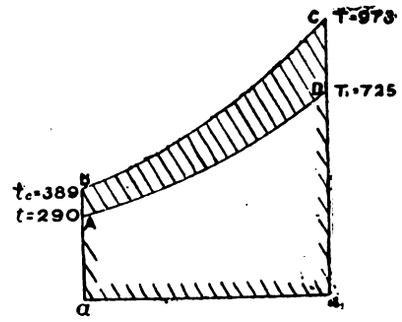

FIG. 4.—Cycle L, Case 1. Entropy-Temperature Diagram.

gross work. The negative work is the work of compressing the gas and delivering it in its compressed state. It is true that with some engines there is no work of delivery. In a reciprocating gas engine in which the gas is compressed in the motor cylinder, the only negative work (ideally) is that of compressing the charge; and, even when a separate cylinder is used for the compression, the work of delivering might be avoided. With a turbine, however, the fluid cannot be compressed in the motor; and, whatever arrangement is adopted, the compressed fluid will have to be delivered after compression. The author has therefore considered it better in all cases to include in the negative work the amount required to deliver the compressed gas. The motor proper, of course, gets the benefit of this work.

In Fig. 1 the work to compress the gas is represented by the area A b B, and the work to deliver it in a compressed state by the area y Y B b. The total negative work is therefore represented by the area y Y B A. The gross work of the motor is represented by the area y Y C D of which the part y Y B b represents the work done

* Since all vertical lines represent adiabatic expansion, therefore, by the laws of adiabatic expansion,

$$\frac{\text{temp. at A}}{\text{temp. at B}} = \left[\frac{\text{press. at A}}{\text{press. at B}}\right]^{\frac{\gamma-1}{\gamma}}$$

where $\gamma = \frac{K p}{K v}$

Similarly $\frac{\text{temp. at } q}{\text{temp. at } r} = \left[\frac{\text{press. at } q}{\text{press. at } r}\right]^{\frac{\gamma-1}{\gamma}}$

But pressure at A = pressure at q, since A q D is a constant pressure line; and pressure at B = pressure at r, since B r C is a constant pressure line,

$$\therefore \frac{\text{temp. at A}}{\text{temp. at B}} = \frac{\text{temp. at } q}{\text{temp. at } r} \quad \therefore \frac{A B}{a B} = \frac{B C}{d C} = \frac{q r}{p r}.$$

† See, for example, "The Gas and Oil Engine," by Dugald Clerk, pp. 46-48.

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before expansion, and the part b B C D the work done during expansion. By deducting the negative work from the gross work the net work is obtained; this is represented by the area A B C D. This net work is the same as that represented on the entropy-temperature diagram (Fig. 2) by the area A B C D on that diagram.

CYCLE I., CASE 1.

If the gas is required to be used in a Parsons turbine without cooling arrangements the maximum temperature must not exceed 700deg. C. (1,292deg. F.). A case with this maximum temperature will now be considered: In all cases—

Let t and p represent respectively absolute temperature C. and absolute pressure (pounds per square inch) before compression.

Let t_c and p represent respectively absolute temperature C. and absolute pressure (pounds per square inch) after compression.

Let T and P represent respectively absolute temperature C. and absolute pressure (pounds per square inch) after combustion.

Let T_1 and P_1 represent respectively absolute temperature C. and absolute pressure (pounds per square inch) after expansion to atmospheric pressure.

Let v represent one cubic foot of the fluid at temperature t and pressure p.

Let v_c, V, and V_1 represent the volume of the same at t_c, p_c, T, P, and T_1, P_1 respectively.

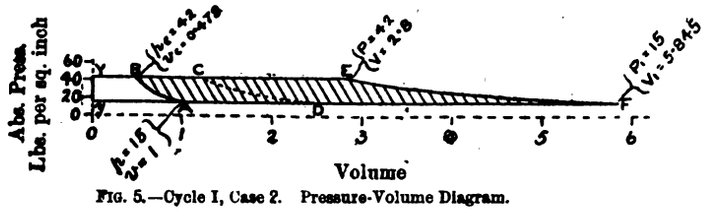

FIG. 5.—Cycle I, Case 2. Pressure-Volume Diagram.

Suppose that in all cases $t = 17$deg. C. (290deg. absolute C.), and the corresponding pressure = 15lb. absolute. Let us first try compressing to 42lb. absolute; t_c will then be 389deg. absolute C. This compression is shown by the line A B on the pressure-volume diagram (Fig. 3) and on the entropy-temperature diagram (Fig. 4). Let heat now be supplied, and the gas expand at constant pressure along the line B C till the temperature is 973deg. absolute C. Let the gas now expand adiabatically along the line C D till the pressure falls to 15lb. absolute. The fluid is now exhausted into atmosphere, and as the new charge is taken at the same pressure and at temperature t, we can assume that the discharged gas is cooled at constant pressure and used over again. We can therefore complete both diagrams by the constant pressure line D A. The heat absorbed by the fluid is represented by the area a B C d in Fig. 4, and the heat rejected by the area a A D d. The heat converted into work is represented by the area A B C D and

$$E = \frac{\text{area A B C D}}{\text{area } a \text{ B C } d} = \frac{t_c - t}{t_c} = \frac{389 - 290}{389}$$

$$= \frac{99}{389} = 0{\cdot}25.$$

The negative work is represented in Fig. 3 by the area y Y B A, the gross work by the area y Y C D, and the net work by the area A B C D.

$$\therefore \frac{\text{negative work}}{\text{gross work}} = \frac{\text{area } y \text{ Y B A}}{\text{area } y \text{ Y C D}} = 0{\cdot}4.$$

The expansion line is carried right down to atmosphere. It should be possible in practice without difficulty to very nearly do this in a turbine although the volume at D is 2½ times the volume at A. In dealing with large volumes and small pressures there is an immense difference between turbines and reciprocating engines. Reciprocating engines require large cylinders. These large cylinders, besides being objectionable on account of bulk and cost, necessitate great frictional losses. The low pressure dealt with is of little import as regards friction, which will be nearly the same whether the pressure is 13lb. below atmosphere or 13lb. above atmosphere. With a turbine, however, the large volume of the fluid does not necessitate such a bulky machine. Moreover, in a turbine the friction depends on the pressure. With high pressures the friction is great, with low pressures very small. In marine propulsion by steam-turbines it is not considered worth while uncoupling the reversing turbines when the vessel is going ahead. These turbines are allowed to rotate (above their normal speed) in the low pressure which exists at the exhaust ends of the main low-pressure turbines.

CYCLE I., CASE 2.

Seven hundred degrees C. (1,292deg. F.) must not, however, be considered as the limiting temperature for gas-turbines. We can employ a much higher temperature if we use water-cooling or other cooling arrangements. Mr. Parsons has circulated steam for heating purposes through passages formed in the rings supporting the fixed blades of his radial-flow steam-turbines.* Water could as easily be circulated, and there should be no great difficulty in passing the water also through the rings supporting the moving blades. It has been proposed by Mr. Parsons and others to circulate water or other cooling fluid through the actual blades of a turbine, these being formed hollow. It has also been proposed to keep the blades of a single-wheel turbine cool by causing the actuating fluid to act only at one point of the circumference of the wheel, while a cooling fluid is projected on to the blades at another point.

By the employment of cooling devices we might possibly

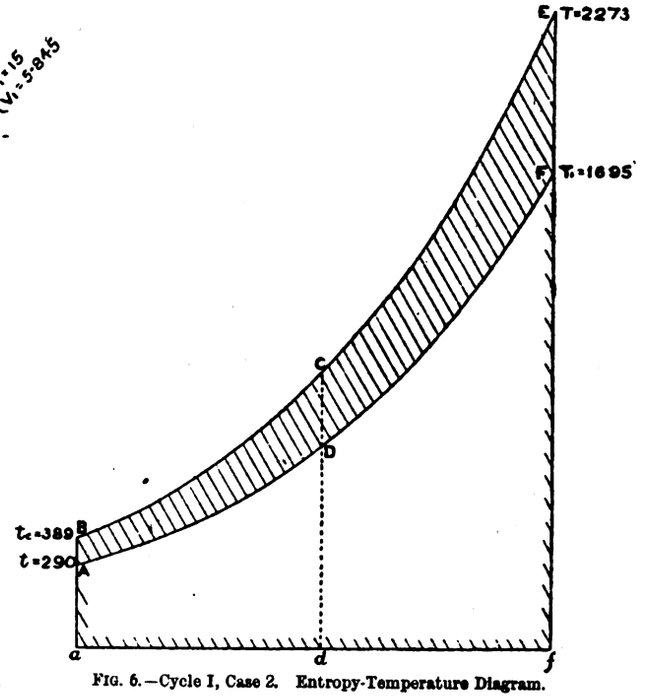

FIG. 6.—Cycle I, Case 2. Entropy-Temperature Diagram.

get a turbine to stand a temperature of 1,500deg. C. (2,732deg. F.), or even 2,000deg. C.; 2,000deg. C. is a very high temperature, and there would be great difficulty in devising and constructing cooling arrangements that would keep the blades in good working order when acted on by gas at a temperature approaching this. Let us assume, however, that 2,000deg. C. is allowable for our maximum temperature; then, if we keep the same compression as in Case 1, our ideal pressure-volume and entropy-temperature diagrams will be as shown in Figs. 5 and 6. In these figures the line C D has been reproduced from Figs. 3 and 4, and is shown in dotted lines in order that the two cases may be readily compared.

Referring to Fig. 6, the heat absorbed by the fluid is represented by the area a B E f, the heat rejected by the area a A F f, and the heat converted into work by the area A B E F. Therefore,

$$E = \frac{\text{area A B E F}}{\text{area } a \text{ B E } f} = \frac{t_c - t}{t_c},$$

$$= \frac{389 - 290}{389} = 0{\cdot}25.$$

* "The Steam-Turbine," by R. M. Neilson (Longmans and Co.), pp. 43-45.

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The increase in the maximum temperature has, therefore, added nothing to the efficiency, and this will always be the case if the initial temperature and pressure are unchanged and we compress to the same amount—that is to say, as long as we start the constant pressure lines from the same points, A and B, we can extend them as far as we like to the right, and connect them by any adiabatic line we please; E will remain unchanged. In Fig. 6 the additional area d C E f is divided by the line D F in the same ratio as the original area a B C d is divided by the line A D.

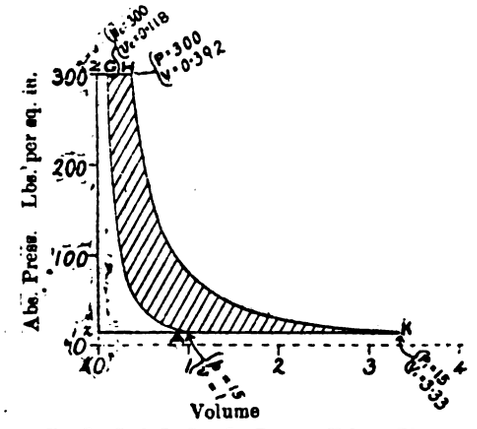

FIG. 7.—Cycle I., Case 3. Pressure-Volume Diagram.

The negative work (in Case 2) is represented in Fig. 5 by the area y Y B A; it is the same as in the last case. The gross work is represented by the area y Y E F, and the net work by the area A B E F.

$$\text{Therefore} \quad \frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area } y\,\text{Y B A}}{\text{area } y\,\text{Y E F}} = 0{\cdot}171.$$

We have, therefore, very considerably diminished the ratio of negative work to gross work.

CYCLE I., CASE 3.

In Case 1 it was necessary to have a low compression, because a high compression with a maximum temperature

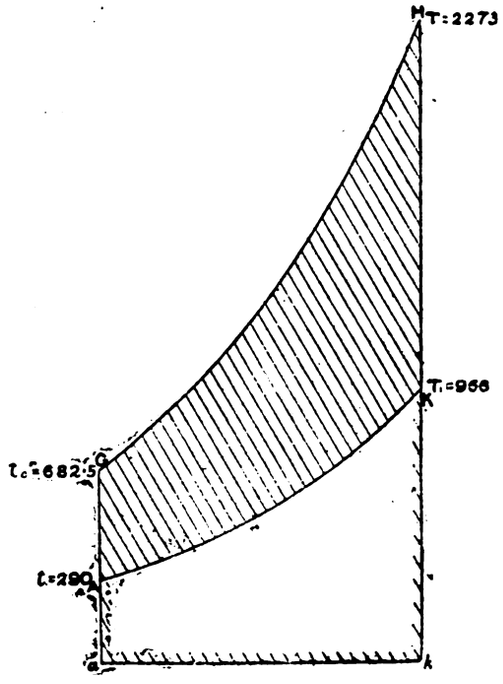

FIG. 8.—Cycle I., Case 3. Entropy-Temperature Diagram.

of only 700deg. C. would have given an impractically high value to the ratio of negative work to gross work. In fact, this ratio was high even with the low compression adopted. With the maximum temperature raised to 2,000deg. C., however, a much higher compression can be adopted. Suppose a compression to 300lb. per square inch absolute is adopted. This will make t_c 682·5deg. absolute C. The pressure-volume and entropy-temperature diagrams will then be as shown in Figs. 7 and 8.

Referring to Fig. 8, it is seen that

$$\text{E} = \frac{\text{area A G H K}}{\text{area } a\,\text{G H } k} = \frac{t_c - t}{t_c} = \frac{682{\cdot}5 - 290}{682{\cdot}5} = 0{\cdot}58.$$

which is much better than (more than double) that in Cases 1 and 2. There is, however, the inconvenience of a high compression, and compared with Case 1 more heat is likely to be lost through radiation owing to the higher average temperature. This question of radiation will be more or less important according to the type of turbine.

The negative work is represented in Fig. 7 by the area z Z G A, the gross work by the area z Z H K, and the net work by the area A G H K.

$$\therefore \frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area } z\,\text{Z G A}}{z\,\text{Z H K}} = 0{\cdot}3.$$

To be continued.)

BRIGHTON CORPORATION TELEPHONES.

The following is the approximate revenue account of the Brighton Corporation telephone department from April 1 to Sept. 30, 1904.

Dr. *Expenditure.*	£	s.	d.
Operating	226	8	0
Line repairs and maintenance	111	1	1
Instrument repairs and maintenance	90	5	11
Exchange repairs and maintenance	72	9	4
Wayleaves	60	0	0
Terminal fees	160	14	7
Post Office commission	2	0	0
Post Office royalty	267	4	0
Rents, rates, and insurance	110	0	0
Management and office salaries	352	13	9
General expenses (stationery, etc.)	142	15	7
Commission on call office receipts	4	16	1
Possible bad debts	30	0	0
	1,630	8	4
Balance to net revenue account	1,263	7	7
	£2,893	15	11

Cr. *Revenue.*	£	s.	d.
Exchange rentals	2,583	6	2
Private rentals	125	3	10
Local tolls	45	19	6
Public telephones	32	2	3
Terminal fees	40	0	0
Post Office commission	32	4	2
Removals and sales	35	0	0
	£2,893	15	11

FORTHCOMING EVENTS.

FRIDAY, OCT. 28.

Physical Society.—At 4.15 p.m., council meeting. At 5 p.m., "An Interference Apparatus for the Calibration of Extensometers," by Mr. John Morrow and Mr. E. L. Watkin; "A Sensitive Hygrometer," by Dr. W. M. Thornton; and "Note on a Property of Lenses," by Dr. G. E. Allan.

Institution of Electrical Engineers (Glasgow Section).—At 7 p.m., annual dinner, at the Grosvenor Restaurant.

SATURDAY, OCT. 29.

Junior Institution of Engineers.—At 3 p.m., visit to the National Physical Laboratory, Bushy House, Teddington.

Glasgow Technical College.—At 7.30 p.m., "The Law of Workmen's Compensation," by Mr. W. B. Anderson.

TUESDAY, NOV. 1.

Institution of Civil Engineers.—At 8 p.m., opening meeting. Address by Sir Guilford L. Molesworth, K.C.I.E., the president, and presentation of medals and prizes.

WEDNESDAY, NOV. 2.

Association of Tramway and Light Railway Officials.—(Nov. 2 and 3.) At Wakefield. See programme in another column.

THURSDAY, NOV. 3.

Rontgen Society.—At 8.15 p.m., presidential address.

Tramways and Light Railways Association.—At 8 p.m., at the Society of Arts, "Notes on Permanent Way," by Mr. A. N. Connett.

Rugby Engineering Society.—At 8 p.m., "Permanent Way for Tramways," by Mr. C. T. Taylor.

FRIDAY, NOV. 4.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., "Electric Railways," by Mr. F. O. Mills.

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THE PRESENT STATUS OF THE EDISON STORAGE BATTERY.*

BY A. E. KENNELLY AND S. E. WHITING.

Type E is the cell now manufactured and placed on the market in three sizes, which differ only in the number of assembled plates. The full capacity of the cell is found to be about 140 ampere-hours, which makes the total output at 30 amperes 173 watt-hours, and at 120 amperes 145 watt-hours; or the specific output 13·7 watt-hours per pound (30 2 watt-hours per kilo) and 11·5 watt-hours per pound (25 4 watt-hours per kilo) at the two rates respectively. The containing cell, as also the grids and pockets, are made of thin sheet steel plated by a special process. The jar completely encloses the element, and the lid is soldered permanently in place. There are four openings in the steel top; two of these are insulated by rubber bushings, through which the terminal posts project. The third opening is a filler hole with gastight hinge-stopper. The fourth opening is a gas vent provided with a valve and gauze screen, to prevent escape of entrained liquid. The insulation between the walls of the can and the enclosed element is all of hard rubber. On the bottom is a four-barred grating, 0·4in. deep. On the ends are ladder-like frames, giving about 0·11in. clearance, and grooved to hold the edges of the plates. On the sides are solid sheets 0·014in. thick. It has been found necessary to subject all the rubber insulation to a special chemical treatment to prevent a foaming action of the alkaline electrolyte. Between the plates are threaded four-cornered rods of rubber about 0·1in. thick and spaced 0·57in. apart. The distance between opposed plate surfaces is about 0·04in. Plates of like polarity are bolted to a horizontal bar at the top, provided with spacing washers and joined to the vertical terminal post.

For use in vehicles the cells are grouped in wooden trays containing three, four, or six cells each. Connections between cells are ingeniously made by taper lugs, and each jar is insulated from its neighbours and from the base by spacing blocks and a rubber pad respectively. The grid itself and the pockets containing the active materials are identical for both positive and negative electrodes. The grid is 9·25in. high—excluding the lug—4·75in. wide, and 0·015in. thick. It contains 24 rectangular holes, each 2·95in. high and 0·5in. wide. Into these holes are fitted pockets. These are made up of strips of 0·003in. steel, having flange edges that telescope together to form the pocket or container of the active material. These pockets have each about 5,000 perforations. The active material of the positive plate is an oxide of nickel in finely-divided form commingled with a conducting substance, such as flake graphite, in order to improve the conductivity of the mass. The active material of the negative plate is finely-divided iron similarly commingled with a conducting substance. The electrolyte is a 20 per cent. aqueous solution of potassium hydrate.

In assembling the pockets are filled with active material, closed, and inserted in the holes of the grid. The plate is then subjected to a pressure of 150 tons for the purpose, first, of flanging the pockets over the holes in the grid in order to lock them firmly in position, and, second, of corrugating the surface of the pocket in such a manner as to provide adequate elastic movement of the envelope in view of the contraction and expansion of the contents. The weight of the active material in its initial condition, and including the conducting material, is about 3·2 grm. per pocket for the nickel and 4·6 grm. for the iron plate. This represents a total quantity of 922 grm. positive active material and 662 grm. of negative active material in an E-18 cell. The weight of electrolyte per cell is 3·1lb. (1·40 kilos) at a normal density of 1·190, which represents about 25 per cent. of the total weight of the cell. The Edison cell is of the oxygen-lift type—that is to say, the process of charging consists in driving oxygen electrolytically from the negative to the positive plate. During discharge the oxygen leaves the positive plate and enters the negative plate. The chemical actions in the cell have not as yet been completely investigated. The following conditions may, however, be accepted provisionally as forming a working theory:

Condition.	Positive plate.	Electrolyte.	Negative plate.
Charged	NiO_2	KOH	
	NiO_2	H_2O	Fe
		KOH	
Discharging	$NiO_2K + H_2O$	HO	$-Fe$
	$NiO_2K + Ni_2O_3KOH$ KOH	HO H_2O	$FeO-$
Discharged	Ni_2O_3	KOH	FeO
		H_2O	
		KOH	

The cycle represented in the table shows that during discharge the electrolyte divides into potassium cations and hydroxyl anions, the former being directed toward the positive plate and the latter toward the negative plate. On arriving at these plates the ions give up their respective charges. At the positive plate the potassium robs the nickel oxide of a portion of its oxygen, and in combination with the water present forms new molecules of potassium hydrate, the original electrolyte. At the negative plate the hydroxyl ions deliver oxygen to the ion and form water. Thus the electrolyte tends to become concentrated in the pores of the positive plate and attenuated in the pores of the negative plate. Diffusion ultimately destroys this difference of concentration, and leaves the electrolyte in its original condition, since at any instant the total quantity of water and of potassium hydroxide (including the pores of both plates) remains the same.

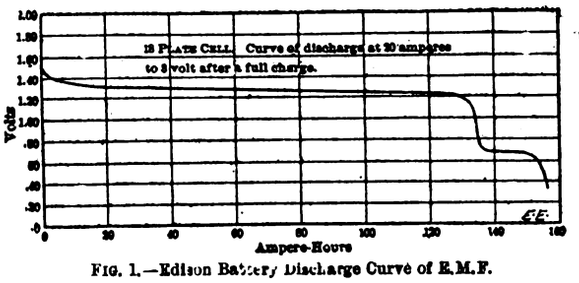

FIG. 1.—Edison Battery Discharge Curve of E.M.F.

It would appear from the form of E.M F. curve (*Fig.* 1) during complete discharge that after the cell has become almost entirely discharged other stages of oxidisation develop, and further investigation may show that the outline of the chemical cycle above presented is very incomplete. Whatever the complete cycle may be, it is in all probability, however, of the type indicated. Various observations, both of the authors and other observers, show that the discharge curve of E M.F. of the type E cell possesses the following peculiarities: (1) an initial period of rapid descent, occupying about 10 per cent. of the delivery period; (2) a nearly steady gradient of gradual descent, continuing until within about 10 per cent. of the end of the whole delivery period; (3) a final period of rapid descent, occupying the last 10 per cent. of the delivery period (assumed as stopping at a potential difference of 0·75 volt). A fair sample of this curve is represented by the heavy line in *Fig.* 1. The initial E.M.F. is influenced by the previous history of the cell, more particularly by the time which has elapsed since the close of the preceding charge. The range of initial E.M F. is between 1·35 and 1·65 volts. It would seem that this E M.F. depends upon the amount of gases remaining after the charge occluded in the pores of the cell. The E.M F. at and near the end of the discharge is also somewhat variable, depending in some measure upon the rate and nature of the discharge. It clearly accompanies the exhaustion of the active materials.

It has been observed both by the authors and by other experimenters that the internal resistance of an Edison type E cell is substantially constant during the main working portion of the discharge corresponding to *b c* in Fig. 2. Thus, in the E-18 cell the internal resistance at ordinary temperatures is about 0·0022 ohm. This would

* Abstract of a paper presented before Section C of the International Electrical Congress at St. Louis.

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correspond to 0·0278 ohm in a type E similar cell weighing 1lb., or to 0·0126 ohm in a cell weighing one kilo. The internal resistance is slightly less at the beginning of the discharge, but becomes considerably greater near the end of the discharge. Since, however, this rise in resistance occurs only during a small portion near the end of the delivery, its effect in the total discharge may be neglected for most practical purposes. The internal resistance does not vary greatly with the discharge rate within the usual working limits of 0 to 150 amperes. In other words, the drop of pressure in the cell is approximately proportional to the discharging current strength. The maximum amount of power obtainable in the external circuit of any cell is $\frac{e^2}{4r}$ watts, where e is the actual E.M.F. and r the actual internal resistance of the cell. Under these conditions the cell will work at 50 per cent. efficiency with equal internal and external resistance. The energy liberated in an Edison E-18 cell is 1·3 volts × 141 ampere-hours = 183·3 watt-hours = 14·48 watt-hours per pound (31·9 watt-hours per kilo), and this liberation of energy is constant to a first approximation for all rates of discharge within the working limits. The amount of this liberated energy which is delivered in the external circuit depends only on the electrical efficiency of the circuit, or on the drop of pressure in the cell. Thus at 90 per cent. electrical efficiency, or 10 per cent. internal drop (corresponding to about 60 amperes in the E-18 cell), the externally delivered energy would be 183·3 × 0·9 = 165 watt-hours.

The charging E.M.F. of an Edison cell is approximately 1·6 volt (somewhat greater at the outset) until about 60 per cent. of the charge has been stored, when it rises to about 1·75 volt simultaneously with increased evolution of gases. The rise is therefore apparently connected with gaseous polarisation. To the E.M.F. of the cell must be added the drop in internal resistance in order to find the potential

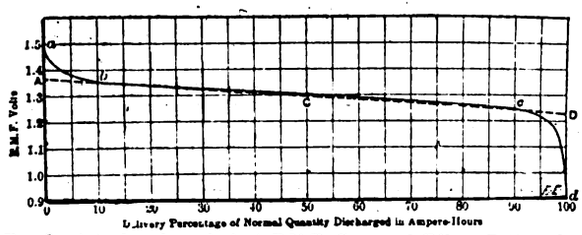

FIG. 2.—Actual and quivalent E.M.F. Curves of Edison Battery during Delivery.

difference at charging terminals. The mean E.M.F. of the cell during charge may, therefore, be taken as roughly $1\frac{2}{3}$ volts. The resistance of the cell during charge is approximately the same as during discharge, being greater at the outset of the charge, corresponding to the condition of resistance at the end of the discharge. During the charge of Edison cells bubbles of gas are liberated at both plates, oxygen at the anode or positive plate, and hydrogen at the cathode or negative plate. The collected gases form an explosive mixture.

Since the mean E.M.F. of discharge is approximately 1·3 volts, and the mean E.M.F.'s charge approximately 1·67 volts, it follows that the superior limit of watt-hour efficiency in an Edison cell is $\frac{1·3}{1·67}$, or 78 per cent. In practice it is always less than this, due to internal drop. The efficiency may best be examined, first, in relation to the voltage of charge and discharge; and, second, in relation to the electric quantity charged and discharged. If there were no drop of pressure due to internal resistance, either in charging or in discharging, and all the electricity charged in the cell (as expressed in coulombs or ampere-hours) were discharged, the ampere-hour efficiency of the cell being thus 100 per cent., the watt-hour efficiency would be 78 per cent., or thereabouts. This figure can, in fact, be approached by employing very low rates of charging and discharging—*i.e.*, by taking many hours to each process. On the other hand, the more rapid the charge and discharge the greater the internal resistance drop in the cell, and the less the efficiency even on the assumption of 100 per cent. ampere-hour efficiency. Thus at 60-ampere charging and discharging rates the potential difference in charge would average about 1·8 volts in the E-18 cell, and the potential difference in discharge would average about 1·17 volts to the 0·75-volt limit, representing a watt-hour efficiency of 65 per cent. with 100 per cent. ampere-hour efficiency.

The Edison cell would manifestly possess an ampere-hour efficiency of 100 per cent. if no gases or irreversible substances were generated in its cycle of chemical action. Thus, if a certain number of grammes of iron were reduced and a certain number of grammes of nickel were oxidised by one ampere-hour of charging current, and no other action took place, then on discharge the reconversion of these masses of active material would develop the complete ampere-hour of electricity. On the other hand, every gramme of hydrogen (or the equivalent mass of oxygen) liberated and discharged from the negative plate during charge absorbs 0·26 ampere-hour of electricity, which is not returned to the circuit during discharge. The ampere-hour efficiency of the Edison cell is therefore determined by the amount of gas escaping during the charge. This in turn depends upon the rate of charge or charging current strength, since the greater this strength the greater the drop in internal resistance, and the sooner the plates are brought to that difference of potential at which the water is rapidly decomposed.

The essential results of various tests are represented in Fig. 3. This chart gives the output of the Edison cell (per unit mass) at varying power rates of discharge. Curves I., II., and III. represent the laboratory tests obtained for type D by the Laboratoire Central d'Electricité, Mr. Hibbert, and M. Hospitalier respectively. Curve V. represents the

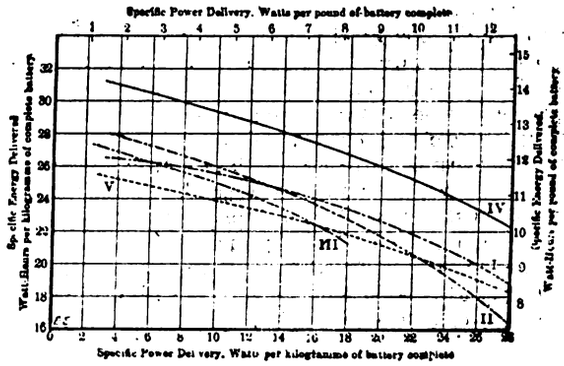

FIG 3.—Curves showing Useful Energy Delivered in Discharge to 0·75 Volt by Edison Battery.

corresponding values for the E-18 cell on normal rated capacity and delivery. Curve IV. represents, on the other hand, the corresponding values for the E-18 cell when operated under laboratory conditions of maximum capacity and delivery. In practice the output may be expected to fall between these two curves, IV. and V. Although the authors' tests of the type E cell have been confined to the E-18, 12½lb. cell, factory tests of the larger sizes of this latest show about 12 per cent. greater maximum output per unit mass than corresponds to Curve V. This may be accounted for by the lesser proportion of deadweight (solution jar and connections) than is presented in the E-18 cell.

Much experience has been attained in actual service from the Edison battery on automobiles. This experience has led to the elimination of some of the minor practical difficulties that any new battery always encounters. The successive improvements in the battery have, in fact, been due to the perception of defects discovered in actual vehicle practice. It would seem that the Edison cell is so durable that no electrical depreciation is discernible in the cells during the three years' total experience of the practical construction of the battery. No mechanical corrosion of the plates or pockets has been discernible during that time, and no depreciation seems to have yet occurred in the active material, judging from the capacity tests of cells, which are stated to be as great at the present time as they were when the cells were first constructed. The authors have recently confirmed this observation in the case of type D cells that have run nearly 3,000 miles in an automobile of the Edison Company in Boston. The capacity of these cells was found to be equal to that of new cells of the same

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type. Two of these cells were opened for examination, and the sediment in them collected and dried. The dry sediment weighed 3·9 grm. and 7·1 grm. respectively, probably less than one-third of 1 per cent. of the active material in the grids. In fact, a new cell freshly set up will show about this quantity of material washed by the solution from the external surface of the plates. No signs of depreciation or corrosion appeared on any of the plates or connections.

According to observations at the factory, Edison cells lose 15 per cent. of the ampere-hour charge in eight weeks of idleness. Another test showed 11 per cent. of loss by standing one week. Hibbert's tests on type D showed 9 per cent. loss in 48 hours and 27 per cent. in 26 days. Hospitalier's tests on type D showed less than 10 per cent. loss after 24 days. A test of the authors on four type E-18 cells gave, after 26 days' idleness, 100 ampere-hours per cell. This represents a loss of 9 per cent. of the normal rated capacity of the cells, or 28 6 per cent. of the maximum rated capacity. At a corresponding charge the delivery within 24 hours would have been about 140 ampere-hours. All of the tests show that the cells are remarkably immune from deleterious effects due to careless treatment. Cells have been allowed to dry out, have been permanently short-circuited, or even charged in the wrong direction. These cells have shown full restoration of their capacity after a prolonged restoring normal charge.

Conclusions.—The Edison nickel-steel alkaline storage cell, in its large output at heavy discharge rates, its low depreciation in capacity, and its durability under severe and adverse treatment, approaches the capabilities of a piece of mechanical apparatus more nearly than is ordinarily credited to electrolytic structures. For this reason it is specially adapted to automobile service, where the treatment is abnormally arduous and severe. The authors desire to express their indebtedness to Mr. Edison for the cells which he placed at their disposal for test, as well as facilities for becoming acquainted with the facts concerning their manufacture. Also to his assistant, Mr. R. A. Fliess, of the Edison Storage Battery Company, who very kindly placed an invaluable collection of experimental data at our disposition. We are also indebted to Mr. C. L. Edgar, president of the Edison Electric Illuminating Company, of Boston, for the use of his battery in tests and information concerning the same from his assistants.

PERSONAL.

The resignation of Mr. A. Le Rossignol, general manager and engineer of the Newcastle tramways, noted in a previous issue, was accepted at the Council's meeting on Wednesday, the 26th inst.

Mr. John G. Bruce, assistant distributing engineer to the St. Pancras Borough Council, has been appointed to the position of resident electrical engineer to the Willesden Council at a salary of £250 per annum.

We are informed that Prof. Harry E. Clifford has been appointed acting head of the department of electrical engineering at the Massachusetts Institute of Technology, Boston, vice Dr. Louis Duncan, resigned.

The Reading Tramways Committee have increased the salary of Mr. Arthur G. Shearer, chief assistant engineer, from £120 to £150 per annum, in appreciation of the satisfactory manner in which he has conducted his duties.

The Blackburn Corporation are considering the following appointments: Messrs. J. H. Cowell and Johnson joint managers of the tramways at a salary of £250 each; Mr. P. P. Wheelwright manager of the electricity works at a salary of £300; to increase the salary of Mr. F. H. Corson, second assistant engineer, to £250; and to appoint a junior assistant in the electricity department.

Mr. J. W. A. Binner, chief assistant engineer of Bermondsey electricity works, who has been appointed as superintendent engineer to the Havanna Electricity Company, Cuba, was, previous to his departure, presented with a handsome dressing case, cabin trunk, and set of books by Mr. W. H. Vincent, borough electrical engineer, on behalf of the staff and employés, as a token of their good wishes for his continued success. Mr. Binner sailed from Liverpool on the 14th inst. in the "Celtic," and his future address is La Companie de Electricidad de Cuba, Aguiai 81 and 83, Havanna, Cuba.

Sale of Plant, etc.—Particulars of sale of plant and goodwill of the business of mechanical and electrical engineers carried on by W. and E. Sumner and Clementson, Limited, and of large plant which has been used for electric lighting of Messrs. Browett, Lindley, and Co.'s works, appear in another column.

LEGAL INTELLIGENCE.

THE MANCHESTER TRAMWAYS.

The case of the Manchester Carriage and Tramways Company *v.* the Swinton and Pendlebury District Council was mentioned before the Court of Appeal on Wednesday, when the defendant Council asked that the hearing should be accelerated.

Mr. Justice Channell had decided that the Council must take over a depôt in their district, and the Council are appealing against such decision.

The Court of Appeal considered that the Council had not made out a case for advancing the hearing of the matter, and the case was dismissed, with costs.

THE LAYING OF TELEPHONE WIRES.

At Brentford County Court his Honour Judge Shortt, K.C., as arbitrator under Section 3 of the Post Office Act of 1878, gave his award in the dispute between the Postmaster-General and the Brentford District Council as to the location of the telephone wires.

The Postmaster-General, to meet the needs of subscribers to the Post Office telephone system, intended to construct lines along Ealing and Hanwell roads at Brentford, but the local authority refused to sanction overhead wires. It was contended for the applicant that he had a duty cast upon him to make the service as cheap as possible in order that the lowest fees could be charged to the public, and he therefore proposed overhead wires, as the roads in question were rural in character and little populated. The overhead installation would cost £71. 4s. 7d., and the underground system £364. 5s. 6d., and the difference was so extensive as to prohibit the service being installed if the Council had its own way.

For the respondents it was urged that they had no power to incur the expense of opening and closing the trenches. The district was thoroughly served by the National Telephone Company, and no extension was needed.

His Honour stated that having visited the roads along which the lines were proposed to be run, he was satisfied, by their narrowness, that they were unfit to have poles set up in them. He did not think the extra expense of putting the wires underground sufficient excuse to outweigh this view, and he therefore found in favour of the respondents, with costs.

IMPORTANT RATING APPEAL.

At the Preston Quarter Sessions the Blackpool and Fleetwood Tramway Company appealed against an assessment by the Thornton Urban District Council, through whose district the tramway passed. Under the Public Health Act of 1875 railways are rated at one-fourth of the actual value of the undertaking, and the tramway company contend that as they pass through enclosed ground in going from Blackpool to Fleetwood their line is entitled to the privilege of a railway constructed under an Act of Parliament. If the line passed through public streets only, it was certainly a tramway, but this line, it was contended, passed through enclosed ground, which had to be obtained by compulsory powers. It was further contended on behalf of the tramway company that they had to pay railway passenger duty to the Board of Taade.

The Chairman said he could not infer from that that the tramway was a railway, and after legal argument on both sides, the Bench decided that the tramway could not be treated as a railway, and the appeal was dismissed, with costs.

The Bench agreed to state a case.

COMPANIES' MEETINGS AND REPORTS

BRITISH COLUMBIA ELECTRIC RAILWAY.

The report for the 12 months ended June 30 last, to be submitted at the meeting to-day, shows an increase in gross receipts of 138,445dol., and the net earnings, after charging renewals, an increase of 60,649dol. The following charges have been made against the revenue account—namely: provision for renewals maintenance, £13,372; bonus to employés, £2,340; amount written off preliminary and issuing expenses, £1,343; added to capital amortisation fund, £1,659; leaving as net profit for the year £49,045. The balance brought forward was £1,099, making a total of £50,144. The directors recommend a dividend on the deferred ordinary stock of 3 per cent., making 6 per cent. for the year, writing an additional amount of £2,000 off preliminary and issuing expenses, transferring to reserve fund £7,104, and carrying forward £2,222. The number of lights in use at June 30, 1904, was 112,911, an increase of 19,812. The number of passengers carried during the year was 8,869,486, an increase of 1,505,197. The construction of the Vancouver power installation is proceeding very satisfactorily. Less than one-third of the tunnel between Trout and Coquitlam Lakes remains to be driven; the concrete dam at Trout Lake, the power-house and the sub-stations have all been completed, and three pipe lines are in place. Since Dec. 18, 1903, the city of Vancouver street-lighting has been carried out by means of power delivered from Trout Lake, and a contract has been entered into to supply the city of New Westminster with power for street-lighting over a term of years. The remaining £45,000 of Vancouver power debentures have been issued during the year, making a total issue of £220,000. The additional funds required by the power company to complete construction work are being supplied by the railway company. The engineers estimate that the work will be completed about May, 1905. The negotiations for the purchase of the

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Vancouver Gas Company have been successfully carried through since the end of the year now under review, and the price of electricity has been lowered.

WESTERN TELEGRAPH.

The revenue for the half-year ended June 30 amounted to £241,981 and the working expenses to £99,547. After providing £13,868 for debenture stock and debenture interest and sinking fund and £5 893 for income tax. there remains a balance of £128.672; to this is added the sum of £4,939 brought from December last, making a total of £127,611. The revenue includes £17,114 dividends upon the Company's investments in other telegraph companies and £7,322 interest on reserve fund investments. A quarterly interim dividend of £31,189 has been paid, £22,000 transferred to the general reserve fund, and £18,000 to the maintenance ships reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which, together, will amount to £51,982, leaving a balance of £4,439 to be carried forward. The dividend and bonus will be payable on Nov. 3.

BATH ELECTRIC TRAMWAYS.

The report of the Bath Electric Tramways, Limited, for 1903 states that the construction of the Company's system was proceeding up to the end of last year, and the accounts submitted relate entirely to construction. The tramways started working on Jan. 2, 1904. Upon that date the operation of the system commenced with a small part of the mileage and with some few of the tramway cars. Both the mileage and equipment have been increased from time to time during the current year, and various sections of the line were at various dates completed and opened, until Aug. 1 last the final section of the system originally contemplated by the Company was opened for traffic, and 40 tramway cars were in use. The traffic receipts from the commencement of operations to Sept. 28, 1904, a period of 39 weeks (less two days) amounted to £25,365.

The first ordinary general meeting of the Company was held on Tuesday at Winchester House, Sir Vincent Caillard presiding.

The **Chairman** stated that an additional route was being laid out ready for construction over the Midland Bridge. Under the Company's original order it was bound to provide £11,500 for street widenings and city improvements. The term "city improvements" was very wide, but by payment of an additional £5,000 the Corporation of Bath had undertaken to reconstruct the Midland Bridge, which would have to be altered to accommodate the new route, and to release the Company from its obligation regarding any "city improvements" that might be made in the future. It was expected that the traffic all the year round would average £750 per week. During the construction of the system, owing to the conditions of the money market, the Company borrowed money privately, but it was at once going to issue £135,000 of debentures to clear off that indebtedness.

The report was adopted.

Subscriptions are invited at par for the issue of debentures to the amount of £135,000, as mentioned above. This stock will carry interest at the rate of 4½ per cent. The subscription list was opened on Wednesday.

ELECTROLYTIC ALKALI.

The annual meeting of the Electrolytic Alkali Company, Limited, was held at Liverpool last week, Mr. C. C. Connor presiding.

The **Chairman**, in moving the adoption of the report (particulars of which we gave last week), attributed the small profits to the general industrial depression. The productive power of the plant had been increased, with the result that the cost of production had been reduced.

A **Shareholder** moved an amendment that a committee be formed to enquire into the position of the Company, and that new directors and auditors be appointed.

After some discussion, the **Chairman** said that the Board would not object to the amendment, though they had the voting power to do so if they wished. The directors were willing to have investigation, as they were convinced it would show that there was no foundation for any allegations of mismanagement. He warned the meeting that when the investigation was closed he would exercise all his power as one of the largest shareholders to prevent publication of any details that would injure the Company.

The amendment was then agreed to as far as the report to a committee was concerned, and the meeting was adjourned.

NEW COMPANIES REGISTERED.

Marks and Hodgkinson, Limited.—Capital, £5,000. Object: to acquire the business of electricians and electrical engineers carried on by J. Marks and H. Clarkson.

Holroyd's Automatic Machine Syndicate, Limited.—Capital, £10,000. Object: to carry on the business of manufacturers of and dealers in automatic machinery of all kinds, engineers, electricians.

Structural, Heating, and General Engineers, Limited.—Capital, £7,500. Object: to acquire and carry on the business carried on at Sussex-street, Sheffield, under the style or firm of William Henry Sidgwick, of civil, mechanical, electrical, heating, and ventilating engineers and contractors.

Saxonia Electrical Wire Company, Limited.—Capital, £10,000. Object: to acquire, carry on, and extend the business of manufacturers of cables and insulated electric light and telephone wires, etc., at present carried on by F. S. Thomas and S. T. Smith, as the Saxonia Electrical Wire Company, at Roan Works, Roan-street, Greenwich.

Garcia Renault Electric Cars and Accumulators, Limited.—Capital, £20,000. Objects: to adopt an agreement with P. Verhaeghe, and to carry on the business of dealers in and factors and vendors of motors, accumulators, cycles, and other vehicles of all kinds (whether propelled by electricity or other motive power), mechanical, electrical, and general engineers, etc.

Pantelegraphy Publishing Company, Limited.—Capital, £100. Objects: to acquire the business of a telegraph code expert carried on by A. C. Baronio at 36, Lime-street, E.C., as the Pantelegraphy Publishing Company, and to carry on the business of compilers, printers, and publishers of telegraphic, cable, cylinder, and other codes and messages, general translators of code and cipher messages, etc.

W. Sisson and Co., Limited.—Capital, £25,000. Objects: to adopt an agreement with W. Sisson for the acquisition of the business carried on by him as W. Sisson and Co., and to carry on the business of boiler-makers, iron, brass, and metal founders, mechanical engineers, manufacturers of steam and internal-combustion engines, and all kinds of implements and machinery, smiths, tool makers, electrical engineers, etc. Registered office: Quay-street, Gloucester.

Liens Registered.

Royce, Limited (Electrical Engineers, Manchester).—Issue on Oct. 7 of £1,900 debentures, part of a series created March 27, 1903, to secure £25,000, charged on the company's undertaking and property, present and future, except uncalled capital. Trustees: Law Guarantee and Trust Society, Limited, 49, Chancery-lane, W.C. Total amount previously issued of same series, £23,100.

Uxbridge and District Electric Supply Company, Limited.—Issue on Sept. 26 of £23,400 5 per cent. debentures, part of a series created July 14, 1904, to secure £35,000. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series. A note is appended to the return to the effect that the previous issue of debentures has been fully satisfied.

APPOINTMENTS VACANT.

Canvassing Engineer, Wolverhampton, Oct. 31. See advertisement.

Engine-Driver, lighting and traction station in the Midlands, Oct. 31.

Improver, Perth Corporation Electricity Works. Wages 12s. per week. See advertisement.

Borough Electrical Engineer and Manager, Poplar. Salary £400 per annum. See advertisement.

Assistant Electrical Engineer, Farnworth Urban District Council. Salary £120 per annum. Applications by 31st inst.

Lecturer and Demonstrator in Electrical Engineering, New Zealand Government. Salary £300; saloon passage. Oct. 29. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Vienna.—The Government Railways require tenders for telegraph tape for 1905. Tenders by Nov. 5.

Melbourne.—The Federal Postmaster-General requires tenders for 6,000 yards of telegraph cable. Tenders by Nov. 15.

Crejour (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Porto Alegro (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Guirgia (Roumania)—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Aberaman.—The Cwmbach Co-operative Society invite tenders for electric lighting of new premises. Contractors to supply all wiring and plant necessary. Tenders to be in Secretary's hands by Nov. 4.

Arenas de San Pedro.—The Municipality require tenders for electric lighting for eight years. Particulars may be had of the Alcalde of that town, province of Avila, Spain. Tenders by Oct. 30.

Erith.—Tenders are invited for material and work in connection with the installation of electric light at the Education Committee's offices at Picardy, Belvedere. Tenders by Nov. 11. See advertisement.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Liege.—Tenders are required for the construction and working (concession) of three electric tramways. A deposit of £400 is required. Particulars from the Provincial Government, Liège. Tenders by Nov. 14.

Hammersmith.—The Guardians invite tenders for a complete wiring installation for the electric lighting of their new workhouse and infirmary at Wormwood Scrubbs. Tenders to the Clerk to the Guardians by Nov. 15.

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La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Cumberland and Westmoreland Lunatic Asylum, Carlisle.—Tenders are required for plant. Copies of tender may be inspected at the office of the Consulting Engineer, Electricity Works, Northallerton, Yorks. Tenders to the Clerk to the Committee of Visitors by Nov. 1.

Ballinasloe (Ireland).—The Committee of the District Lunatic Asylum invite tenders for wiring the temporary buildings for 35 incandescent lamps of 16 c.p. each, at a pressure of 200 volts, and the necessary overhead cables to connect same with engine-house, and all else necessary. Tenders by Nov. 14.

Madrid.—An application has been received from Don José Xinxo for a concession for an electric tramway starting from the Plaza Rovira in Gracia and terminating at San Juan de Horta. The notice is published with a view to eliciting any applications for the same concession on more advantageous terms; such applications to be made by Nov. 10.

Craivo (Roumania).—The *Moniteur des Intérêts Matériels* (Brussels) announces that the adjudication will take place at 4 p.m. on Oct. 25 (Nov. 7) at the Mayoralty of Craïova, of the concession for construction and working of a line of tramways (mechanical traction) in the town of Craïova. The duration of the concession is fixed at 50 years. A provisional deposit of £200 is required.

Burslem (Staffs).—Tenders are invited for the supply and erection of the following electric lighting plant at the workhouse, Chell, for the Guardians of Wolstanton and Burslem Union: (Section A) water-tube boilers, with fittings; (B) feed-water heater, feed pumps, piping, etc.; (C) two 25-kw. steam dynamos and booster; (D) switchboard; (E) cables and wiring; (F) accumulators; (G) arc lamps. Tenders to Mr. J. A. Lowndes, clerk, by 12 noon on Nov. 15.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Peok and Co., 63, Leadenhall-street, London, E.C. Tenders by March 31.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegraph Office Yard, Thursday Island, of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Stoke.—The Guardians have accepted the tender of Blackburn, Starling, and Co., at £48, for the installation of the electric light in the workhouse. There will be 60 lights, 11 sockets, and 55 switches. There were four tenders.

Exmouth.—Mr. T. Abell has secured the contract, at £2,160, for erecting the generating station. The nearest tender was, according to the *Exmouth Chronicle*, by another Exmouth builder, at £2,170; whilst a Topsham contractor quoted £2,189.

Ilford.—The Urban District Council have accepted the tender of the British Westinghouse Company, Norfolk-street, Strand, W.C., at £670, for the supply of balancer and switchboard panel and reversible traction booster and switchboard panel.

Motors.—Messrs. Bruce Peebles and Co., Limited, 25, Victoria-street, S.W., report the acceptance of the following: Natal and Durban Railways, Durban (locomotive shops)—40 motors, averaging 10 h.p. each; Geelong Tramways—500-e.h.p. lighting and traction direct-coupled set; Oude and Rokilkhand Railway (H.M. India Office)—generators, motors, motor-generators, and balancers for railway shops, at £4,900.

Perth.—The Corporation have accepted the following tenders for the construction and equipment of about 4¾ miles of route length of tramways, constructed as single line with passing poles: permanent way and paving, including copper bonding, R. W. Blackwell and Co., 59, City-road, London, E.C.; overhead equipment, R. W. Blackwell and Co.; cables, ducts, etc., Callender's Cable and Construction Company, Hamilton House, Victoria-embankment, London, E.C.; cars and equipments, Hurst, Nelson, and Co., Motherwell, N.B.; car depôt buildings—excavator, brick, and mason work, E. McKearney, Scott-street, Perth; iron and steel work, W. Hume, Kirkside, Perth; carpenter, etc, T. Leith and Co., Victoria-street Perth; slater work, J. Buchan and Son, King street, Perth; plumber work, MacLeish, Morrison, and Co., Mill-street, Perth; plaster work, T. P Jameson, Baillieston, Glasgow; glazier and painter work, G. R. Douglas and Son, Prince's-street, Perth.

Sub-Contracts.—Messrs. Browett, Lindley, and Co., Limited, Patricroft, report the following recent orders: From Messrs. Mather and Platt, Limited, Salford, three 200-kw. engines and one 100-kw. engine for the Priddy's Hard Victualling Yard and Royal Forton Barracks, to Admiralty specifications; from Messrs. Bruce Peebles and Co., for Canada, two engines, each to drive a 250-kw. alternator, and to give a further 50 per cent. overload: from the British Westinghouse Electric and Manufacturing Company, for the Frodingham Iron and Steel Company, one 575-b.h.p. engine—this engine to be capable of giving 100 per cent. overload; from the Cellulose Fabrik Skotselven, Norway, one 40-b.h.p. engine; from Messrs. Steel Bros. and Co., London, for delivery to Rangoon, one 50-b.h.p. engine; from the Union Card Paper Company, Montreal, Canada, one 50-kw. engine; from Messrs. Campbell and Isherwood, Bootle, two 30-b.h.p. engines for shiplighting—the above orders totalling up to about 3,500 b.h.p.

Brighton.—The Town Council have received the following tenders for the installation of electric light, telephones, and fire-alarms in the diphtheria pavilion, borough sanatorium, Bear-road, Brighton:

G. Hignett and Co., 2, North-street-quadrant	£328	5	0
Private Wire and Telephone Installation Company, Limited, 5, Palmer-street, Westminster, S.W.	241	5	0
H. J. Galliers, 3, St. James's-street	240	0	0
C. G. Reed and Sons, Limited, 26, North-street	239	10	0
Wright, Methuen, and Co., 34, Pall-mall, Manchester	199	18	0
Electrical Engineering and Maintenance Company, 5, Eastcheap, E.C.	198	0	0
Page and Miles, Limited, 60, Western-road	197	15	0
A. E. Fellingham, 10, North-street-quadrant	190	0	0
Cox-Walkers, Darlington	170	18	6
G. Virgo, 40, Edward-street (accepted)	152	0	0

Rest of Brighton.

BUSINESS NOTES.

TRACTION.

Wigan.—Trial runs on the line to Ashton have proved satisfactory.

Pudsey.—The Council have instructed the clerk to publish notice of intention to apply for a provisional order.

Cambridge.—The syndicate have arranged with the Corporation for the exclusion of the Silver-street route from the tramway scheme.

Stockport.—The Corporation have passed a confirmatory resolution for the purchase of the company's undertaking at a price of £224,000.

Wolverhampton.—The last of a series of extensions was opened last week, when the Board of Trade inspected the Wednesfield route and pronounced it quite satisfactory.

Bournemouth.—The arbitration proceedings between the Corporation and the Poole Electric Tramways Company closed last Friday, when Mr. Balfour Browne addressed the arbitrators on behalf of the company.

Glasgow.—Lord Balfour of Burleigh, the arbiter appointed by the Board of Trade in connection with the dispute between the Corporation and the Paisley Tramway Company, visited Paisley on Saturday and inspected the line.

Cheshunt.—The Urban Council are considering a proposal by one of its members that the Council should stipulate with the County Council and the company for a minimum roadway width of 45ft. in connection with the proposed tramway.

Wellingborough.—Replying to a letter from the Corporation, the company state that they cannot say at present when the work of construction will actually be commenced, but that they have no intention of allowing their powers to lapse.

Blackpool.—The proposal of the General Purposes Committee that 1d stages should be allowed on the Marton route has been confirmed. There will be two such stages. A proposal to have 1d. stages on the promenade route was rejected.

Leicester.—A trial trip over the new routes, Humberstone-road, East Park-road, and Evington-road, took place on Wednesday, and this was followed by an announcement that the Humberstone-road and East Park-road sections will be opened for traffic on Tuesday next.

Belfast.—In his report upon the estimates prepared by the Corporation officials for the electrification of the tramways, Mr. Lacey, the consulting engineer, substantially agrees with such estimates. The terms of the penalty clauses in the contract are to be finally settled by the town clerk.

Leith.—The transfer of the tramways to the Corporation has been completed, and plans relating to the reconstruction for electric traction have been forwarded for approval to the Local Government Board, and also to the Corporation of Edinburgh, the latter being the road authority in respect of a portion of the system.

Handsworth.—By the invitation of the South Staffordshire Tramways (Lessee) Company, the members of the District Council and their officers inspected the tramways the other day. A special car was put on, and after a pleasant journey the party sat down to luncheon at the New Inns Hotel, when some amiable speeches were delivered.

Birmingham.—The Bill providing for tramway extensions has been drafted, and will be considered at a special meeting on the 31st inst. A deputation of ratepayers and shopkeepers attended before the Tramways Committee with a petition that alternative routes to Corporation-street and Martineau street should be adopted.

Metropolitan Railway Co.—The settlement of differences between this company and the Great Central Railway Company is announced. The latter company is to become the owner of the duplicate lines constructed by the Metropolitan Company between Neasden and Harrow, and joint owners of the section between Harrow and Quainton Road.

Coventry.—The Corporation have resolved to inform the Coventry and District Tramways Company that unless speedier progress is made with the Smithford-street extensions they will appeal to the Board of

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Trade. The company are unable to accede to the application of the inhabitants for an extension of the Earlsdon section, as the outlay entailed would be somewhat heavy.

King's Norton.—At a special meeting of the District Council on Tuesday the following resolution was carried: "That the Tramways Committee be instructed to present a special report to the next meeting of the Council upon the question of all their negotiations as to the future working of the tramways in the district of the Council, and the present position of such negotiations with such recommendations thereon as they might deem advisable."

Bury.—It has been decided not to proceed with the extension of the Tottington section, but to apply for powers to continue the Elton lines through Ramsbottom to Stubbins. Under the Bill, Bury will be required to construct the line to Stubbins within three years, or the powers will pass to Ramsbottom; and if after the lines are constructed by Bury they are found to be financially successful, Bury will be compelled to continue the tramways to Edenfield within seven years of the passing of the Bill.

Accrington.—Terms have been arrived at by the Tramways Committee with the Oswaldtwistle Urban Council with respect to the running of trams up Union-road, Oswaldtwistle. In order to widen the roadway the Corporation purpose acquiring some old property in Union-road, and the Urban Council will be allowed to fix gas brackets or electric lights to the standards. The application of the Clayton-le-Moors Urban Council for a double line within the township and round Sparth-road to the Forts Arms has been refused.

Tipton.—At the meeting of the District Council on Tuesday the Tramway Committee reported that they had considered with the Council's solicitor the clauses of the agreement with the company in view of the stoppage of the cars on the Bloomfield line. They found that the company had failed to carry out several matters mentioned in the agreement, and particularly in reference to the electrification of the line. They recommended that the solicitor take steps to enforce the terms of the agreement, and that the Board of Trade be requested not to grant any further extension of the license to use steam on the line.

West Fife.—A conference of the authorities interested in the West of Fife electric tramway scheme was held last week, when the following districts were represented: Dunfermline, Inverkeithing, Cowdenbeath, Lochgelly, and Kirkcaldy. The question particularly discussed was that of municipal control. Failing this, several members voiced the opinion that there might be joint action for arranging uniform terms. After full interchange of views on the subject it was agreed to adjourn the conference until such time as plans had been submitted by the Tramway Committee and examined by the municipal and district authorities interested.

London United Tramway Co.—A conference of Middlesex local authorities was held on Tuesday at the Town Hall, Ealing, for the purpose of determining what procedure should be adopted with the view of prevailing upon the London United Tramways Company to abate "the intolerable nuisance" caused by the noise of its cars. Resolutions were unanimously passed recommending the authorities concerned to form a joint committee with power to take such steps as were necessary. The conference did not explain how the "intolerable nuisance" is to be abated, and the convenience of the tramway service to the inhabitants generally should outweigh the objections of a section of the community.

Heywood.—The Tramways Committee are not prepared to accede to the suggestion of Bury and Rochdale that Heywood should pay 5d. per car mile for working expenses. They accordingly again offer to pay 4½d. per car mile run, or in the alternative to pay the actual working costs to be fixed by an expert or by an arbitrator appointed by the Board of Trade. If this is not acceptable to Bury and Rochdale, the committee suggest that Heywood shall provide their own cars and work them, and that each Corporation shall have running powers over the lines in their respective boroughs between Bury and Rochdale, the number of cars run to be according to the length of line in the boroughs.

Huddersfield.—After a lengthy meeting on Saturday last the following resolution was passed by the tramway employés: "That this meeting of the men employed on the Huddersfield Corporation tramways enters its most emphatic protest against the proposed annual medical examination. We also decide to gratefully accept the good offices of the Trades Council with a view to their bringing pressure to bear on the Town Council, and secure that a most reasonable and equitable regulation shall be substituted for the one passed at the last Town Council meeting." It is reported that the men have decided to write to the town clerk asking him to cause the matter to be deferred six months, and if, in the meantime, any men are instructed to go to the medical officer, they are to refuse to go.

N.E.R. Electrification.—A remarkable performance in electric railway operation was accomplished recently on that portion of the line of the North-Eastern Railway near Newcastle which has been electrically equipped by the British Thomson-Houston Company, Limited. Owing to the festivities occasioned by the visit of the Channel Squadron to Newcastle, the passenger traffic on the electrified line was enormously increased, necessitating on the first day the continuous running of 86 out of the possible 89 available cars, and on the following day the full complement of cars (89) between the hours of 5 p.m and 11 p.m. Although the equipment was subjected to exceedingly heavy and usual demands, not a single breakdown or interruption to service was experienced. The successful operation of this line, one of the first and largest surface electric railways in the United Kingdom, and its ability to successfully meet sudden and heavy demands certainly augurs well for the future of heavy electric traction.

Southend.—At last week's meeting of the Town Council the borough surveyor submitted plans and estimates for the extension of the tramways from Pleasant-road and Southchurch-avenue to the Half-way House as follows: laying of the track, £7,100; making road and building sea-wall to the Half-way House, £10,560 The electrical engineer estimated that the cost of equipment would be £6,559. Having regard to the large cost of extending the roadway and sea-wall to the Half-way House, the committee thought it desirable in the present instance to limit the extension of the tramways to a point near the end of the existing paved promenade. It was recommended that the borough engineer be authorised to carry out the work of laying the permanent way as far as the end of the existing parade at an estimated cost of £2,600, and that the electrical engineer be authorised to carry out the necessary electrical equipment of such extension at an estimated cost of £5,951. In deference to the Law and Parliamentary Committee, it was decided to postpone the matter for the present.

Plymouth.—In November, 1903, the Devonport and District Tramways Company, who work all the tramways in Devonport and district, and own part of them, gave the statutory notice of their intention to apply for powers under the Light Railways Act of 1896 to construct in Devonport and Plymouth light railways, the effect of which would be to link up practically the whole of the tramway system of the Three Towns. As the result of a conference between representatives of Plymouth Corporation and the company it was arranged that the company should not proceed with their proposed scheme until after the Corporation had applied for a provisional order to construct tramways from Tavistock-road to the borough boundary. Since then the Corporation has obtained such provisional order, but up to the present no steps have been taken towards the construction of the tramways. It is now reported that the company, being of opinion that the extensions projected by them would meet a public requirement, have decided to proceed with their application to the Light Railway Commissioners.

Newcastle.—There was an animated debate at a meeting of the Corporation on Wednesday concerning the position of the electric tramway service. On the motion that the resignation of the general manager, Mr. Le Rossignol, should be accepted, Alderman Ellis, the new chairman of the committee, said that there had been reckless extravagance. Alderman Newton said that 82 men had been doing the work of 28 men, and cars were built simply to give men employment. There was a number of walking gentlemen whose only business it was to draw salaries. It was stated that the economies effected under the new *régime* amounted to nearly £20,000 per annum. The general manager's resignation has been accepted, his salary to be paid up till Dec. 9. A letter was read from Mr. Le Rossignol, in which, after recounting the progress of the tramways, he stated that since the commencement of this year the attitude of a member of the Tramways Committee had been unendurable, so that when he received the offer of an appointment in the Colonies, he decided to accept it. It is reported that, with a view to reducing expenses, the service on some of the sections will be curtailed.

Liverpool.—Responding to a vote of thanks for the ability with which he had presided over the Tramways Committee during the past year, Sir Charles Petrie, chairman of the Tramways Committee, gave last week some interesting figures showing the progress of the tramways. During the nine months ended Sept. 30, compared with the same period in 1897, which was the last year of the old company's control, the passengers had increased from 29,000,000 to 87,500,000, or 201·9 per cent.; the mileage had increased from 4,500,000 to 9,100 000, or 102·8 per cent.; and the revenue from £219,000 to £406,784, or 85·1 per cent. The average length of the 1d. fare in Liverpool was 2¼ miles. The entire length of the tramways was 101 miles, and the committee had under consideration the question of extending the tramways, and have recommended the City Council to obtain parliamentary powers this session to construct 33½ miles of additional line. Having referred to the substantial provision made for depreciation, he stated that during the next year the carriage of parcels and light merchandise would receive consideration. The scheme of light railways has been rejected, except in regard to the route from Church-lane to Eaton-road, which will be proceeded with by Bill. The discussion on tramway extensions has been adjourned. After considering a canvass of the inhabitants, the Tramways Committee recommend that the Harbourne route should be omitted. It is proposed to lengthen the route from Five Ways to Monument-road.

Salford.—The report on the year's working of the tramways shows gratifying results. The fares amounted to £198,422. 7s. 6d. In addition, £161. 18s. 1d. was received from the Manchester Corporation as the proportion of fares due to Salford for working the Bury Old-road lines, and £63. 15s. 8d. was recovered for damage done to cars, making a total income of £198,646. 1s. 8d. The expenditure on revenue account was £138,541. 6s. 4d., showing a gross profit on the year's working of £60,106. 14s. 11d. Current cost £47,986. 10s. 2d. The traffic expenses amounted to £57,508. 17s. 1d., of which £40,494 was for wages of motormen, conductors, etc., £7,649. 13s. 4d. wages for cleaners, oilers, etc., and £1,429. 17s. 3d. wages of clerks and inspectors. The profit of £60,348. 17s. 8d. was disposed of as follows: interest and redemption of loans, £34,005. 14s. 2d.; rents of lines, £10,903. 4s. 5d. (Manchester Corporation £6,355. 12s. 7d., Eccles Corporation £4,147. 11s. 10d., and Prestwich District Council £400); depreciation and renewals fund, £3,439. 19s. 1d.—the balance (£12,000) being transferred to the borough fund in aid of rates. In addition to this large contribution in relief of the ratepayers, the committee paid the sum of £5,250. 10s. 6d. in rates. The high price paid for electricity (2d. per unit) has hampered the Tramways Committee, and as the result of a vigorous protest, the Tramways Committee are now charged 1½d. The substantial saving thus effected will, it is expected, enable the committee to deal with the reserve and renewals fund in a more adequate manner.

London County Council.—The Council have decided to introduce "tokens" for use on the tramways. The Duchy of Lancaster objecting to the plan relating to the construction of the tram subway in regard to the portion near Waterloo Bridge, the Highways Com-

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mittee recommend that parliamentary powers should be sought to make a slight alteration in the structural arrangements. The City Corporation have unanimously agreed to submit the Council's proposal for a tramway along the Embankment to the committees concerned for a joint report. Several members expressed approval of the scheme. Next week the Council will be asked to vote £22,500 for tramways in Rosebery-avenue. In the letter sent by the Council to the Corporation it is stated that the adoption of a circular route will enable the County Council to fully and adequately meet the requirements of the requirements of the public using its tramways, and will also to a large extent relieve the difficulties which at present exist in dealing with the traffic at the termini during the busy hours of the morning and evening. The experience which has been gained in the electrical working of the tramways has convinced the Highways Committee that the linking-up of the existing services in the manner proposed is urgently required in order that the Council may adequately cope with the fresh conditions arising from the use of mechanical power on the tramways, while, in addition, the committee feels that the new tramways will afford travelling facilities of the utmost value to those going to or returning from their work on the north side of the Thames. At the junction of Blackfriars Bridge and the Embankment the County Council proposes that both tracks should be constructed in the carriageway south of the statue of the late Queen Victoria. With regard to the method of traction for the proposed tramways on the Embankment, it is suggested that the underground conduit system should be adopted, in which case it is anticipated that some small alterations may be rendered necessary in the roadway.

LIGHTING AND GENERAL.

Beckenham.—The immediate necessity for improved lighting of the main road between Clock House Station and Kent House-road is being urged.

Wellingborough.—The Urban District Council are negotiating with the Northampton Electric Power and Traction Company as to lighting and cleaning.

West African Telegraph Co.—The directors have declared an interim dividend for the six months ended June 30 at the rate of 4 per cent. per annum.

Hampstead.—The income from the electric lighting undertaking for the six months ended Midsummer was £30,494, as compared with £24,543 during the first half of 1903.

Eccles.—The Electricity Supply Committee have under consideration a report from their engineer as to the purchase by the Corporation of electrical motors for hiring-out purposes.

Glastenbury.—The Post Office authorities are willing to erect a telephone exchange in the Shepton Mallet area. The County Council have agreed to become subscribers for the police stations.

Putney.—The Municipal Alliance have decided to lay their correspondence with the County of London Electric Supply Company on the maximum demand system before the Borough Council.

Bingley.—The Highways Committee have referred to a sub-committee the consideration of an application by the National Telephone Company for permission to lay underground telephone conduits in the streets.

New Title.—The name of the Angus Electric Light and Power Company, Limited, Montrose, has been changed to the North of Scotland Electric Light and Power Company, Limited, owing to the extension of their undertakings.

Kilkenny.—We understand that application has been made for sanction to a loan of £10,000 for electric lighting. The Citizens' Association have asked the Corporation to adopt the electric lighting scheme for the city without delay.

Bury.—Sanction has been obtained to borrow £37,060 in connection with the extension of electricity plant. The Local Government Board have postponed sanction to the borrowing of £7,500 for stores and offices until plans, etc., have been submitted.

Shildon.—The Northern Counties Electricity Supply Company are preparing for the erection of a generating station, the Council having sealed an agreement under which the company undertakes under a bond of £2,000 to complete the scheme by Jan. 1, 1905.

Newton Abbot.—The Council have informed the Urban Electric Supply Company that they are considering the desirability of purchasing a photometer from Messrs. Alexander and Co., and have asked if the company would have any objection to that means of testing.

Chatham.—The improvements at Chatham Dockyard are now well advanced, and preparations are also being made to light the dockyard with electricity. The power station has already been commenced. New and more up-to-date plant for the yard is expected before long.

Fleetwood.—An offer has been made for the transfer of the electric light and power syndicate's undertaking. The syndicate have not yet decided whether to accept the offer. The Electric Lighting Committee are awaiting further information before taking any steps in this matter.

Stock Exchange.—The Stock Exchange Committee has appointed Nov. 10 special settling day for Callender's Cable and Construction Company's further issue of £100,000 4½ per cent. first mortgage debenture stock, and have ordered the said securities to be quoted in the official list.

Mansfield.—The Electricity Committee have suggested to the Roads Committee that 10 additional arc lamps be erected. If this is done, the committee will make the charge £20 each per annum for the whole of the lamps in the borough. Another 10 arc lamps are to be erected in another road.

Kensington.—Permission has been granted to the Post Office to lay pipes for telephone wires, etc., in Stanhope-gardens, Collingham-place, Arundel-gardens, Holland-park, Hanover-terrace, Barkston-gardens, and to the Notting Hill Electric Lighting Company to extend their mains in Kensington Park-road.

Yarmouth.—The Corporation have decided to take their electricity cables under the river instead of over it as at first intended under the powers conferred by the 1897 Act. The Harbour Commissioners' officials have offered no objections to the plan of the borough surveyor, and the work is to be done about next February.

Arbroath.—The Electric Lighting Committee have agreed to recommend to the Town Council to hand over the provisional order to the Empire Electric Lighting Company, the terms being (1) that at the end of every five years the Council may be able to repurchase the order, and (2) that the Corporation can take it up at the end of 20 years as a going concern.

Hanwell.—The Council have decided to approach the Ealing Corporation and the Urban District Council of Harrow as to the terms on which they would be prepared to supply electrical energy to this Council. A proposal that steps be taken to obtain expert opinion as to how best to deal with the electric lighting order has been referred to the Lighting Committee.

Ealing.—The business manager of the electricity undertaking, in his last report, states that the record number of 62 applications for supply had been received since the previous committee meeting, the previous largest number being 46. The number of consumers now on the books was 2,187; 58 new consumers, with 1,110 lamps, had been connected, making the total number connected 80,188 lamps.

Watford.—The Local Government Board have declined to accede to the proposal of the Urban District Council to send their engineer and surveyor and their electrical engineer on a visit of inspection abroad in connection with the proposed electric pumping schemes. The electrical engineer in his last report states that the number of consumers connected to date is 360, and that the demand for current for motive power shows a satisfactory increase.

Bath Electric Tramways.—Subscriptions are invited at par for an issue of £135,000 4½ per cent. redeemable first mortgage debenture stock. The company's system is slightly over 13 miles in length of route, of which about 4½ miles is double and over 8½ miles single line. It connects Batheaston, Bathford, Weston, Twerton, and Combe Down with the centre of Bath. The first section of line was opened for traffic on Jan. 2, 1904, and the last section on Aug. 1, 1904.

Gillingham.—The resident engineer in his last report stated that the equivalent of 82 8-c.p. lamps had been connected to the mains since the previous committee meeting, making a total of 11,897 8-c.p. lamps, with 199 consumers, connected, and that applications had been received for 422 8-c.p. lamps. The engineer has been requested to submit a plan at the next meeting of the committee for the lighting of Rock-avenue. A new cable is to be laid in Trinity-road.

Liverpool.—An enquiry has been held into an application of the City Council for sanction to borrow £400,000 for purposes connected with the supply of electrical energy. Mr. Cripps (assistant town clerk) said that the undertaking was in a very prosperous condition. In 1896, when it was acquired by the Corporation, the output totalled only 1,350,000 units, while at present it was over 26,000,000 units. The additional capital funds were needed to increase the plant and works.

Luton.—The electrical engineer's last report shows that since Sept. 16 last 15,887 units have been generated, an equivalent of 502 8-c.p. lamps and one motor connected, making a total of 197 consumers with 12,429 lamps and 59 motors of 199½ h.p. Applications have been received for over 700 additional lamps and motors equal to 200 h.p. The number of units generated show an increase of 65 per cent. over the number generated during the corresponding period of last year.

Uttoxeter.—The North Staffordshire Railway Company's new electric lighting plant at the Uttoxeter Station was inaugurated last week. The installation has been carried out under the supervision of Mr. A. F. Rock, the chief of the North Staffordshire Railway electrical department. The generating station is at the new locomotive shed. The plant consists of a Bumsted and Chandler engine coupled direct to a 20-kw. dynamo. There are at present 18 arc and over 40 incandescent lamps at the passenger station, but it is intended shortly to extend the mains and light up the goods station and yard.

Marconi's Wireless Telegraph Co.—The directors have conditionally allotted to the shareholders in proportion to their holdings 30,000 shares of £1 each at the rate of one new share for every seven shares held on Oct. 24, 1904, at the price of £1 per share. No fractions of shares will be issued, and consequently holders of less than seven shares will not be entitled to participate in the *pro rata* allotment, and shareholders holding upwards of seven shares will only be entitled to one new share for each complete seven shares held. This notice does not apply to shares converted subsequent to Oct. 24, 1904.

Electricity Shares.—The best class of electric lighting shares return from 4½ to 5 per cent. The Brompton and Kensington and Charing Cross ordinary bring in 4½ per cent. To secure 4¾ per cent. the investor should buy St. James's ordinary, and for 5 per cent. he should look to Westminsters. He can secure 5½ per cent. from Edmundson's, and 5¾ per cent. from Metropolitan Electric. A new issue of 4½ per cent. second debenture stock at par is announced by the County of London Electric Supply Company. A new issue of Bath Electric Tramways debentures is noted in another column.

Glasgow.—The Corporation have agreed to supply current to consumers in Rutherglen and Pollokshaws on the same terms as to those in the city. At the last Council meeting it was proposed: "That, in consequence of the divided opinion of the Corporation as regards the present and future value of the telephone undertaking, it be remitted to the Telephone Committee to call in the services of an expert in

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order to report to the Corporation as to the present state and value of the plant, and probable depreciation that will require to be given effect to, in order to avoid loss when the undertaking will be sold to the Government at a fair value 10 years hence." The motion was negatived by 30 to 4.

Erith.—The resident engineer has kept a careful record of the lamp renewals used by each lamp attendant from May 1 to Aug. 31, and found that the cost per lamp per man for this period was as follows: 1s. 4d., 1s. 9d., 1s. 8½d., and 10½d. for each. Having regard to this report, the wages of the successful competitor have been increased from 28s. to 30s. per week. Several applications have been received for the supply of current to houses in roads where any further connections to the street-lighting mains cannot be made, and upon sufficient applications being received, distributing mains will be laid. The surveyor has been directed to proceed with the erection of the transformer station on the land in Avenue-road.

Woolwich.—At a recent meeting of the Electricity Committee the Eltham electricity scheme, which was before the Council on Sept. 29, and taken back by the chairman, was again under consideration. It was agreed to again recommend it to the Council, with the addition of an extension from High-street, Eltham, to New Eltham and Foots Cray, at an additional estimated cost of £4,500. The estimated cost of the whole scheme now is as follows: Plumstead electricity station at Shooters Hill, £13,000; site and sub-station, £1,500; Shooters Hill to Eltham and Lee Green, £12,585; sites and sub-stations, £2,143. 10s.; High-street, Eltham, to New Eltham, £2,450; site and sub-station at New Eltham, £1,150; New Eltham to Foots Cray boundary, £900—£33,736. 10s.

New Issue.—The County of London Electric Supply Company, Limited, are issuing to their shareholders at par £150,000 4½ per cent. second debenture stock, being the balance of a total of £400,000 second debenture stock (ranking immediately after the issued £400,000 first debenture stock of the company), and redeemable at £105 per cent. in either of the following events: (1) the voluntary liquidation of the company, or (2) at the option of the company at any time after May 1, 1923, by the company giving six months' notice in writing. When fully paid the stock will rank for issue *pari passu* with the existing £250,000 second debenture stock. The stock may be paid up in full on allotment, and discount will be allowed on the amounts prepaid at the rate of 4 per cent. per annum.

Keighley.—The last report on the electricity undertaking shows on capital account a total expenditure up to the end of June of £48,556—£9,300 on land and £39,256 on works. On revenue account the receipts for the year amounted to £2,922. 8s., as compared with £2,102 for the previous year, and expenditure on trading account to £2,090 as against £1,933 for the year 1902-3. In addition interest, sinking fund contributions, and other payments amounted altogether to £2,454, which left a deficit for the year of £1,629. To this was added the deficit of £1,850 on last year's revenue account, making in all £3,473, £3,206 of which has been met out of the general district rate, leaving a deficit of £267 to be carried forward. There was stated to be a steady increase in demand for both private lighting and motive power, the actual increase being nearly the same as last year.

London Gazette.—The last day for receiving proofs in the estate of Charles Aubrey Smith, electrician, 23, King-street, Regent-street, W., will be held on Nov. 19, 1904. A general meeting of the members of the Metropolitan District Electric Traction Company, Limited, will be held at Hamilton House, Victoria-embankment, E.C., on Nov. 28, 1904, at 12 o'clock noon for the purpose of having an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of. The partnership between Julius Edward Wedekind and Tinniswood Miller, carrying on business as electricians and engineers at 43, Clerkenwell-road, London, under the style of Charles Peacock and Co., has been dissolved by mutual consent. Notices of applications for electric lighting provisional orders appear by the Ravensthorpe and Bishop's Stortford Urban District Councils.

Maidstone.—It has been decided to instal electric light at the local prison. The following statistics as to the progress of the work up to date are available: For the March quarter of 1902 the revenue was £607, 1903 £1,524, 1904 £2,210; June quarter, £528, £795, and £1,160 respectively; September quarter, £849, £1,249, and £1,875; December quarter, £1,245, £1,880, and for the December quarter, 1904, £2,800. In 1902 the revenue account therefore amounted to £3,230; 1903, £5 448; while if the December quarter comes out as anticipated, there will be approximately this year £8,046. Over £300 is now due for current for the tramways. The works' costs in 1903 totalled £2,845, and this year they are estimated to amount to £4,070. The coal costs in 1903 were for the March quarter £271; June, £209; September, £285; December, £349; 1904—March, £555; June, £312; September, £490.

Huntingdon.—During a debate last week, held under the auspices of the Trinity Social Union, Mr. W. E. Milns (of the Urban Electric Supply Company) pointed out that he was not prepared to arrange a scheme for Huntingdon, but he might say it would probably cost from £7,000 to £10,000. Water power had been suggested, but it was very deceptive, and could not be used without having also an auxiliary steam plant. The first year's profit of their company had been £1,100 at Stamford and £847 at Grantham. All their other systems in towns of under 20,000 people showed profit. In Stamford they started with 27 consumers and 2,000 lamps; the first year they had 238 and 9,000 respectively; the second 460 and 14 000; and up to September this year 540 and 18 000. Out of this number, 128 were extensions and 4,300 lamps were additions to the original installation. A motion was passed in favour of electric lighting.

Ormskirk.—The Guardians have now finally adopted to light their premises by electricity generated by themselves. They have already spent about £3,000, including about £1,500 on boilers and fittings, and a similar sum for housing the boilers and provision for electricity. The wall, the contract for the erection of which has been let to Messrs. R. Taylor and Son, will enclose the land recently purchased from Lord Derby, and, when completed, the whole of the property belonging to the Guardians will be fenced round with a 9in. brick wall. Formal consent has been given (1) to the execution of works for the purpose of lighting by electricity the workhouse of the union and the provision of boilers and other fittings in connection with the boiler-house at such workhouse; (2) to the expenditure for the above purposes of a sum not exceeding £4,750; (3) to the borrowing of the sum of £5,000, or such part thereof, as may be necessary for the purposes.

Sunderland.—An enquiry has been held into an application for sanction to borrow £25,000 for the purposes of electric lighting. Alderman Bruce (chairman of the Electricity and Lighting Committee), Mr. J. F. C. Snell (electrical engineer), Mr. J. Haswell Brown (borough accountant), and Mr. Chas. Bevan (committee clerk) attended. The latter explained that the money was required for extensions to buildings and machinery in connection with the Hylton-road and Dunning-street stations, and also extensions to mains and services to sub-stations in connection with the undertaking. Mr. Snell said the electrical undertaking had been in existence for 10 years. Last year they had 950 consumers, with a total of 197,683 8 c.p. lamps, the total kilowatts installed being 5 530. The total units sold last year amounted to 3,580,139, and the financial result was a revenue of £36,168. The engineering and management costs amounted to £19,769 leaving a gross profit of £16,359, which was allocated as follows: interest, £7,999; sinking fund, £7,114; reserve fund, £1,246. The total of the loans sanctioned for the undertaking was £288,635, and the total amount that had been expended was £286,079. Some portion of the money they were now asking leave to borrow had already been expended.

London County Council.—The Local Government Committee, in their report upon the refusal of the Postmaster-General to pay rates on the wires of the Post Office telephones, stated that the National Telephone Company, with which the Post Office was in competition, were assessed in respect of their wires, as were also municipal authorities undertaking telephonic service. It appeared to them inequitable, therefore, that no contribution in lieu of rates should be made in respect of telephone wires fixed for the Postmaster-General. Further, the policy which was being followed appeared to be contrary to the spirit of the Treasury minute dated June 25, 1874, which was to the effect that Government property should contribute to local rates on the estimated rateable value which would attach to such property if it were in private occupation. That the matter was an important one to the Council and the local authorities would be gathered from the fact that at the last quinquennial valuation the undertaking of the National Telephone Company in London was assessed at about £30,000. The Council adopted the committee's suggestion to approach the Government and to endeavour to secure the application of the Treasury minute of June 25, 1874, to the Post Office telephone undertaking; and that the metropolitan borough councils and assessment committees should be asked to support the action of the Council.

Pemberton.—The new waterworks opened last week are interesting on account of both their source and the electric pumping machinery. The water, which is collected from the whole of the gathering ground on the east of Billinge Beacon, lodges in the worked-out seams of the old disused mines of the district, which serve as a vast underground reservoir. This supply has been tapped by means of a shaft, of 12ft. diameter sunk to a depth of 66ft. A chamber has been constructed at the bottom of the shaft to receive a set of electric pumps of the same capacity as the set placed in the new engine-house at the top, which are capable of delivering 25,000 gallons per hour. A receiving lodge is at the top, constructed to hold 25,000 gallons, so that in the event of anything going wrong with either set of pumps, there is a reserve to draw upon. The pumps at the top force the water in the reserve lodge up to the township reservoirs, a distance of 1,500 yards away. The supply of the water now tapped in very dry weather makes something between 3,000 and 4,000 gallons per day, while in wet weather it reaches from 750,000 to 1,000 000 gallons per day. The two sets of pumps are driven by two 25-h.p. electric motors, which receive current from the Pemberton electric works. Trial pumping has been carried out without the level of the water being perceptibly diminished. The whole of the work has been carried out under the supervision of Mr. Geo. Heaton, the consulting engineer, and Mr. T. Partington, the electrical engineer, Mr. J. Fairhurst, of Pemberton, having been the contractor.

Southport.—An enquiry has been held into an application by the Corporation for borrowing powers for £20,000 for the purpose of extension of the electricity estate. Councillor Ingham (chairman of the Electricity Committee), the deputy town clerk (Mr. E. S. Harper), and the borough electrician (Mr. R. S. Downe) gave evidence. Mr. Harper explained that the loan was necessary in order to keep pace with the growth of the ordinary electricity undertaking. No new works of any magnitude were proposed on the present occasion. The principal item, £1,584, was for four miles of high-tension cables, which would be laid down in order to equalise the pressure in two outlying districts of the town—viz., Scarisbrick New-road and High Park and Churchtown. A sum of £6,000 was required for meters and services, and £6,000 for low-tension mains. Experience has shown that it costs about £4,000 per annum to provide meters, services, etc., and the sum they were now asking for would last for two or three years. The sum for the high-tension cables would carry them through the same time. The work would most likely be carried out in 12 months. Mr. R. S. Downe, borough electrical engineer, handed in the following estimate for electric lighting for the next three years: Four miles high-tension cable and laying, £1,584; 1,000 cast-iron pipes for crossing streets, at 7s., £350; 12 50-kw. transformers, at £60, £720; four watertight transformer tanks, at £15, £60; two sub-stations

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and switchgear, at £360, £720; services and meters, at £2,000 per annum, £6,000; low-tension mains, at £2,000, £6,000; line booster, 500 amperes 50 volts, £250; battery, £1,300; automatic reversible battery booster, £400; battery room, £300; switchboard extensions, £50; equipment of meter-testing room, £150; six mechanical stokers, £479—£18,363; contingencies, £1,637—total, £20,000.

St. Marylebone.—The Finance Committee last evening reported that the London County Council have completed the loan to the Borough Council of £1,415,000 for the payment of the electric light purchase money and expenses as sanctioned by Act of Parliament, and that the temporary loans running since July 1—viz., £500,000 (with interest) from the London and Westminster Bank and £800,000 from other sources—have been duly discharged. The committee's report further states: "This Borough Council will have to pay to the London County Council the discount of £3. 5s. 2d. per cent., together with stamp duty on the bills of 1s. per cent., the bank charge for management at the rate of £200 per million, say 5d. per cent., and advertising and general expenses. As to the last item, we are not in a position to report, the amount not having been yet certified. Apart from this, the rate at which we shall have to pay will be about £3. 6s. 7d. per cent. When comparing this with the rate of interest on a loan raised in the ordinary way, with interest payable quarterly, it must be remembered that the rate of £3. 5s. 2d. is calculated, not upon the amount now received, but upon the amount which will be payable 12 months hence. Calculated upon the actual amount of money now borrowed, the rate works out at about £3. 7s. 4d. per cent. On the other hand, the fact that we shall only have to find the interest at the end of 12 months instead of quarterly means that we shall save interest upon the first three quarterly payments of interest. As this will enable us to postpone future borrowings to the amount of about £12,000 per quarter, we may fairly reckon this as worth 3½ per cent. per annum. The saving represented by this amounts to over 9d. per cent. on the whole loan. The rate, therefore, at which we shall pay works out as follows: interest on money borrowed, £3. 7s. 4d.; bill stamps, 1s.; management, 5d.—£3. 8s. 9d.; less value of postponement of interest, 9d.—£3. 8s., or a trifle over 3⅝ per cent. This represents a saving for the first year of about £1,400 on the rate of 3½ per cent. assumed in Mr. Wright's original estimates, and about £5,000 on the revised estimate of 3¾ per cent. From these sums, however, will have to be deducted the costs of the issue when ascertained."

Manchester Telephones.—The work of laying pipes underground for the carrying of telephone wires is proceeding rapidly. At the last meeting of the Telephones Committee a report was submitted by the city surveyor (Mr. T. de Courcy Meade) stating that he had prepared contract plans and specifications for laying the pipes underground on the routes indicated by the cartoon made for the committee's information. On May 21, 1903, Mr. Meade reported that it was necessary to modify some of the routes selected by the National Telephone Company, and that he was endeavouring to substitute routes away from the main thoroughfares, where the opening of the ground would cause the least inconvenience and disturbance of business. This method has been followed wherever practicable. The work has been completed under certain contracts and taken over by the National Telephone Company in three cases, and cables are now being laid. In the other cases, the report states, the laying of the pipes is in progress, and will shortly be completed. The length of pipes is 107 miles 1,476 yards, and the cost of the work under 10 contracts is £37,413. The Corporation now receive an annual rental of £1,690 for telephone easements, based on the number of subscribers and the junction boxes in use, and the rent will be increased as the system is extended. The work has been carried out under the direction of the Paving Committee, and, considering the number of streets interfered with, the complaints received of inconvenience to the public by street disturbance have been remarkably few. The city surveyor thinks that ultimately, when all the contracts are completed, the overhead telephone wires on tramway routes within the present city boundary can be placed underground. The National Telephone Company are proceeding as rapidly as possible with the cable-laying, and on some routes the number of overhead wires has already been materially reduced. The question of laying telephone pipes within the districts of Moss Side and Withington has been deferred pending the inclusion of those districts within the city. We understand that until the necessary pipes have been laid throughout the added areas, the arrangement under which all overhead telephone wires are to be removed by the company from the tram routes within the city will be suspended.

London County Council.—On Tuesday it was agreed to lend the Islington Borough Council £160,259 for the payment of outstanding loans for electric lighting. The following notices under Electric Lighting Acts and Orders were agreed to: St. Marylebone Metropolitan Borough Council, of intention to lay mains along portions of North-street (Edgware-road), Salisbury-street, Grove-road, Lissongrove, Marylebone-road, York-street, Upper Baker-street, York-place, Paddington-street, Ashland-place, North-street, South-street, High-street, Marylebone-lane, Bulstrode-street, Welbeck-street, Queen Anne-street, Chandos-street, Langham-place, Riding House-street, Wells-street, Marylebone-passage, East-street, Dorset-street, Manchester-street, Blandford-street, Baker-street, King-street, Gloucester-place, Montague-place, Seymour-place, Bryanston-place, Queen-street, Homer-street, Crawford-street, Chapel-street, Burne-street, Bell-street, Carlisle-street, Abercorn-place, Hamilton-place, Northwick-terrace, St. John's Wood-road, Aberdeen-place, Cunningham-place, Park-road, Albert-road, Abbey-road, Grove End-road, Circus-road, Wellington-road, Acacia-road, Ordnance-road, and Norfolk-road; Charing Cross and Strand Electricity Supply Corporation, to build street boxes at the junction of Wellington-street and Russell-street and in Carey-street; County of London Electric Supply Company, to lay low-tension mains along (*a*) Hotham-road, (*b*) Fontenoy-road, and (*c*) Carmalt-gardens; County of London Electric Supply Company, to lay high and low tension mains along Luttrell-street, Larpent-street, Campion-street, Upper Park-fields, Holroyd-street, Eumore-street, Tildeswell-street, and Colinette-road, and to build transformer boxes in Brenda-road and at the junction of Goldsmith-road and Hill-street; London Electric Supply Corporation, to lay high and low tension mains along portions of Tooley-street, Unicorn-passage, Parish-street, Fair-street, Tower Bridge-road, and across New Cross road, and to fix transformer boxes in Unicorn-passage, Parish-street, and Tooley-street; Metropolitan Electric Supply Company, to lay low-tension mains along portions of Eagle-street, Southampton-row, and Kingsway; Notting Hill Electric Lighting Company, to lay mains (*a*) across Westbourne grove and (*b*) along a portion of Kensington Park-road; South Metropolitan Electric Light and Power Company, to lay low-tension mains (*a*) along two new roads and a portion of St. German's-place and across Kidbrooke-grove, and (*b*) along and across portions of Vanbrugh Park-road. Notices served under orders granted to local authorities were received from the Stepney Metropolitan Borough Council of intention to lay mains along Harford-street and a portion of Bridge-street and along a portion of Narrow-street.

Bradford.—The Electricity Committee in their annual report state that the year under review has been an active one, in consequence of the inauguration of new works, modifications to existing works, and the serious breakdowns which have occurred to the plant. The planning of the lighting effects and the installation of power at the exhibition had also been carried out by the staff of the department, entailing an amount of work out of all proportion to the expenditure involved, owing to the special nature of the work and the conditions under which it had to be carried out. Early in their term of office the committee had under consideration the defects in the engines "Hylda" and "Florence." These are being put in order, and a third engine (a 1,000-kw. generator to duplicate one already supplied) is now under erection. The cost of this will be £11,142. Designs for new general supply and traction boards have been prepared by the engineer, and this will be carried out by direct labour. The total estimated cost of the work is £11,400. The rearrangement of and additions to the condensing plant have also been decided. New mechanics' and carpenters' workshops and new stores have been built at a cost of £3,820. No. 3 boiler-house has also been extended to the full length, and an order placed for the extension, at a cost of £1,431, of the coal and ash conveying plant, which had previously been on order for the first portion of this boiler-house. A new pump-room is being equipped and two Babcock water-tube boilers are under erection, while an additional Green's economiser is at the same time being provided. The total cost is £11,524. Two new reservoirs, having an effective combined capacity of 1,820,000 gallons, are being constructed under the supervision of the waterworks engineer for the storage of cooling water from the beck for surface condensing purposes. The contract has been let, and the excavations are being proceeded with. The new reservoir will not, however, be available for use until next autumn at the earliest. The work involves the straightening of the beck across the electricity works site. The cost of the work, including the reservoir, beck straightening, the first installation of cooling plant, and connections will amount to about £20,000. The committee say that the maintenance of the supply of electricity for both general and traction purposes would in any event have been onerous on account of the alterations upon the new switchgear and condensing plant works. The whole output for the general supply had been handled by means of temporary switchboard arrangements, while the traction supply had been maintained with switchgear excessively overloaded. As much as 2,585 kw. had been disabled at one time out of a total plant capacity of 7,300 kw. It had been necessary upon several occasions to run every available engine overloaded to maintain the supply, and this had only been done by increasing the output of the plant in Nos. 1 and 2 works by 600 kw. by altering the cut-off of the engine. A 300-kw. generator had been erected at Sunbridge-road, and was supplied with steam raised by the destructor. This plant was intended for use upon the traction supply, and a storage battery was being provided for use in conjunction with it for this purpose. The generator was, however, being temporarily used for supplying current for lighting purposes. As the official trial of the dust destructor had not yet been made, it was as yet too early to speak about the adequacy of the latter from a steam-raising point of view. The committee's expenditure upon this plant had been £7,823. New feeder cables have, or are at the moment, being run into various streets for the purpose of the better control of the tramway distribution. In addition to the feeder about 11,000 yards of network had been laid during the year, chiefly for the purpose of linking up detached mains previously laid. A subway under the Midland Railway between Valley-road and Midland-road had been constructed in order to provide a direct route between the works and the western section of the city, and would result in a considerable saving in the cost of mains for both general supply and tramway purposes. The approximate cost of the subway was about £1,600. The outlay upon mains extensions, exclusive of the subway, from the end of June, 1903, to June 30 last was £33,591. The price of electricity for lighting was 4d. per unit, and was subject to a discount of 2½ per cent. for prompt payment, and a free supply of incandescent lamps in proportion to the number of units consumed for incandescent lighting. The total number of consumers had increased from 1,740 to 1,923, an increase of 10½ per cent. The figures showing the number of units sold bring out the interesting fact that the current produced has increased fivefold in five years. The total units for the half-year ended June 30, 1899, was 1,019,846, and for the half-year ended June 30 last the total was 6,942,049. The total for the year 1899 was 2,416,130, and for last year 11,806,529. It is, of course, from tramway traction that the great increase has arisen, the current used for this purpose last year amounting to 7,075,300 units, as compared with 618,282 units in 1899. The demand for electricity for motive power has advanced steadily year by year—from 463,630 units in 1899 to 2,540,757 units in 1903. For private lighting the advance has not been so substantial,

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though it has been steady, at the rate of about 200,000 units increase per year, the totals for the two ends of the quinquennial period being 1,275,214 and 2,133,545 units respectively. The use of electricity for public lighting has varied considerably, the totals for the five years being as follows: 59 004 units in 1899, 76,445 in 1900, 58,797 in 1901, 54,116 in 1902, and 56,917 in 1903. The total number of incandescent lamps connected is 64,024.

PROVISIONAL PATENTS, 1904.

OCT. 17.

22287. Improvements in electrical switches. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London. (Complete specification.)

22290. Improvements in safety devices for the trolley poles of electric cars. James Hawley, Limited, and Daniel Richard Wallwork Hardman, 34, Castle-street, Liverpool.

22296. Improvements in electrical ignition apparatus for internal-combustion engines. Percy Richardson, 19, Lancaster-road, West Norwood, London.

22326. Improvements in controllers for electric motors. Philip Middleton Justice, 55, Chancery-lane, London. (The Voltage Controller Company, United States.) (Complete specification.)

22342. Improvements in arc lamp electrodes. Körting und Mathiesen Akt.-Ges., 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 31, 1903, being date of application in Germany.) (Complete specification.)

22355. Improvements in or relating to telephone installations. Deutsche Telephonwerke R. Stock und Co. G. m. b. H., 322, High Holborn, London. (Date applied for under Patents Act, 1901, Aug. 25, 1904, being date of application in Germany.) (Complete specification.)

22362. Improvements in connection with arc lamp hoisting gear and fittings for the same. Crompton and Co., Limited, and Ernest William Abbott, 18, Southampton-buildings, Chancery-lane, London.

22364. Improvements in electrical switches. Crompton and Co., Limited, and Ernest William Abbott, 18, Southampton-buildings, Chancery-lane, London.

22368. Improvements in means for generating intermittent electric currents for ignitors of oil-engines and other purposes. Franklin Wise Howorth, 46, Lincoln's-inn-fields London. (Malcolm P. Ryder, United States.) (Complete specification.)

22369. Improvements in means or apparatus for regulating the difference of potential between portions of electric current distributing systems. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

OCT. 18.

22372. Improvements in means for trolleys or vehicles to pick up and return electric current from and to conductors they traverse and obtain motion. Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

22401. Improved automatic signalling apparatus for electric tramway. Charles James Jewell, 12, Chesterfield-street, King's Cross, London.

22404. A simple device for preventing broken trolley wires on electric tramways from falling. William Cecil Kirwan and Kyran Quaney, 11, Brookfield-terrace, Anglesea-road, Donnybrook, co. Dublin.

22443. Combined telephone and sounding telegraph. August Hjalmar Anderson, 33, Cannon-street, London.

22470. Improvements in and relating to filaments of the kind used in incandescent electric lamps and in processes of manufacturing said filaments. Edgar Alfred Cleveland, 83, Cannon-street, London. (W. R. Whitney, United States.)

22475. Improvements in or in connection with overhead live wires or conductors. Charles William Wilson, 6, Lord-street, Liverpool.

OCT. 19.

22479. Improved electric lamp. Edward Thomas Pickup and William Tice, 1, Wellington-chambers, York-street, Westminster, London.

22505. Improvements in doors adapted to be opened and closed by electrically controlled means. Percy Wright, 34, Castle-street, Liverpool.

22511. Blowing magnet arrangement for arc light lamps. Heinrich Beck, 216, Friedrich-strasse, Berlin, Germany.

22515. Improvements in apparatus for use with the X-rays (Roentgen rays). John Orme, 2, Drayton-road, Leyton-stone, Essex.

22519. Improvements in electrical circuit makers and breakers. William Morgan and William Henry Warden Proctor, 18, Hertford-street, Coventry.

22522. Improvements in arc lamps. John Morecraft Wellington and Walter Francis Daniell, 88, Chancery-lane, London.

22529. Improvements in electrical connections. Herbert Vincent Howard, 9, Warwick-court, Gray's-inn, London.

22536. Auxiliary appliance for the prevention of the occurrence of excess pressures on switching on and off electrical installations of high voltages. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

22544. Improvements relating to the overhead trolley wires or conductors of electric tramways and the like. Sidney Weiss Mitchell, 18, Southampton-buildings, Chancery-lane, London.

22574. Improvements applicable to electric steering gear for ships and for other purposes. John Smith Raworth, 46, Lincoln's-inn-fields, London.

OCT. 20.

22616. Improvements in or connected with the wiring of telephone or other electrical plants. Albert Parker Hanson, Oswaldestre House, Norfolk-street, Strand, London.

22628. Improvements in electric arc lamps. James Brockie, 33, Chancery-lane, London.

22631. Improvements in methods of exciting electromagnets by alternating electric currents. Marius Latour, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 20, 1903, being date of application in France.) (Complete specification.)

22647. Improvements in electrical resistances. Ernest Francis Moy and Percy Henry Bastie, Greenland-place, Camden Town, London.

22652. Improvements relating to circuit breakers. Frank Roll McFeatters and Adolph Frederick Christmas, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22653. Improvements in electric motors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

22659. An improved manufacture of composition or compound for brushes of dynamo-electric machines, for bearings, and for other articles. The Morgan Crucible Company, Limited, and Charles William Speirs, 4, South-street, Finsbury, London.

22665. Improvements relating to circuit breakers. Frank Roll McFeatters and Adolph Frederick Christmas, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

OCT. 21.

22690. Improvements in electrical generators and motors. Robert Ernest Workman, 5, John Dalton-street, Manchester.

22706. Improvements in electricity meters. Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 4, New Bartholomew-street, Birmingham.

22731. Improvements relating to electrical traction overhead conductor equipment. Charles Adolph Schierwater, 10, St. George's-crescent, Liverpool.

22743. Improvements in apparatus for the electrical treatment of gases. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22744. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22752. Method of and apparatus for transforming alternating currents of constant voltage and frequency into continuous currents of variable voltage. George Faget, 65, Chancery-lane, London. (Complete specification.)

OCT. 22.

22768. Improvements relating to the conductors or live rails used in electric railways and the like. Richard William Scott, 3, East Mount-terrace, Haughton-road, Darlington.

22789. Improvements in dynamo-electric machinery. Siemens Bros. and Co., Limited, and John Gordon Wilson, Queen Anne's-chambers, Broadway, Westminster, London.

22793. Improvements in or relating to starting and controlling rheostats for electromotors. George Henry Hooke, 111, Hatton-garden, London.

22808. Improvements in alternating-current motors. Robert Lundell, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22813. Improved scraper for electromagnetic separator. Ernst Heinrich Geist, Electricitäts Act.-Ges., 322, High Holborn, London. (Date applied for under Patents Act, 1901, Jan. 18, 1904, being date of application in France.) (Complete specification.)

22817. Improvements in and relating to electric power transmitting mechanism. The British Thomson-Houston Company, Limited, and Bernard Hoppe, 83, Cannon-street, London.

22818. Improvements in and relating to systems of control for electrically-operated doors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22819. Improvements in alternating-current electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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22320. Improvements in and relating to variable speed windings for alternating-current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22321. Improvements in and relating to windings for alternating-current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22322. Improvements in and relating to alternating-current electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22323. Improvements in the control of electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 10, 1904.

1903.

22090. Manufacture of electrodes and resistances. Cornaro.

22440A. Telephone switchboards. Fairweather. (Kellogg Switchboard and Supply Company.) (Date applied for under Patents Rule 9, Oct. 17, 1903.)

23355. Electrically-operated valves, especially applicable to turbines. Warwick Machinery Company, Limited. (General Electric Company.)

23375. Electric silent discharge apparatus. Schneller and Koeleman.

24693. Apparatus for limiting electric currents. Azarola.

24630. Apparatus for the electrical transmission, reception, recording, and reproduction of sound. Craven.

24798. Electrically-driven vehicles. British Thomson-Houston Company, Limited. (General Electric Company.)

26459. Brakes for railway and like vehicles. British Thomson-Houston Company, Limited. (General Electric Company.)

26916. Means for advertising on, and indicating the routes of, electric tramcars and other electric vehicles. Walkden.

27287. Means applicable for use in suspending electroliers. Milne.

27392. Brush-holders for dynamo-electric machines. The British Thomson-Houston Company, Limited. (General Electric Company.)

27394. Alternating-current dynamo-electric machines The British Thomson-Houston Company, Limited. (General Electric Company.)

1904.

571. Means of connection between brush-holders and pillars of dynamo-electric machines and electric motors. Rees.

6716. Electric switches. Babcock. (Date applied for under International Convention, March 23, 1903.)

7247. Sealing of the ends of insulated electric conductors. Lee.

9874. Electric switches. Dunn. (Date applied for under International Convention, Aug. 25, 1903.)

10276. Electric block signal systems. Silvene.

11439. Incandescent electric lamps. O'Brien. (Date applied for under International Convention, May 25, 1903.)

16581. Electrical binding screws or terminals and the like. Bouchet. (Date applied for under International Convention, Feb. 15, 1904.)

17243. Fenders for electric cars and other vehicles. Keith.

18021. Insulating electric conductors. Kitsee.

18429. Selective telephone call mechanism. Hawxhurst.

19232. Electric arc lamps. Blondel. (Date applied for under International Convention, Sept. 9, 1903.)

19998. Current-collecting devices for electric generators and motors. Elers. (Date applied for under International Convention, Sept. 26, 1903.)

19999. Electrical transformers. Fortescue. (Date applied for under International Convention, Sept. 30, 1903.)

20277. Manufacture of incandescence bodies for electric glow lamps. Abel. (Siemens und Halske Akt.-Ges.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	5/16-7/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	5½-6
—— 6 per cent. Cum. Pref., 1-100,000	5	5½-6
—— 4½ per cent. Mortgage Debentures	100	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	3½-4
—— 4 per cent. Mortgage Debenture Stock	100	87-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	½-¾
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	94-97
—— 4½ per cent. 2nd Debenture Stock	100	70-75

Name.	Amount paid. £	Last price. £
Callender's Cable, Debentures	100	102-105
—— Ordinary	5	9½-10½
—— 5 per cent. Pref.	5	5-5½
Crompton and Co.	3	1½-2
—— 5 per cent. Debentures	100	90-95
Edison and Swan United, "A" Shares, 1-99,261	3	½-¾
—— "A" Shares, 01-017,139	5	1-2
—— 5 per cent. Debentures	100	79-84
—— 4 per cent. Deb. Stock, Red.	100	78-83
Electric Construction, Limited, Nos. 1 to 112,100	2	1-1½
—— 7 per cent. Cumulative Pref.	2	2-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9-9½
—— 4 per cent. 1st Mort. Deb. Stock	100	91-96
W. T. Henley's Telegraph Works, Ordinary	5	10½-11½
—— 4½ per cent. Preference	5	5-5½
—— 4½ per cent. Debentures	100	108-111
India Rubber, Gutta Percha, and Telegraph Works	10	19½-20½
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	10-10½
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	101-104

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	11½-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	9½-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	10½-11½
—— 4½ per cent. Debenture Stock. Red.	100	103-106
Bromley (Kent) Electric Light and Power Co.	5	5½-6½
—— 4½ per cent. 1st Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	10½-11
—— 7 per cent. Preference	5	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	7½-8
—— Nos. 20,001-30,000	5	7-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	12½-13½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-109
Charing Cross and Strand, Nos. 1-70,000	5	8½-9
—— 70,001-80,000	5	8-8½
—— 4½ per cent. Cum. Pref.	5	5½-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4½-5
—— 40,001-80,000	5	4½-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-106
Chelsea Electricity Supply	5	6½-7
—— 4½ per cent. Debentures	100	108-111
City of London, Ordinary	10	10½-11
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London Electric Supply, Ordinary	10	9-10
—— 6 per cent. Cum. Pref.	10	11¾-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	101-104
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	6½-6¾
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	1½-2½
—— 5 per cent. Debenture Stock, Red.	100	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5½-6
—— 4½ per cent. First Deb. Stock, Red.	100	101-104
Havana Electricity, Limited, 1-15,000	10	9½-10½
Hove Electric Lighting, Limited, Ord. 1-13,000	5	7½-8½
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	101-105
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	1½-2½
—— 6 per cent. Pref.	5	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	112-117
—— 4½ per cent. Cum. Pref.	5	5¼-5½
—— 3½ per cent. Mortgage Debenture, Red.	100	96-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	14½-15½
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-86 and [illegible]-14,310	5	5¾-6½
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	93-101
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2¾-3½
—— 4 per cent. Debenture Stock	100	98-101
South London, Ordinary		4½-4¾
South Metropolitan Electric Light and Power Co., Ord.	1	¾-1
—— 7 per cent. Cum. Pref.	1	1¼-1½
—— 4½ per cent. 1st Mort. Deb.	100	106-110
—— Ditto, June, 1904		
St. James's and Pall Mall, Ordinary, 101-40,000	5	14-15
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	4½-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	4¾-5
Westminster, Ordinary	5	12½-13½
—— 5 per cent. Cum. Pref., 110,101-133,251	5	6-6½

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	5¼-5¾
—— Ord.	5	6¾-7
—— Permanent 6 per cent. Debenture Stock, 1888	100	139-142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	10[illegible]-106
Barcelona Tramways, Limited, Ord., 1-20,000	10	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	9-10
—— 5 per cent. Deb., Red., 1-600	100	98-101
—— 4½ per cent. Red. Deb. Stock	100	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	10-11
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	1½-2½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	3¾-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96-101
British Columbia Electric Railway Co., Ord. Def.	100	99-102
—— Ord Pref.	100	100-103
—— Non. Cum. 5 per cent. Pref.	10	10½-10¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104 p c
—— 4½ per cent. Vancouver Power Deb.	100	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	9¾-10½
—— 5 per cent. Cm. Pf., 30,001-60,000	10	11-11½
—— 5 per cent. Perpetual Debenture Stock	100	115-118
—— 4½ per cent. 2nd Deb. Stock	100	95-98

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Name.	Amount paid. £		Last price. £
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5		3⅞-4¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5⅛-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5⅛-5⅜
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	102 105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7 -7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways ,Nos. 1-480,000	1	–	1¼-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4¾-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	103-106
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1898), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5		3¾-4¼
—— 4 per cent. Debenture Stock	100	–	89-92
Kidderminster and District Lighting and Traction, Pref.	5	–	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10½-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	105-105
Madras Elec. Trams. (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	¼-⅜
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	¼-1
—— 4½ per cent. Deb. Stock, Red.	100	..	101-102
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, Ordinary	5	-	⅛
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100	–	88-93

Name.	Amount paid. £		Last price £
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12-12½
—— 5 per cent. Cum. Pref.	10	–	9¾ 9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	–	103-105
Potteries Electric Traction, Ordinary 30,001-40,00	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8½
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,132 6 per cent. Preference	1		1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	–	100 p.c.

Electric Railways.—

Central London, Ordinary	100	–	91-94
—— 4 per cent. Pref.	100	–	100-102
—— ,, ,, deferred	100	–	79 81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	107-110
City and South London, Consolidated Ordinary	100	–	47-49
—— 4 per cent. Debenture Stock	100	–	106-109
—— 5 per cent. Pref. Stock '91	100	–	122-125
—— ,, ,, ,, '96	100	–	117-120
—— ,, ,, ,, '01	100	–	113-117
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10½
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	–	98¾-99¼
Waterloo and City, Ordinary	100	–	86-89

Telephones.—

National Telephone, Preferred	100	–	106-108
—— Deferred Stock	100	–	96-98
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅜
—— 5½ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	104-106
—— 4 per cent. Prov. Cert.	–	..	67-69
Ontario Power and Electric Company	1	..	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1¼-1¼

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 22	1,199	1,141	+ 58	— h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	—	—	—	—	—	8	8	,, 15	14,160	3,201,585	336,049	1·03	10·11	1,770	5 04
Barking Corporation	,, 22	45	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 23	1,002	1,079	- 77	—	23·53	23½	March 31	56,0 3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Tramways	,, 22	5,645	5,192	+ 453	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 21	860	815	+ 45	+ 2,911	24	23	,, 25	43,374	7,742,692	951,484	—	10 94	—	4·59
Blackpool Corporation	,, 20	501	410	+ 9	+ 5,690	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	Sep. 5	1,463	1,368	+ 95	- 40	16½	16½	Dec. 31	32,021	2,253,981	600,757	3·34	12·75	2,001	7 05
Bolton Corporation	Oct. 21	1.815	1,745	+ 70	+ 475	38	38	March 31	94,151	19,835,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 19	945	921	+ 24	+ 1,925	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 22	4,414	3,705	+ 709	+24,476	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 25	901	8 0	+ 91	+ 3,256h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 21	4,837	4,859	- 22	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 22	1,116	822	+ 194	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 23	331	376	- 42	—	8¼	—	March 31j	11,574	2,556,134	232,378	1·08	9·81	1,570	7·57
Cardiff Corporation	,, 22	1,964	1,927	+ 36	+ 1,763	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 22	178	190	- 12	—	—	—	Dec. 31g	9,937	2 805,277	334,393	—	7·17	—	—
Central London Railway	,, 22	6,6 9	6.737	- 38	— h	6	6	,, 31	362,471	44,9 3,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 21	2,805	2,946	- 140	- 1 477h	6¼	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	Sep. 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Oct. 20	478	505	- 23	- 2 504	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 21	220	220	—	—	7·23	7·23	March 31f	12,341	2,360,755	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 22	197	184	+ 13	—	4½	4½	,, 31	11,255	2,871,332	280,931	0 94	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 21	09	115	- 6	— h	7	6¾	Dec. 31g	6,2 4	883,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 21	3,822	3,774	+ 48	} —	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 21	836	832	+ 64											
Dundee City Tramways	,, 19	818	813	- 25	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 22	654	628	+ 2	+ 1,195	10·77	10·75	March 31	34,312	12,950,2 9	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 22	14,924	13.896	+ 28	— h	145	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	Sep. 21	342	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	Oct. 19	2,636	2,535	+ 100	+ 3 5 6	33	30½	March 31	68,283	16,322,054	1,387,885	1·00	11·79	2,059	8·77
Huddersfield Corporation	,, 22	1,253	1,225	+ 28	+ 2,736	35	35	,, 31	65,545	11,89 ,287	1,652,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 22	2,167	1,883	+ 284	+ 8,678	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 22	386	262	+ 24	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 19	126	145	- 21	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 19	208	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 22	5,480	5,250	+ 230	+10,693	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	Sep. 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 15	10,533	10.242	+ 291	+12,740	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 23	1,495	1,632	- 137	- 1,2 0h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 15	13,145	9 584	+3,560	+76,5 1	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 22	165	170	- 5	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 20	142	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 22	12.241	11,500	+ 741	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 21	1,784	1,185	+ 598	+ 7,974h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 22	117	91	+ 26	+ 1,155	2½	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 22	3,721	3,647	+ 74	—	43	38½	,, 25	183,027	39,715,120	4,059,807	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	,, 22	501	445	+ 56	—	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	29	,, 31	91,448	18,204,426	1,928,193	1·15	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 20	436	480	- 44	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co	,, 15	97	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 23	4,689	4,493	+ 195	+ 2,865	34½	—	,, 25g	216,309	55,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 20	917	867	- 49	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 19	272	243	+ 29	+ 1,292	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 21	573	354	+ 208	—	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 23	1,238	1,038	+ 150	—	19·5½	18·48	,, 31	62,506	14,848,958	1,433,463	1 01	10·46	—	6·08
Swindon Corporation	,, 1	312	—	—	—	3½	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 24	678	625	+ 52	+ 1,429	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 20	1,060	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 19	786	435	+ 351	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
j Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Wireless Telegraphy.—It is reported that the Marconi Company has been requested by the Hungarian Government to establish wireless telegraphic communication between Ancona and Fiume.

The Institution.—The 1904-5 session will be opened on Thursday next, when the president, Mr. Alexander Siemens, will deliver his inaugural address, and the premiums awarded for papers read during last session will be presented. On Thursday, the 1st prox., the annual dinner will be held at the Hotel Cecil under the ægis of the President and Council, when we hope that the usual large gathering will assemble.

New Publications.—"Life and Energy," by Walter Hibbert (London, Longmans, 2s. 6d.), being an account of four addresses given at the Polytechnic Institute, and embodying an attempt at a new definition of life, with applications to ethics and religion.—The *Journal* of the Franklin Institute (America) for October contains papers on "Electrolytic Receivers in Wireless Telegraphy," by Dr. Lee de Forest; and "Telpherage," by C. J. Messer.

The American Institute.—We have received a copy of this association's *Transactions* for October, which contains a paper on the telautograph by J. Dixon, Mr. B. J. Arnold's presidential address, and the discussions on the following papers: "Long Spans for Transmission Lines"; "Synchronous Motors for the Regulation of Power Factor and Line Voltage"; and "The Theory of the Regulation of Alternators." In his address the president reviews the progress of electricity, and deals with the problem of electrifying the railroads. An abstract of his views appeared in our issue of the 21st ult.

Electro-Harmonic Society.—The next concert will be held in the King's Hall of the Holborn Restaurant on the evening of the 11th inst., which will be a ladies' night. The chair will be taken at 8 o'clock promptly by Mr. J. S. Raworth. The programme promises to be fully up to the standard of its predecessors, if it does not surpass them. Vocal music will be provided by the Misses Katherine Longland and Maggie Purvis and Mr. Wm. Forington, while the instrumental department will be in the able hands of the musical directors, Messrs. T. E. Gatehouse and A. E. Izard. There will also be selections by the orchestra. In addition, the talented artiste, Miss Helen Mar, will contribute short stories, Mr. Frederick Chester will present ventriloquial and humorous sketches, and musical sketches will be given by Mr. Astley Weaver. The hon. secretary is Mr. W. E. Lane.

Trade Marks in China.—Messrs. W. P. Thompson and Co., of 6, Lord-street, Liverpool, who have devoted special attention to the subject of patents and trade marks, state that they have received telegraphic information from China that the new regulations for registering trade marks in that country have come into force this week, and as one of these regulations is that the applications will be entertained in the order of their presentation (and the first comer will have the right of registration where there are two conflicting applications), it is very desirable that the marks of English firms shall be filed as quickly as possible. There are 54 classes into which goods are sub-divided, a compilation based largely on the English and German classification, but a decided improvement on both, and a fresh application has to be made for each class. From reports in the daily Press we gather that the new code is not viewed with unmixed satisfaction by some of the Powers chiefly concerned, and that general apathy prevails in regard to it; but prudence suggests that British manufacturers would do well to formally effect an early registration.

The Students' Section.—The opening meeting of the Students' Section of the Institution of Electrical Engineers for the session 1904-5 will be held in the library of the Institution, 92, Victoria-street, on Wednesday, the 16th inst., at 7.30 p.m., when Mr. J. Swinburne, past-president, has kindly consented to deliver an address. The following papers are down for reading at the three following meetings: Nov. 30, "Motor-Controlling Switchgear," by L. J. Pumphrey; Dec. 7, "The Gordon Electric Light Installation at Paddington, 1884-1904," by M. G. Tweedie; Jan. 18, 1905, "Notes on the Construction and Maintenance of Large Telephone Exchange Equipments," by A. L. Stanton. The students' hon. secretary (Mr. A. G. Ellis, 177, Warwick-road, Kensington), will be pleased to communicate with any student members desirous of taking part in the discussions on any of the above papers, and will be glad as far as possible to lend copies of the papers to such students.

Personal.—On Wednesday of last week Mr. W. B. Esson, M.I.C.E., M.I.E.E., was presented by the staff, foremen, and workmen of Messrs. Johnson and Phillips's electric light and power works with a handsome roll-top writing desk and revolving chair as mementoes of the 10 years he had been associated with them while acting as chief engineer and manager to the firm. The presentation took place at the Charlton works, Mr. E. A. Brandon, who had been Mr. Esson's chief assistant, acting as spokesman. In making a suitable reply, Mr. Esson remarked that from the nature of the gift which had been so generously bestowed upon him, it was evident that a good deal more work was expected from his hands.—We learn that Mr. H. H. Jeffcott has been appointed assistant in the metrological department of the National Physical Laboratory. Mr. Jeffcott, after a distinguished career at Trinity College, Dublin, in physics and engineering, during part of which he was a pupil of the late Prof. Fitzgerald, has been with Messrs. Siemens Bros. at Woolwich and Stafford for the past two years.

The American Student.—If we recollect aright, Prof. Ayrton, on returning to this country with the Mosely Commission, expressed the view that in the matter of literary attainments the English youth compares favourably with his Transatlantic *confrère*, while the latter scores in the bold and rapid application of knowledge. The *Electrical World* of New York gives the passages printed below from an essay on the subject of electricity at an examination in the neighbourhood of New York. Perhaps the author's *forte* lies in the practical side, but the literary style of the thesis rather seems to lend support to the first part of the professor's view: "Electricity is the most and greatest invention's that ever existed . . . . they invent all kinds of musical instruments such as graphaphones and phonographs and sewing machines and electric lights and trolley cars and its acts quicker than steam. Silk mills is also run by motors & Dynamos . . . . of course I think we will have flying machines in time that is run by electricity & its got a great effect in shock and electric bells in use for ill people." It is perhaps only right to add that the author was a candidate for the Civil Service.

Power Transmission. — The Central California Electric Company, which is operating three water-power electric plants transmitting electric power to Sacramento, Grass Valley, and other cities, has decided on a new water-power plant. Surveys have been made, and the preliminary engineering work is in hand. It is proposed to instal a hydro-electric plant with a capacity of about 25,000 h.p.,

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and it is stated that the plant will be operated under the highest head in the world. The new installation is to be located on the banks of the American River at Alta Station, 60 miles from Sacramento in a direct line. The tail water from the present power station at Alta is to be conducted by a short canal to a point where a drop of 2,100ft. can be obtained by use of a pipe-line. The water-wheels will be constructed on lines similar to those of the Escher-Wyss wheels, built for high-head plants in Switzerland. There will be four direct-connected units, the polyphase generators to have a capacity of either 4,000 kw. or 5,000 kw. each. The turbine wheels will have the water admitted to the buckets internally, and will be about 4ft. or 5ft. in diameter. An innovation will be the high speed of the generators—750 revolutions per minute.

Iron Production in America.—The report just presented to the United States Geological Survey on the production of iron ores in 1903 shows that the yield aggregated 35,019,308 long tons. This represents a decrease of 1½ per cent. as compared with the preceding twelvemonth, which, however, was the record year. The quantity mined in 1903 considerably exceeds the united output of Great Britain and Germany for 1902. The mineral was obtained from 22 States, Minnesota, Michigan, Alabama, and Wisconsin being the leaders. Nevada was added to the list of iron-producing States. The ore was of the four general commercial classes—red hematite, brown hematite, magnetite, and carbonate. Red hematite constituted over 86 per cent. of the total. The carbonate ores showed an increase of 26 per cent. over the previous year. The regions of Lake Superior maintain their pre-eminence in iron ore production. In the State of Wisconsin the year under review witnessed the initial output of the Baraboo range, where there are believed to be substantial deposits of Bessemer ore. The total value at the mines of the 35,019,308 tons produced in 1903 was some £13,300,000, the average price per ton being 7s. 10½d., an increase of 2½d. per ton over the previous year.

Spark Lines in Arc Spectra.—The American *Physical Review* contains an abstract of a paper on the conditions which govern the appearance of spark lines in arc spectra, which was read before the American Physical Society by Mr. Henry Crew. The author examined the intermittent arc between magnesium electrodes simultaneously with the Duddell oscillograph and the spectroscope, and arrived at the following results: (1) It was found that the voltage curve of the ordinary arc thus photographed showed no extra E.M.F. at break; nor did the spectroscope show the spark line at λ 4,481. (2) When the break at the arc was quickened by means of an air blast, the extra E.M.F. at once appeared in the voltage curve and the spark line in the spectroscope. (3) When the arc was surrounded by an atmosphere of coal gas, thus bringing out the spark lines, the voltage curve showed the extra E M.F. at break. This gives the probable explanation of the effect of an atmosphere of hydrogen as noted by various observers—viz., the break is quickened—hence high extra E M.F. is introduced—hence spark lines. (4) The introduction of spark lines by use of small currents, discovered by Hartmann, is given an interpretation different from his, but in accordance with his results, with the above results, and with the modern electron theory of the arc and spark discharge.

New Storage Battery Cell.—The Dayton Manufacturing Company of Ohio, which has for several years been manufacturing storage batteries for use in train lighting, has devised a new stationary cell, a description of which appears in the *Electrical Review* of New York. The elements lie horizontally and are placed in a round glass jar. The grids are cast from lead containing a considerable percentage of antimony, which strengthens the grid and avoids warping or buckling. After the grids are pasted and the plates hardened by a special process, they are assembled into elements, the individual plates being connected together by means of hard lead bolts about ½in. in diameter. A ¹in. square steel rod is cast in the centre of these lead bolts, giving them great rigidity. The bolts are made fast by lead nuts, which serve the double purpose of spacing the plates and holding them securely in place. Between the plates are placed two sheets of porous separating material, these sheets extending about ⅛in. beyond the edges of the plates. After the elements are assembled, the edges of the plates and the nuts are electrically welded, so as to ensure perfect connections. The horizontal position of the plates makes it practically impossible for the active material to fall from the plates or to be forced out due to the action of the gases which are formed while the cells are being charged. The porous separators absorb about seven-eighths of the electrolyte required for a normal discharge, so that in case a jar should break, the flow of current will not be interrupted.

Australian Trade Marks.—Attention is directed by Messrs. Edward Evans and Co., of 27, Chancery-lane, to the fact that the new Australian Federal Trade Marks Act is shortly to be promulgated. The measure has been passed by the Legislature, and will be brought into operation immediately after the necessary formalities have been complied with. Under the Act, existing State trade mark registrations may be extended or converted into Commonwealth registrations, and thereupon the State registrations will cease. All State registrations will lapse 14 years from the commencement of the new Federal Act, or when any renewal fee would become payable thereon. The essential features of trade marks registerable under the new Act are substantially the same as those prescribed under the English Act—namely (*a*) a name of a person printed, impressed, or woven in some particular and distinctive manner; (*b*) a written signature or copy of a written signature of the person applying for registration thereof, or his predecessor in business, as a trade mark; (*c*) a distinctive device, mark, brand, heading, label, or ticket; (*d*) an invented word or invented words; or (*e*) a word or words having no reference to the character or quality of the goods and not being a geographical name used or likely to be understood in a geographical sense. It has, however, to be noted that any word or words, letter, figure, or combination of letters or figures, which do not necessarily involve any of the essential features above referred to, may be registered as a trade mark under the new Act if such have been used before Jan. 1, 1901.

Lava for Electrical Purposes.—The growing use of talc for electrical purposes is the subject of a booklet just issued by the American Lava Company, in which is described the process of converting the mineral talc ($H_2MG_3SI_4O_{12}$) into what is generally known as lava. The talc is machined in its natural chalky condition, and then baked under a temperature of about 2,000deg. F. to a condition of extreme hardness. The material so produced is unaffected by any heat short of this temperature, and is thus available for use in the construction of arc lamps, rheostats, electric heating apparatus, etc. It is absolutely free from metal oxides or other impurities which would impair its insulating value. Changes in atmospheric moisture do not cause it to either swell or shrink, and as its coefficient of expansion with temperature is negligible, it is of special value for instruments requiring a fixed relation of their parts under all conditions. Arc lamp carbon guide bushings are made in

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thousands according to limit gauges, allowing from but 1½ to less than one-half of 1 per cent. total variation in dimensions. For a kilned product, lava offers unusual advantages in regard to uniformity. Several tests with transformers of large capacity and carefully calibrated electrostatic voltmeters have proved its high dielectric strength, which is calculated at from 75 to 250 volts per thousandth of an inch thickness, depending, as in the case of all insulators, upon the absolute thickness of the sample tested. Compared with mica, it lends itself to a large variety of shapes in which the former cannot be employed. Latterly the cost of lava has been greatly reduced, with the result that it now competes with most of the commoner insulating materials.

Electricity in Textile Mills.—In a paper presented to the New England Cotton Manufacturers' Association, Mr. Chas. Robbins extols the advantages of electrical power for spinning and weaving. It is evident, the author remarks, that an engine or turbine for operating an electric generator will furnish a more uniform and steadier speed than the regular mill engines, and if this uniform speed is available at the spinning frames and looms, an increased production with a more uniform quality of work must result. The author's experience is that electrically-driven mills accomplish this. He further points out that the ideal power plant is one that is so laid out that each unit is working at its maximum efficiency at all times, requires a minimum amount of attendance, occupies the least possible space, and at the same time of such a design that it may readily be extended, and when so enlarged have any or all generating units supplying power to any and all points, irrespective of location of power, demand, or distance. The author states that these conditions are best met by electricity. The alternating-current motor has the widest use in textile mills for the reason that its design is so simple. There are no moving electrical contacts, and as a consequence the only attention required is to keep the motor clean and to properly fill the self-oiling bearings. One of its characteristic features is its automatic regulation, requiring power only in proportion to its output and being capable of sustaining, should occasion demand, large overloads without injury. Owing to the inherent design of this type of motor the uniform rotative speed of the prime mover is available, just as though it were directly geared, and thus a gain in production results from a steady and even speed. The author concludes by eulogising the qualities of the Nernst lamp for illuminating cotton factories.

The Junior Institution of Engineers.—The annual general meeting of this institution was held recently at the Westminster Palace Hotel, when the council's report, balance-sheet, etc., were presented. Good progress was recorded, the membership having risen to nearly 800, and the assets to close on £1,000. Special reference was made to the numerous visits to works which had been made, to the value of the papers read and discussions at the meetings, the conversazione, anniversary dinner, summer meeting in Germany, and other features of activity. Mr. Samuel Cutler, jun., M.I.Mech.E, was re-elected chairman. During the evening two of the past chairmen, Mr. W. J. Tennant and Mr. Percival Marshall, gave an extremely interesting account, illustrated by lantern slides, of their visit to the United States and the St. Louis Exhibition. Another visit occurred on the following Saturday afternoon, when through the kindness of Dr. R. T. Glazebrook, F.R.S, vice-president, an inspection was made of the National Physical Laboratory at Bushy House, Teddington, of which he is the director. For upwards of two hours the members, under his guidance with that of the staff, were kept intensely interested examining and listening to the explanations of the uses and modes of manipulation of the many beautiful instruments and appliances to be seen throughout the various departments of the laboratory, including thermometic, electrical, photometric, metallographic, metrologic, photographic, optical, chemical, and engineering (wind pressure testing, alternative stress testing, insulating material testing, temperature distribution in field coils, etc.). Mr. S. Cutler, jun., in moving a vote of thanks to the director and his staff at the conclusion of the visit, alluded to the great practical utility of the work carried on in the laboratory, which afforded an excellent illustration of the application of science to the solution of the everyday problems which confronted the engineer, chemist, and other commercial men in their work.

Area of Supply.—The Chancery Division was engaged last week in deciding whether the Metropolitan Electric Supply Company were empowered to supply energy within the urban district of Willesden. From the report of the case given in another column, it will be tolerably obvious that Mr. Justice Farwell's decision in finding that the company possesses no such power was inevitable. The proceedings were nominally instituted at the instance of the Crown, the actuating authority being the Willesden District Council, which holds an order for supplying energy within the district. Under sundry orders the company is vested with power to supply energy in specified areas within the Metropolis, but lack of space in such crowded districts compelled them to seek authority for establishing a generating station at Willesden. The confirmatory Act sanctioning this step conferred no extraneous powers for supplying energy, and any such external supply was expressly vetoed by Section 5 of a special Act passed in 1889, as well as in the company's provisional order. For the purpose of the generating station the company acquired a plot of land at Willesden from the London and North-Western Railway, to whom it has been supplying large quantities of power. The Council were thus threatened with the loss of one of the largest consumers within their district. Counsel on behalf of the company argued that the Electric Lighting Act of 1899, to which the Board of Trade's model provisional order was appended as a schedule, did not contemplate London in the prohibition against supplying energy outside the specified area, and that under its articles of association the company had general powers of supply. The judge, however, had no hesitation in deciding that there was no authority for such a wide interpretation of the company's powers, which he held were restricted to the areas specified in the company's orders. The general question of the advisability of granting undertakers extensive areas of supply on economic grounds is, of course, outside the subject at issue in these proceedings, and Mr. Justice Farwell's view seems to be the only logical one, otherwise the act of the company might create an embarrassing precedent

Fire Precautions on Underground Railways.—The necessity of protecting underground electric railways against fire has been engaging the attention of the Board of Trade and the London County Council. In approving such schemes the Board of Trade will include a direction that efficient hydrants, hose, and fire-prevention appliances shall be provided; and the Board have suggested to the Council that the chief officer of the latter's fire brigade shall certify as to the sufficiency of the apparatus. The Council intimated its willingness to undertake this function if certain minimum requirements and recommendations were laid down, and on the Council's suggestion the Board have adopted the following: "(*a*) A hydrant of the fire brigade pattern to be fitted at each end of each platform, and such hydrant to be provided with sufficient hose and

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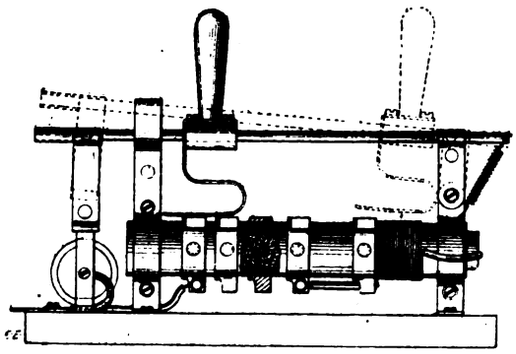
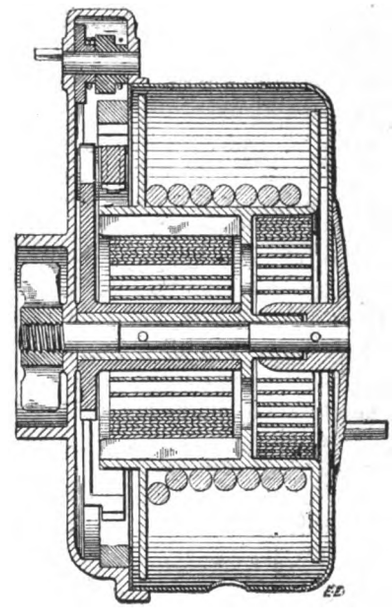
¾in. nozzle to reach the whole length of the platform and of the longest train in use on that particular line; at least six buckets of water and six of sand to be available on each of the several platforms; an extincteur to be supplied to each carriage and to each lift. (*b*) It is recommended that provision should be made for some experienced person responsible to the owners of the railways to periodically inspect and report to the owners on the fire appliances and test the extincteurs, and the owners to be responsible for the good order of all such appliances and for seeing that the railway staff is stationed and drilled; all waste and dirt to be removed at least daily." The recommendations further point out that unless overcrowding in the carriages and lifts is prevented and the gangways of the former kept clear, the extincteurs will probably prove to be useless, and that in the event of fire obtaining any hold in a tube railway the municipal fire brigade would be practically of no avail, so that the railway authorities must rely upon their own resources. The prudence of these measures is obvious, beyond which they will serve to reassure any timorous passengers who, remembering the Paris disaster, still view tube travelling with some apprehension.

Starting Box for Motors.—A patent has recently been obtained in the United States by Mr. J. F. Tracey for a starting box for motors, a description of which, with the accompanying diagram, is given in the *Electrical Review* of New York. The object of the invention is to provide for the automatic movement of the spring contact away from



the plane of the stationary contact plates or prints simultaneous with the reverse movement of the switch arm. The form of starting box consists of a series of contact surfaces formed as a part of and integral with jaws, which pass around a non-conducting tubular support. Within this tubular support is packed a finely-divided conducting material, such as cast iron. The jaws of the contact surfaces are secured in position by means of pins, passing through the wall of the non-conducting tube and through the conducting filling within the same, so that these pins form not only a support for the conducting surfaces, but also electrical connections between the contact surfaces and the finely-divided conducting material of the core. These contact surfaces may be spaced any suitable distance apart according to the amount of resistance desired between adjacent surfaces. The tube carrying the contacting surfaces is secured to a base in any suitable manner, preferably by brackets having semicircular portions embracing the tubes near their ends. The movable contact, made in the form of a spring, is secured to a head, movably mounted on a bar, which is pivotally connected by an arm to one of the brackets. On the free end of the bar is secured the armature of an electromagnet which is designed to be included in the circuit of the field of the motor. When the magnet is excited, the bar will be held in such relation to the contact surfaces that a movement of the sliding head will cause the contact spring to move along and in electrical contact with the surfaces. As soon as the current in the field is reduced or cut off, the magnet becomes de-energised so that the bar is free to be shifted either by its own weight if the starting box is arranged in a vertical position, or by a spring if the starting box is arranged horizontally. By this movement of the bar the latter will assume such an inclined position that the head will slide freely to the lower end of the arm to normal position.

Improved Trolley Retriever.—The *Street Railway Journal* describes a new form of trolley retriever brought out by Mr. C. J. Earll, of New York. This device, as distinct from a trolley catcher, not only checks the upward movement of the trolley when it jumps the wire, but also pulls it down far enough to safely clear the overhead structure. The Earll apparatus was placed on the market nearly three years ago, but the new design embodies several improvements. It is both compact and light, and has a very large rope space. The heavy retriever spring and the light spring which takes up the trolley rope slack are wholly inside the drum. The enclosing case is made up of a malleable iron back and a drawn-steel shell, which fits into a recess in the back, where it is held by the central shaft on which the sheave rotates, being secured by a thumb-nut at the rear, as shown in the accompanying



sectional illustration. This thumb-nut is the only screw used in the device. When this nut is taken off, the shaft may be withdrawn and the steel case removed from the back, thus giving access to every part. The drum has a bearing on the shaft 3½in. long, the diameter of the case is 7¾in., and the weight of the retriever 14lb. All of the parts are made of steel except the drum and back, which are of malleable iron. Some diversity of opinion exists as to whether, in resetting the retriever after the pole has jumped the wire, the retriever should be set before replacing the trolley on the wire, whether it should always be set to the same extent, or whether the trolley should be replaced and the car started before setting the retriever. One of the features of Mr. Earll's device is that by merely removing certain parts and substituting others which are interchangeable with them, the retriever can be reset by any of these methods. Where the first is used, it is not necessary to touch any part of the retriever to accomplish the setting, but merely to take hold of the rope. Where the second or third method is employed, the set lever has to be depressed before pulling out the rope. In all three methods of setting, the trolley pole may be pulled down close to the roof of the car before beginning to set, thus enabling the tramway employé to use the up-pull of the trolley pole to assist in

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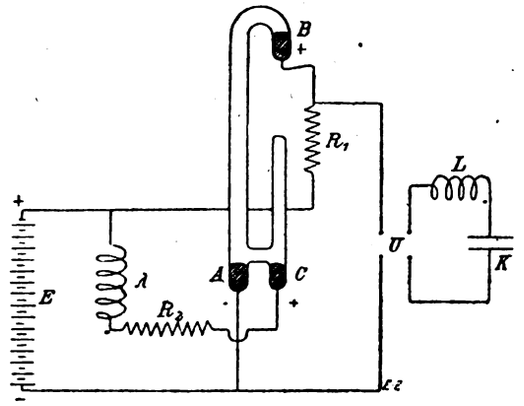
setting without danger of carrying the pole high enough to strike the span wires should the car be in motion.

French Municipal Plant.—The electrical plant lately installed for the municipality of Lyons is one of the largest of its type in Europe, the ultimate capacity being 22,000 h.p. Water power is obtained from a neighbouring canal, the available head varying from 33ft. to 40ft., though during extremely high water it drops to 26ft., owing to the rise of water in the tail-race. The canal is 11·6 miles long, 10 miles of which is the head-water canal and 1·6 miles the tail-race. The present equipment consists of eight turbines of 1,250 h.p. each, three of 250 h.p., and two of 1,500 h.p. each. Six additional turbines of 1 500 h.p. each are in process of erection. The power-house is 525ft. long and 50ft. wide, inside dimensions. The canal is led back of the power-house, each turbine being provided with a special tube leading to the turbine chamber, the entering water being controlled by a cylindrical hooded valve 9 9ft. in diameter, which is controlled from the interior of the plant. The portion of the canal at the power-house is built of solid concrete and masonry. The upper part of the building is of brick and the roof is of steel construction with a monitor running the entire length of the building, thus providing ample light and ventilation. The turbines are of the vertical type, and are located on the lowest floor level, the revolving part of the generator being directly connected to the vertical extension of the turbine shaft on the level of the power-house floor. The regulators, bearings, and the oil-pumps are located on an intermediate stage between the turbines and the generators. Each turbine is placed in a separate enclosed chamber, and is readily accessible. The chambers of the 1,250-h.p. turbines are of cast iron. The turbine revolving part is conical in shape, and revolves at a speed of 1,200 revolutions per minute. Each turbine has three divisions, the highest of which is used at times of very high water, this being kept closed by the regulating mechanism at other times. The operation of the divisions is controlled by collars which fit around the circumference of the turbine body, and are movable in a vertical plane by means of rods. The two lower collars are balanced so that the upward movement of one causes the downward movement of the other, and thus the regulating mechanism is relieved of the weight of the shaft and collars. The 250-h.p. turbines are used for driving the exciters. The latest 1,500-h.p. power turbines are of the double-turbine type, which is capable of developing a higher efficiency under the conditions prevailing at this plant, as it has been discovered that the variation in the available head and the frequency of such variation is considerably greater than had at first been expected. The dynamos are three-phase machines, running at 120 revolutions per minute and furnishing current at 3,500 volts. The three machines for furnishing the exciting current are located between the alternators in front of the generator switchboard. These machines are each direct connected to the vertical shaft of a 250-h.p. turbine, and revolve at a speed of 250 revolutions per minute. The generator switchboard contains 19 panels, the three centre ones carrying the measuring instruments for the generators and exciters and the eight panels on either side being for the generators. The switchboard, which is located in a raised gallery, has a steel frame with white marble panels. The switching room is located in an extension of the building in the rear of the board. On a horizontal table in front of the switchboard are the rheostat hand-wheels for controlling the exciter current. In the rear of the building is located the feeder switchboard. The entire power-house is lighted by arc lamps. The turbines were built by Escher and Co., of Zürich, and the dynamos and other electrical machinery by Brown, Boveri, and Co. The turbines, dynamos, motors, and distribution system cost £400,000, and the entire undertaking, including the necessary land and right-of-way, entailed the expenditure of £880,000, the outlay being increased through difficulties with the water supply. The plant is the subject of a descriptive article in the *Electrical World* of New York.

Singing Arc.—The *Electrical World* of New York contains an abstract of an account of an experimental investigation made to examine the theory of Duddell, according to which the fundamental condition to be fulfilled in a singing arc is that dv/di is smaller than zero, where dv is the change of the voltage and di the change of the current in the arc. This condition is fulfilled only with homogeneous carbon, so that if the theory is correct, only an arc between homogeneous carbons could be made to sing. The author has, however, made experiments in which he produced the singing arc with iron electrodes and with mercury electrodes. In the latter case the above differential quotient was presumably positive. His arrangement for the mercury arc is as follows: Since during each oscillation the arc is extinguished, it must be artificially lighted again. For this purpose he makes the cathode of the tested arc at the same time the cathode of a small artificial arc. In the accompanying diagram E is a storage battery, A the



common cathode, B the anode of the main arc, R_1 its regulating resistance, C the anode of the auxiliary arc, R_2 its regulating resistance, U a two-pole switch, L a self-induction, and K the capacity of the condenser circuit. In the circuit of the auxiliary arc a reactance coil is inserted in order to keep the current constant. In the large arc, A B (7in. long), the current was two amperes, the voltage 30; in the small arc, A C, the current was one ampere. Thus Duddell's conclusion has been shown not to agree with the facts. It had been developed mathematically under the supposition that the current is sinusoidal, or what is really the same, that the energy of the oscillations is supplied exclusively from the condenser circuit. But it has been shown that the current wave in the condenser circuit is far from being sinusoidal. The author gives the following theory of the singing arc: If the arc is first burning quietly and self-inductance and condenser are then connected in shunt, the electricity will flow in large quantity to the capacity. If the main current is not strong enough to simultaneously supply the arc and to charge the condenser, the voltage at the arc will decrease. When it becomes smaller than the sum of the cathode drop and anode drop, the current will be extinguished. Then only the single circuit containing the condenser and the battery is left, and the condenser is charged. Now, the voltage at the arc will also increase again, and if the cathode is still hot enough the arc will be started again. The condenser will then be discharged, and so on. The high temperature of the cathode is of great importance.

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HADFIELD'S EAST HECLA WORKS, SHEFFIELD.

Since electric traction on tramways came into vogue in this country, many reputations have been won by home firms for sound work, but few have improved upon Continental methods in any direction to the extent that Messrs. Hadfield's Steelfoundry Company, Limited, have done. It seems but a short time since American practice was accepted in this country as a standard. Thanks, however, to the scientific knowledge and commercial ability of a few such men as Mr. R. A. Hadfield, M.I.C.E., the Old Country has shown where improvements could be effected, with the result that much has already been accomplished towards converting our recent lag into a decided lead so far as quality of work and its durability are concerned. The name of Hadfield has become prominent in the tramway world, chiefly on account of its association with special track work. At no time during the development of tramways were engineers more interested in the construction and maintenance of tracks than to-day. The passing of the horse car and the introduction of the electrically-driven car have rendered a

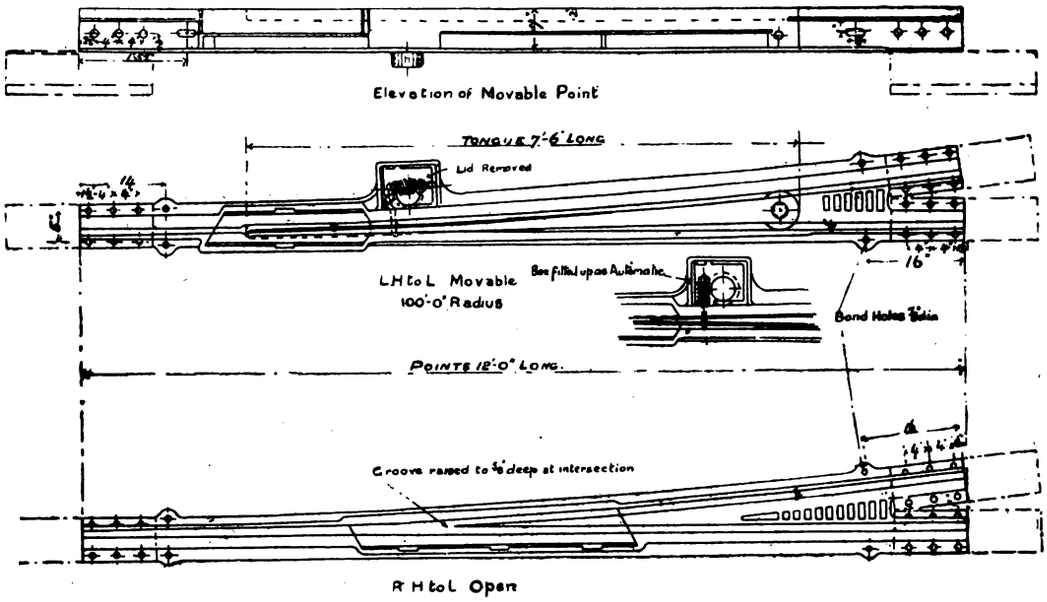

FIG. 1.—Details of Hadfield's Combined Automatic and Moveable Point.

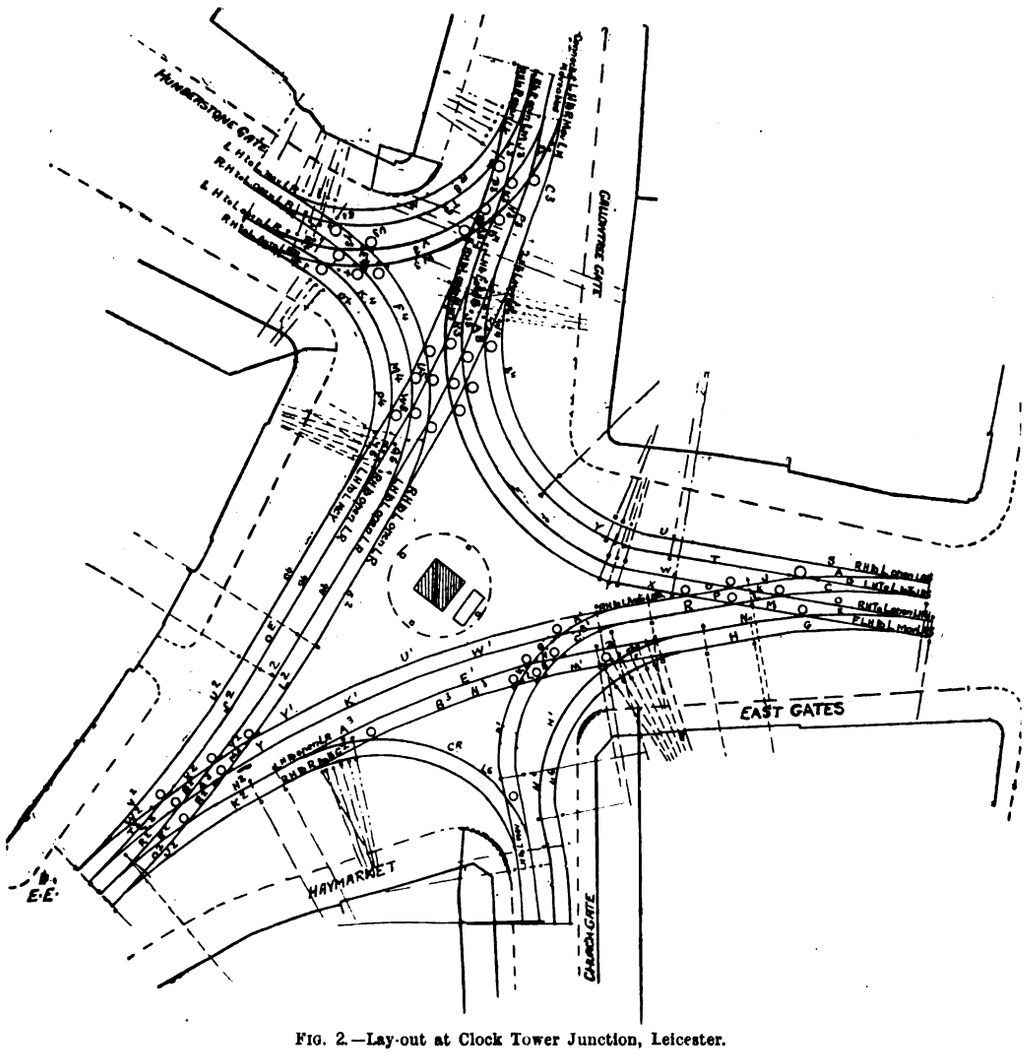

FIG. 2.—Lay-out at Clock Tower Junction, Leicester.

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reconsideration of the methods of tramway track construction absolutely necessary. In the past, short points of ordinary cast steel were found to be adequate for their purpose, but it has been conclusively shown that under electric traction the wear and tear on the permanent way is much more severe than it was in the case of either horse

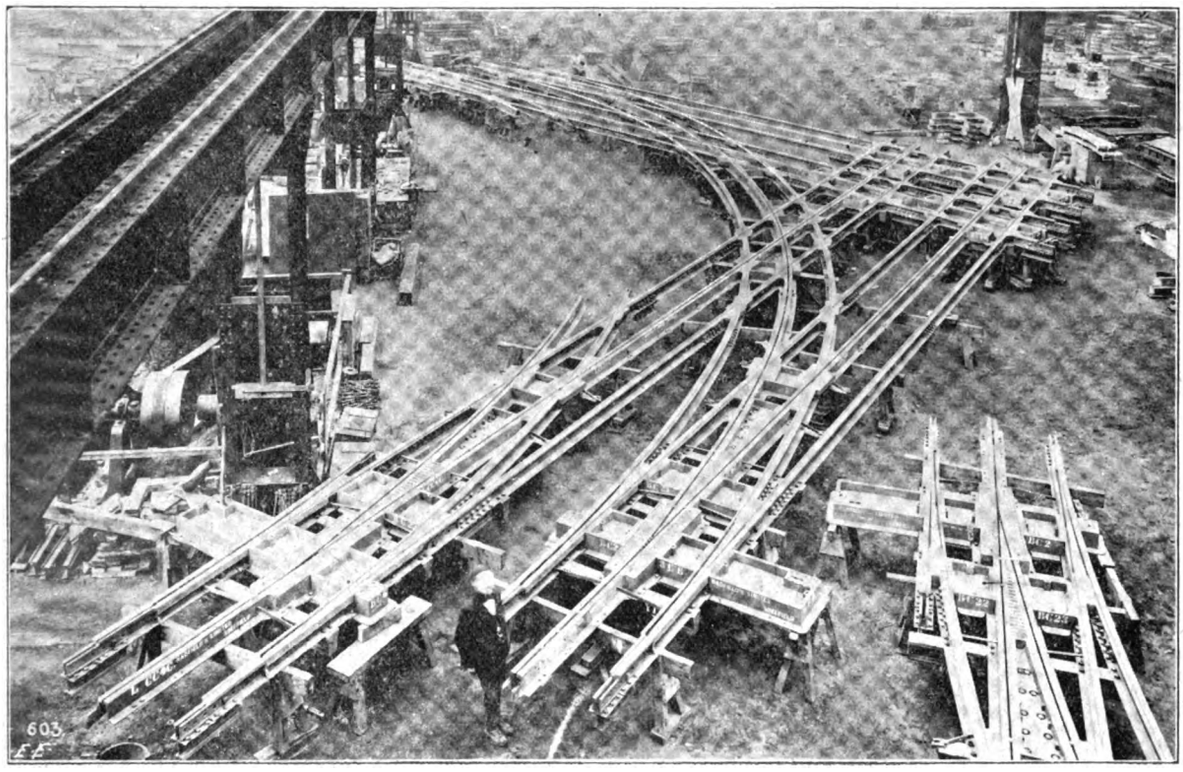

FIG. 3.—Junction for the London County Council Tramways.

or steam cars; more particularly has this been shown in regard to the points, crossings, and special junction work. The higher speeds at which the cars run, the increased weight of the cars, and the heavier loads carried by them, have undoubtedly an important bearing upon the reduced life of the permanent way. Bearing in mind the altered conditions, it is satisfactory to know that a firm of British manufacturers have risen to the occasion, and are in position to supply a material which for resistance to wear and tear is inferior to none on the market to-day. We refer to the Hadfield Company's patent "Era" manganese steel, which combines great hardness and toughness with high tensile strength, the two first-mentioned qualities being so pronounced that the best tool steel cannot machine it. At the same time the material is not brittle in any sense of the word, but, on the contrary, can be bent cold without showing any sign of fracture. It is not, therefore, surprising that engineers responsible for the maintenance of tramway tracks should have recognised in "Era" manganese steel a material for points and crossings which is calculated to give the maximum of wear at a low ultimate cost.

In addition to making points and crossings of this special steel, the firm have also supplied large numbers of "Era" manganese steel rails for use on sharp curves. Amongst the users of this type of curved rail are the Liverpool, Bradford, Bournemouth, and Sheffield Corporations; in fact, whole junctions, including not only points and crossings but also straight and curved rails of this steel, are in extensive use on tramways throughout the country. They also manufacture toughened cast-steel points and crossings either with or without "Era" inserts, the former, to meet modern requirements, being supplied of any length up to

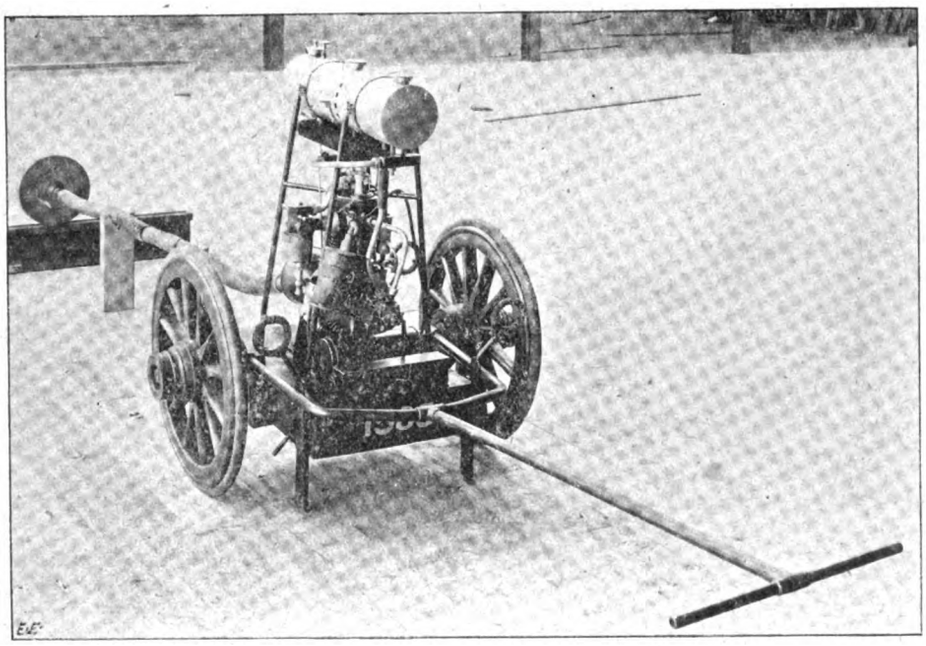

FIG. 4.—Hadfield's Motor Emery Grinding Machine.

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15ft. It is noteworthy that the company have made the longest tramway casting in Great Britain.

Their improved patent combined automatic and movable point (of which details are shown in Fig. 1 herewith) has found considerable favour. Referring to the illustration, it will be seen that this point is so designed that it can be converted from an automatic pulling or pushing point into a movable one, or *vice versâ*. The necessary alteration can be carried out by an ordinary platelayer in a few minutes without interfering with the permanent way or delaying the traffic. The whole of the mechanism is contained in a box at the side of the point, and is kept as near the top as possible, so as to be free from accumulations of dirt, etc. Under their patent the firm also supply either the frog or leg type of crossing, with or without inserts, as well as the cast-iron bound type with "Era" manganese steel inserts.

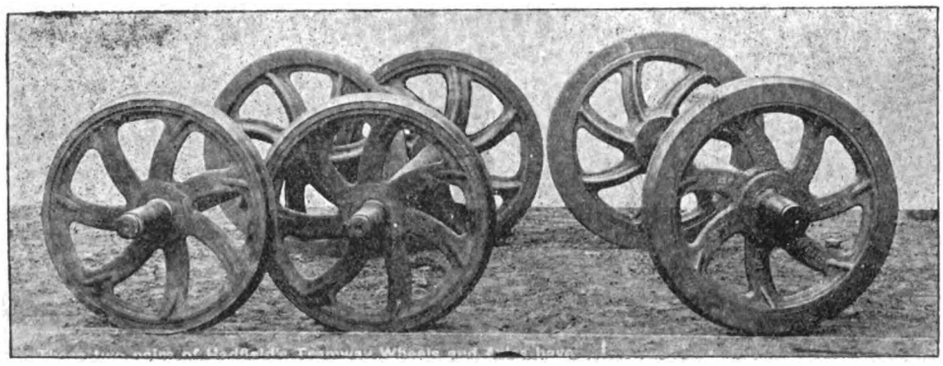

FIG. 5.—Hadfield's Steel-Tyred Car Wheels, showing wear after 2¼ years' service and a total mileage of 79,680.

A recent visit to Messrs. Hadfield's East Hecla Works, Sheffield, enabled us to fully appreciate the splendid facilities with which the company have provided themselves in this department. The old method of constructing special work on site, with its consequent serious inconvenience to the general public, through the street excavations being unduly prolonged, is no longer continued, since electric traction has rendered absolute accuracy essential to success, and this can only be obtained by the exercise of the greatest care, in which the time factor, of course, plays an important part. We believe Messrs. Hadfield's were the first firm in this country to meet the new conditions. They constructed a setting-out floor, and adjoining it is a lay-out yard six acres in extent, equipped with modern electrically-driven machine tools for bending, sawing, and drilling rails. Here we saw a great variety of special work for railways, tramways, and docks in progress. The company undertake full responsibility in connection with all special work entrusted to them for construction. To facilitate the easy running of cars they have adopted, as the result of considerable experience and research, "standard spiral" or "easement" curves, which are introduced wherever possible.

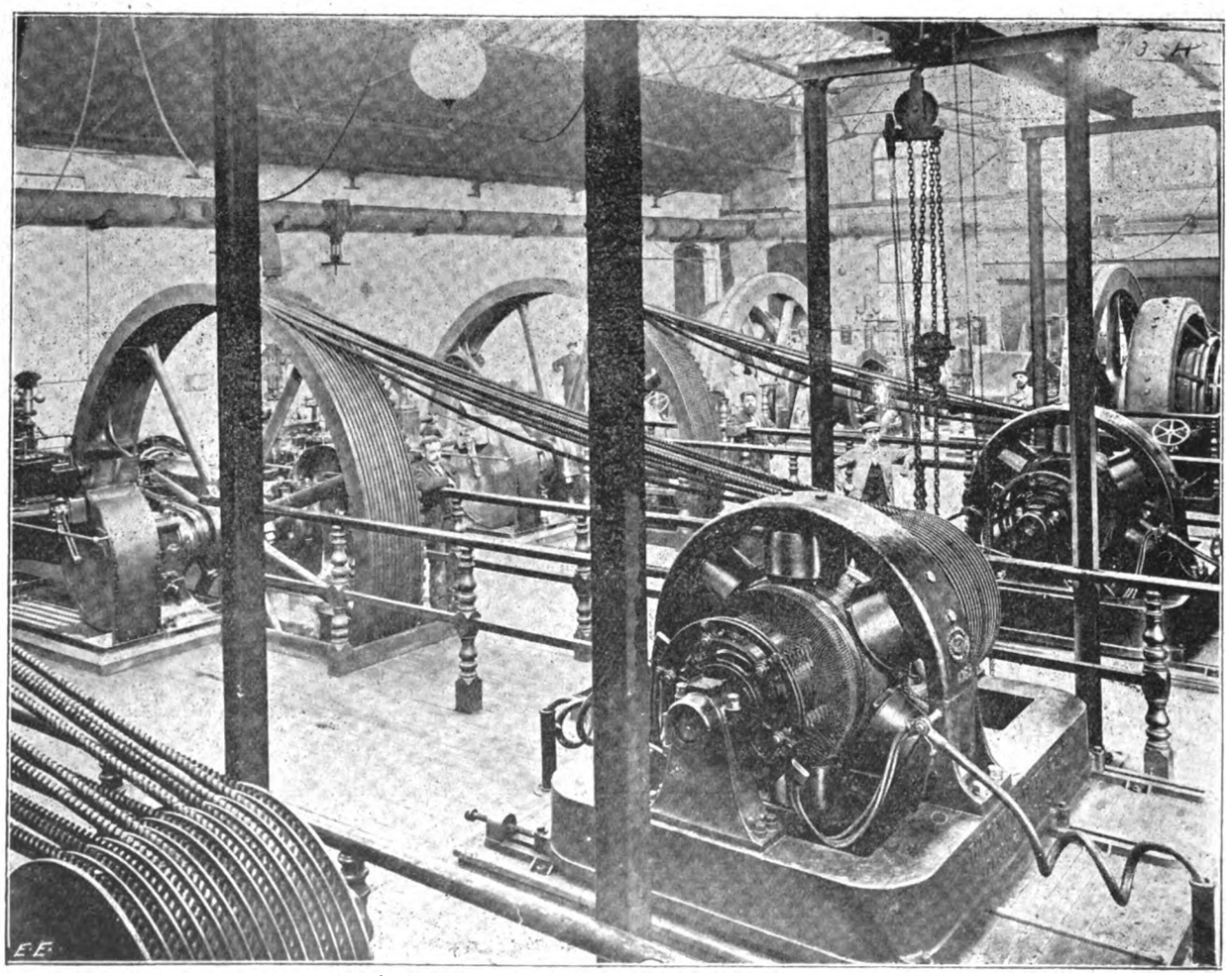

FIG. 6.—Interior View of Power House, Hadfield's East Hecla Works.

Of the vast amount of special track work recently carried out by the firm, that in connection with the Leicester Corporation tramways deserves particular mention, since it included the now famous clock tower junction, which claims the distinction of being the largest lay-out in the

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country. The total weight was over 100 tons, and it was laid by the Corporation's own staff in 10 days—a fact which speaks well for the accuracy of the parts. From the illustration (Fig. 2) it will be seen that this lay-out comprises no less than 10 running tracks.

that the second contract was divided, half going to America and half to Sheffield, and although the English firm had to instal a number of large machines to cope with the work, it is satisfactory to note that their contract was completed a fortnight within the specified time. Since then they have

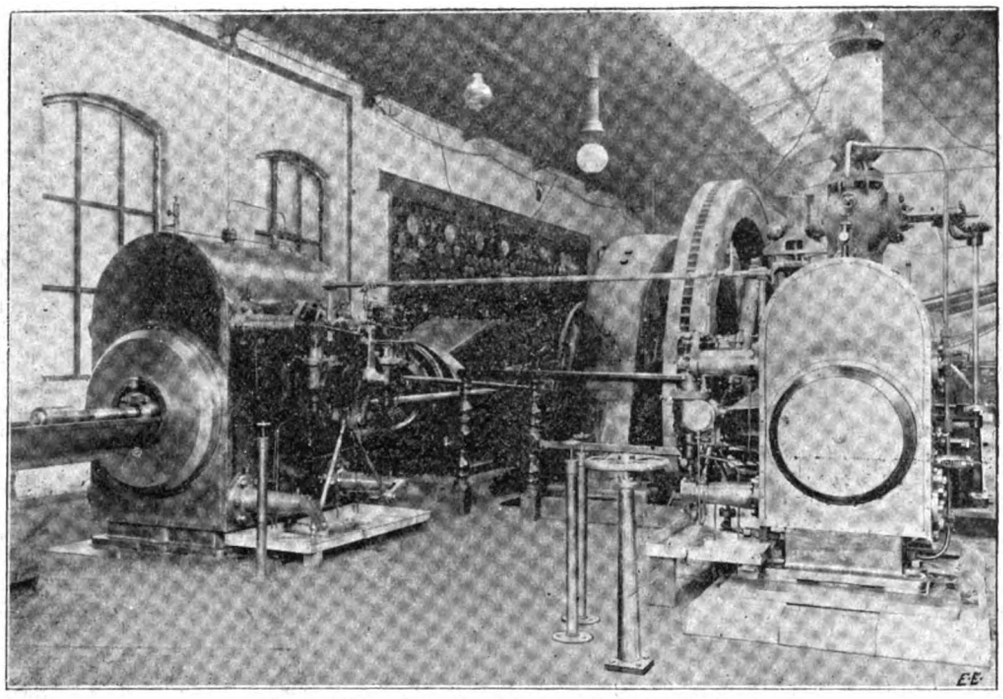

FIG. 7.—300-kw. Generating Set, Hadfield's East Hecla Works.

As specialists in the construction of the complicated lay-outs incidental to electric conduit tramways, Messrs. Hadfield's have also had considerable experience. Their first contract in this particular line was for the Bournemouth Corporation tramways, the points and crossings for both trolley and conduit lines being made of "Era" manganese steel. When the first special work contract for the new lines of the London County Council was issued, no firm in this country would undertake to complete in the time specified, wherefore the order was sent to America. On the next occasion Messrs. Hadfield's, who had prepared meanwhile, entered into the competition with the result obtained and successfully executed two further orders for the same authority. The accompanying illustration (Fig. 3) shows a junction, included in one of their orders, erected at the works before being dispatched.

There is no need to enumerate the tramways in connection with which this enterprising firm have constructed special work. Suffice it to say the list would be lengthy, and include most of the important undertakings throughout the country. At the time of our visit the lay-out floor was covered with work for Johannesburg, Erith, Exeter, and Chesterfield, among other places more or less remote from each other.

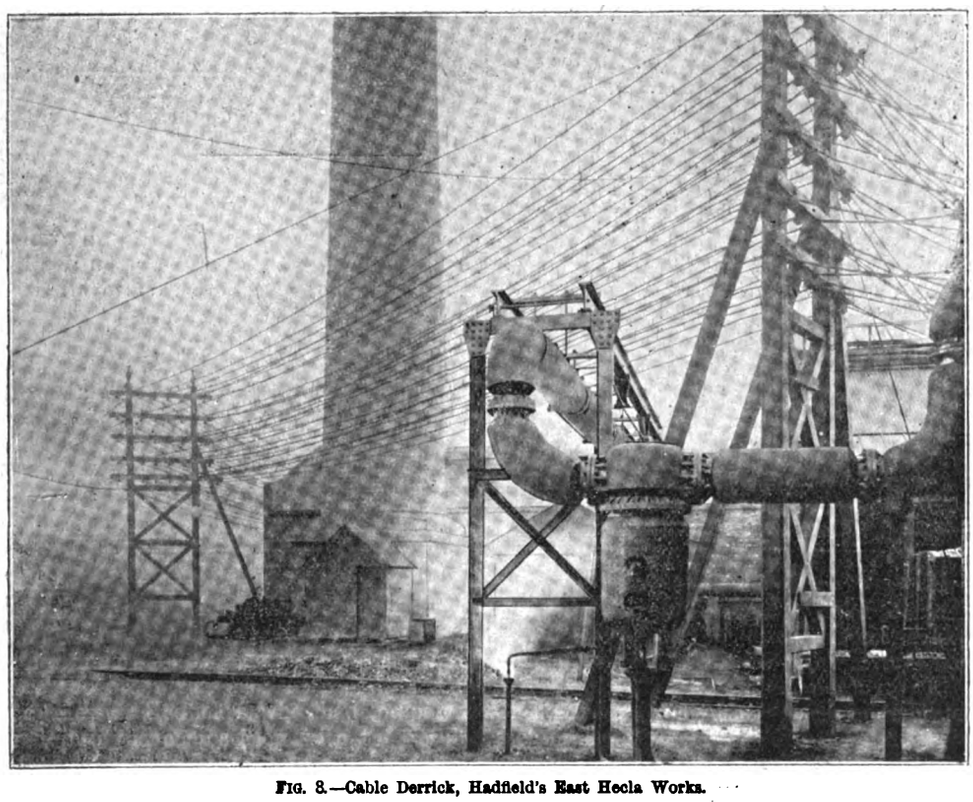

FIG. 8.—Cable Derrick, Hadfield's East Hecla Works.

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While on the subject of special track work, brief reference may be made to an interesting grinding machine designed and manufactured by Messrs. Hadfield's. This machine (Fig. 4) enables the groove and tread of tramway track work to be ground after having been fixed in position without interfering with the running of the cars. It is especially useful where "Era" manganese steel has been used, as this material cannot be machined in the ordinary way. The grinder is furnished with a petrol motor of 3½ b.h.p., with water-cooled head, the water being circulated by means of a small pump attached to one end of the motor shaft. The motor is fitted with electric ignition. The emery wheel is connected with the motor by means of a flexible shaft and universal joint. It is claimed that this machine has an advantage over the electrically-driven type of grinder, in that it does not require any outside source of power to work it.

Messrs. Hadfield's have also specialised the design and manufacture of steel-tyred wheels for electric street cars.

Fig. 5 illustrates a set of wheels which have been used in regular service for 2½ years in Sheffield, where, owing to the hilly nature of the district and numerous short curves, the working conditions are exceptionally severe. The total mileage covered by the wheels shown on the left in the illustration was 79,680, and we understand this type of wheel has been found to be much more economical in working than the ordinary chilled wheel. With regard to the construction of these wheels, it may be said that they are formed by a centre made of best toughened cast steel, on which is fitted a rolled tyre of a specially hard and tough grade of steel, which, being homogeneous in its composition, ensures regular wear. As a consequence, they preserve their circularity, and will run smooth till the last, not, therefore, requiring to be trued. Large numbers of these wheels are being turned out to meet a growing demand. In another department we noticed a number of castings for electrical machinery, including magnet rings 16ft. in diameter, and weighing 20 tons each, besides numerous smaller sizes. The East Hecla establishment is exceptionally fitted for this class of work, possessing as it does what is claimed to be the largest foundry in the world. This foundry is a sight worth seeing. It is of huge dimensions, being served throughout by electrically-driven cranes of various types and powers.

In the foregoing we have touched upon such only of Messrs. Hadfield's specialities as concern our readers—a comparatively small part of the whole, in fact. Naturally the supply of power is no small item in a works of this description. All the machine tools are electrically driven. The power is taken from a central station which is equipped with five generating sets—three of 160 kw. output and two of 300 kw. output each. Fig. 6 is a general view of the plant. These generators produce continuous current at 230 volts, and the current is used at this pressure for both power and lighting. The switchboard is divided into five panels, with the necessary main switches, regulating resistances, main ammeter, and voltmeter for each generator, all being arranged for parallel running. The main distribution leads are taken from the 'bus bars, and for each main lead a circuit breaker is provided, together with an ammeter, so that each distributor can be cut out from the switchboard, and the amount of current passing through the individual distributors observed. The three 160-kw. generators are rope-driven by cross-compound Corliss engines having cylinders 17in. and 28in. diameter by 3ft. stroke, running at 90 revolutions per minute. The rope flywheels are 15ft. diameter, and drive the generators at 400 revolutions per minute. The two 300-kw. sets, on the other hand, are direct driven by cross-compound engines having cylinders 20in. and 36in. diameter and 36in. stroke, running at 100 revolutions per minute, the armature being carried on the crankshaft between the cylinders. One of these sets is shown in position in Fig. 7. The last of the accompanying illustrations (Fig. 8) shows one of the cable derricks outside the generating station, and will give an idea of the extensive system of cables used throughout the works.

In conclusion, we have to thank Messrs. Hadfield's for the assistance they have given us preparing the above article.

NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(Continued from page 625.)

The solenoidal switches are the most interesting to study, and the various combinations which can be devised with this type are endless, and so adapt this pattern of starting switch for any purpose. In the description which has been given of the general type of solenoidal starter, it would be noted that all the parts are open, and are therefore liable to be tampered with; the apparatus is one of great utility, but it is intricate, and requires a certain amount of attention. The same makers have another pattern, which is shown in Fig. 7, and which they term a "full-proof" starter. This switch, if well made, fulfils all the requirements of a good starter, and is suitable for any circuit, as the whole of the switch, with the exception of one handle and a push button, are enclosed in an iron case. The advantages claimed for this switch may be summarised as follows: (1) The operator starts the motor by one movement of the handle; at the same time only a slow motion of the contact lever is possible, its speed being regulated by a dashpot, which is not under the control of the operator. (2) The main switch is interlocked electrically with the rheostat arm, and cannot be closed until all the resistance is cut out of circuit. (3) A maximum and minimum circuit breaker of simple construction are contained in the switch, one of which comes into operation either with an overload or with an interruption of the current. The circuit breaker

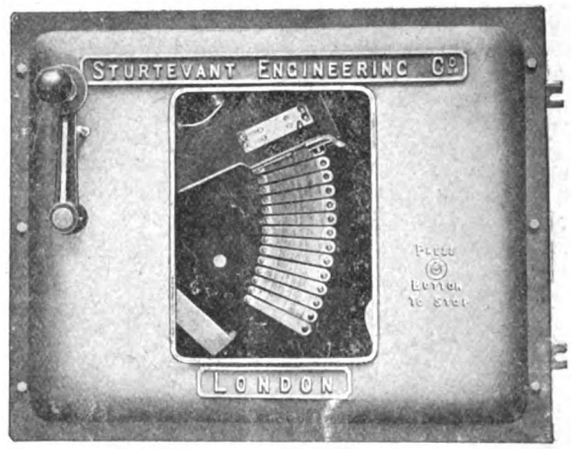

FIG. 7.

having been opened from either an overload or interruption, it cannot be closed again until all the resistance is reinserted. (4) The circuit is invariably broken by the circuit breaker, and never under any circumstance by the contact lever; hence there is no sparking at the contacts, with consequent sparking. (5) The circuit breaker is fitted with carbon points, and for large sizes magnetic blow-outs are also included, so that an arc cannot be maintained. (6) The motor can be stopped at any time, either before or after it has attained its normal speed, by simply pressing a push button or by reversing the starting handle, and in either case the circuit is still broken at the circuit breaker. If to these conditions it is seen that the resistance is of the proper section and well mounted so as to eliminate any fear of undue temperature rise or danger of sagging, it will be seen that the switch answers all requirements, while at the same time it is an instrument which is little likely to get out of order, and can be operated by any fairly intelligent man. Being well enclosed, it can also be erected in more or less exposed positions.

The description of the construction of this switch willl show how the various conditions are attained. The main switch or circuit breaker, which is mounted on the upper right-hand side of the slate, is controlled by a powerful solenoid, and is also fitted with heavy carbon contacts for making and breaking the circuit, and with laminated phosphor-bronze brushes for carrying the current continuously. On the left-hand side of the slate is an ordinary motor-starting switch, having its contact lever arranged so

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as to fall by the action of gravity, and cut the resistance out of the motor circuit, unless held in the position of all resistance in by the small detent in the upper portion of the slate. A second lever attached to the operating handle is used to lift up the contact lever to its highest position, when it engages with the detent mentioned. On the side of the rheostat contact lever is mounted a short-circuited piece, which bridges two contacts when the contact lever is in its highest position. A similar bridging piece is mounted on the tail of the operating lever, this being used to bridge another two contacts when the operating handle is in its position for starting the motor. It is necessary that both these two sets of contacts should be bridged to complete the solenoid circuit of the main switch. When this solenoid circuit is completed the main switch closes, and in closing trips the detent which held the contact lever in its highest position, thereby allowing the latter to fall and cut out the resistance from the motor, circuit, the speed at which the contact lever falls being controlled by an adjustable dash-pot. When the contact lever leaves the highest position it disconnects the two contacts in the main switch solenoid circuit, which were previously bridged by the contact strip attached to it. The main switch solenoid circuit then remains completed through the bridge piece carried on the tail of the operating lever, and through the main switch itself; consequently, if the current supply fails, or if the operating handle is moved back ever so little, the main switch opens and cannot be again closed except by bringing the operating handle back to its full extent, so as to lift the contact lever to the highest position, and then bringing the operating handle forward to the running position. On the lower right-hand corner of the slate a small electromagnet is mounted, having an adjustable armature, which, when lifted by the magnet, opens a carbon-tipped switch which is in the solenoid circuit of the main switch, and hence causes the main switch to open. The winding of this magnet is connected in the main motor circuit, and the armature can be adjusted so that it will lift and stop the motor at any desired overload. An external resistance, which may take the form of lamps, is also included, and are usually inserted into the main switch solenoid circuit as soon as the main switch is closed, thereby reducing the current consumed to a minimum. A small push button is mounted on the case, which, when pressed, lifts the armature of the overload magnet, and so causes the main switch to open.

From the above description it is apparent that it is quite impossible for the operator to use this switch in an improper manner. There is only one handle accessible, which normally would be in a horizontal position. To start the motor it is necessary to bring the handle to a vertical position, where it is held by a spring catch; after this the whole operation of starting the motor is performed automatically by the starting switch. If the operator, instead of bringing the handle to a full vertical position, moves it only to an intermediate position, the main switch will not close; or if after bringing the handle to the correct position he moves it back, with the apparent intention of preventing the contact lever from cutting out the whole of the resistance, the main switch will immediately open, and the whole operation of starting must be commenced *de novo*.

It is unnecessary to explain that switches of this type are more expensive, if we only consider first cost, than are the more ordinary types complete with no-volt release and overload preventers commonly met with. The question, however, arises, what is meant by the word expensive? If account is taken of the life of the switch, and, above all, of the motor which the switch is intended not only to control, but also to protect, then there is no doubt that these higher-priced switches are not so expensive as are the lower-priced ones. The user has three things to consider in making up his accounts: the first is the interest on the money laid out on the installation; secondly, the running cost of the plant; and, thirdly, the cost of upkeep and repairs. It may be urged that he can insure the whole of his electrical plant, dynamo, motors, and controllers against breakdown, and that the various insurance companies will quote no lesser rate because he has adopted the most elaborate controlling switches that he could find, and that as they pay all costs of repairs it is unnecessary to protect them against breakdown by spending more money than is absolutely essential on the installation. This argument is fallacious, for it overlooks the fact that although the insured is reimbursed the amount the repairs cost, he is not compensated for the loss in profits caused by the stoppage of the motor consequent on the breakdown. Even assuming that he were compensated at the rate of some agreed upon sum for each day the motor was stopped, unless this amount were large he might still be a loser. Suppose that he were manufacturing in the machine driven by the motor goods under penalty, the loss both in money and prestige might be very great. The principal object of insurance appears to be the periodical inspection of the whole plant by independent experts, who while independent have a serious stake in the upkeep of the machine, amply sufficient to prevent their inspections being of a perfunctory character. It is still to the benefit of the insured to adopt any reasonable suggestion for the better welfare of the plant. If only persons considering the question of adopting motor installations could be persuaded generally to have the scheme prepared and the work carried out under expert advice, a better class of starting switch would undoubtedly become more general; but the writer is also convinced that if contractors would give alternative estimates—one for the work with the ordinary controlling appliances, and a second for the same work with the best class of starting switches—and at the same time distinctly and briefly state the advantages accruing from the use of the best type, a general advance would be made. This would be to the benefit of the motor manufacturer and to the purchaser, while at the same time the contractor would participate in the good result, for he would establish a reputation for sound and good work, while at the same time he would make a decent profit on each transaction, for it is a well-known fact that cheap jobs leave but little margin to the contractor, while on good contracts a fair profit is assured.

There is every reason to press for improvement in the controlling devices when so many good motors annually break down owing to defective starting switches. We have seen that Mr. Gibbings, when borough electrical engineer of Bradford, was compelled to design an improved starting switch, as the number of breakdowns to motors hired out by his Corporation, and which were directly due to poor starters, was so very great. In a similar manner, if we turn to the reports of the various insurance companies undertaking this class of risk, we find they state that the number of breakdowns per annum is equal to one machine in nine, and one machine in seven of those insured. It must also be borne in mind that these machines insured are not old and obsolete machines, but good machines, as the companies do not accept indiscriminately for insurance every machine proposed, but that it is first examined by one of their inspectors, and his report considered by a trained electrical engineer in the office; further, the insured machines are also periodically inspected several times a year, and every means is taken by the company to see that it receives proper attention. The large number of breakdowns then assumes a serious aspect, especially when it is stated that the majority of the breakdowns occur to motors, and that the two principal causes are dirt and *inadequate and defective starting switches*. When the number of failures in ordinary work is compared to the number of failures in connection with motor-driven printing presses, and which are fitted with the best types of controllers possible to obtain, the case in favour of using a better class of starting switch generally in order to obtain the highest economy is fully proved.

The starting switches so far dealt with have all been for non-reversible motors, but as the general practice is now to adopt electrical driving for all classes of hoist work, whether for a passenger hoist, a goods lift, or crane work, reversible motors are necessary, and the starting switches must be designed to give perfect control under all conditions. For cranes it is customary to instal either three or four motors, depending upon the size of the crane. In small cranes there is generally a separate crane motor for hoisting, longitudinal travel, and cross traverse, while in larger sizes there may be a fourth motor for slewing; these motors are generally series wound. For lift work the motor is generally shunt

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wound, and two different systems may be adopted. In the first place, the motor may be non-reversible, and the hoist worked off crossed and open belts. This system is frequently met with in connection with good hoists in warehouses, etc, but this system is never met with in passenger hoists. Here the motor is controlled from the cage, and it is made of the reversible type. The same type of motor is also now being more frequently adopted for good hoists, the only difference being that the motor must be controlled from each separate floor. If only one controlling point situated close to the hoist is required on each floor, then the arrangement is very similar to that required for the passenger hoist; but at times several controlling points are required, and while each of these must be independent, it is also requisite that two different motions cannot be given to the cage at the same time. All these different requirements mean different types of starting switches.

In the reversible motor the shunt current always flows in the same direction, and the different directions of the motor are attained by reversing the direction of the current through the armature. When the current is reversed in direction through the armature, the same precautions must be taken as in the case of starting a motor from rest. The stoppage of the current must first bring the armature to rest so that no current passes through it in the reverse direction until it is so at rest, as the mere stoppage of the current would not bring it to rest immediately owing to the mechanical inertia. It is usual to fit the winding drum with some form of strong magnetic brake. This should be actuated by the main current if the shunt is maintained excited during the operation of reversal, but as it is customary to entirely disconnect the motor from the supply feeders at this period—that is, to break both shunt and armature circuits at each reversal—it is more customary to insert the magnetic brake circuit in the shunt circuit. As soon as the current commences to flow through the shunt the solenoid controlling the magnetic brake is energised, and the brake slipper is lifted off the drum, and the motor is free to revolve in either direction, while conversely, as soon as the shunt current is broken, the solenoid is de-energised, and the brake is applied. This magnetic brake, especially in the case of passenger hoists, should be effective and reliable, as upon its action depends not only the life of the motor, but also the safety of the passengers, and the successful working of the hoist.

In all starting switches for reversible motors which are controlled from the cage, a rope pulley is fixed to the spindle operating the lever. The pulley and rope are so arranged that the rope can only be moved a certain distance in either direction. When it is pulled to its full extent in one direction the cage will move upwards, when to its full extent in the other the cage moves downwards, while the intermediate position brings the motor to rest. In reversing the direction of the cage, the rope must be pulled past this intermediate position, and the starting switch, acting in conjunction with the magnetic brake, must be designed so that under every circumstance the motor is stopped as the rope is pulled past this point.

(To be continued.)

THE MEASUREMENT OF THE POTENTIAL OF THE ELECTRODES IN STATIONARY LIQUIDS. THE DETERMINATION OF CHANGES OF CONCENTRATION AT THE CATHODE DURING ELECTROLYSIS.*

BY HENRY J. S. SAND, PH.D., M.SC.

In recent electro-chemical investigations accurate data are, as a rule, to be found regarding current density, voltage, temperature, and concentration of liquid taken, and very often also regarding the potential of one of the electrodes, defined as the drop of potential on the boundary between it and the electrolyte. The actual concentration of the electrolyte in contact with the electrode, is, however, very often uncertain, owing to the removal of substance by electrolysis. Some years ago I was able to demonstrate the great importance of this factor in connection with the electrolysis of acid solutions of copper sulphate. When small current densities were employed in a stationary solution, it was possible to show with a fair amount of accuracy that evolution of hydrogen only took place after the complete removal of copper salt from the liquid in contact with the electrode. On the other hand, when large current densities were employed, this local depletion took place so rapidly that even the most vigorous stirring could not prevent it. The result obtained in this research could be predicted theoretically when the assumption was made that the process occurring at the electrode itself was of a reversible nature—that is, that on the boundary between electrode and electrolyte, chemical equilibrium must be supposed to remain continually established. The matter may also be stated in the following manner corresponding to a form in which it has recently been put forward by Nernst as a general principle: Differences of chemical potential cannot exist for a finite period of time on the boundary of two phases—that is "between infinitely near points"—as this would lead to infinitely great forces and reaction velocities. According to this assumption the actual velocities of electro-chemical reactions, and of all others which occur on the boundary of two phases, are infinitely great as soon as conditions of equilibrium have been overstepped by a finite amount, the observed velocities being simply limited by the rate with which diffusion and convection renew the material removed by the reaction. As conditions of equilibrium in electro-chemical reactions are determined by the electrode potential, by which name I propose to indicate the drop of E.M.F. on the boundary between electrode and electrolyte, and the rate of these reactions is proportional to the current strength, this may be expressed in the following manner: "When the electrode potential at which a reaction begins has been exceeded by a finite amount, the current strength becomes independent of it, being only limited by the velocity of convection and diffusion. The instance just referred to of the deposition of copper conforms to this rule, for it seems very probable that when a sufficient drop of potential is maintained on the boundary between electrode and electrolyte, the rate of deposition of copper only depends on the rate of renewal of the metal salt at the electrode. Examples of a similar kind have been studied by Brunner—viz., the rate of reduction of iodine to hydriodic acid with definite cathode potentials and the rate of liberation of hydrogen from weak solutions of acids under similar conditions.

As has already been indicated, Nernst and Brunner are plainly of opinion that all cases of electro-chemical action may be ultimately considered from the same point of view. It is not the object of the present paper to enter very fully into a thermodynamical discussion of the principle involved. It will suffice to point out that the latter seems sufficiently invalidated for *a priori* application to actual cases owing to the impossibility of stating that the atoms chemically reacting on the boundary of two phases are in infinite proximity. In fact, the results of several recent researches, notably those of Haber, stand in opposition to conclusions drawn from the principle under discussion. The object of all these researches is the investigation of the dependence of electro-potential as defined above on current density. In Haber's work the reduction of nitrobenzene is examined, but instead of finding the current density to be independent of the potential of the cathode, his results point to a logarithmic dependence of the latter on the former. In fact, he has partially explained his results, starting from the not improbable assumption that the variations of potential are brought about by the absorption in varying concentrations of hydrogen, or other reducing material, by the electrode. In the further elaboration of this view his results may all be foretold if we adopt as an empirical fact that the velocity of reduction at the electrode, v, depends on the concentration of hydrogen, c, in it according to the relation

$$v = \kappa c^{\gamma}$$

in which κ and γ are constants depending on the conditions of the experiments. In contradiction to this, as will be understood from what has already been said, Nernst's view

* Paper read before the Faraday Society, Oct. 25, 1904.

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would require that once the conditions of equilibrium have been overstepped, the above velocity should be infinitely great. As a matter of fact, Haber's results have been doubted by Brunner, who believes that changes of concentration in the liquid adjoining the electrode may be partly responsible for them. To this Haber and Russ have replied, stating reasons for the correctness of the results obtained by the former. In view of the fact that the investigation of the dependence of electrode potentials on current density seems one of the most important problems of contemporary electro-chemical research, its appears very desirable to have independent methods for the determination of the rate at which changes of concentration occur in the layer of electrolyte adjoining the electrode.

When the diffusion coefficients required for calculating these changes of concentration are not known, it would seem that the most reliable method for arriving at an estimation of their rapidity is afforded by the investigation

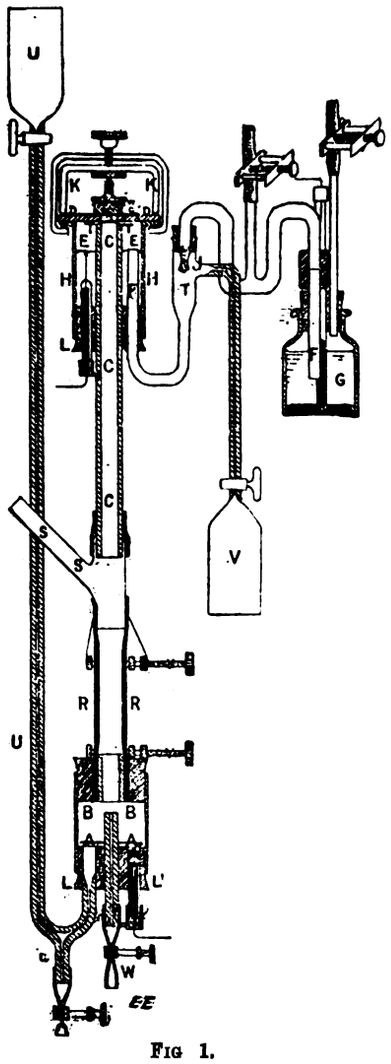

FIG 1.

of the behaviour of stationary liquids free from convection currents. This was the method adopted by me for the examination of copper solutions. When hydrogen began to be evolved owing to complete depletion of the copper-salt at the electrode, a sudden, very large fall of cathode potential took place, which caused a corresponding increase of voltage between the two electrodes that could be easily observed. This method is only applicable where very sharp breaks of potential occur, and the anode is not polarisable in the liquid employed. Another method has since been described by Cottrell. In it a constant E.M.F. is maintained between the electrodes; the current, however, must remain so minute, or the resistance of the electrolyte be so small, that practically no E.M.F. is required to overcome it according to Ohm's law.

It is the object of the present paper to describe a method which will allow the electrode potential in stationary liquids of the most varying kind to be measured, when very much larger currents are employed than those which can be made use of according to Cottrell's method, and at the same time to indicate the nature and the scope of the conclusions that can be drawn from the results obtained.

DESCRIPTION OF APPARATUS AND ELECTRICAL ARRANGEMENTS.

It was necessary that the apparatus should fulfil the following conditions: (1) The electrode under examination must be placed horizontally either at the top or at the bottom of the apparatus. It should be readily interchangeable and accessible to observation during an experiment, and allow the current to have uniform density. (2) The electrode not under examination should be as non-polarisable as possible, and no gases must be evolved which might stir the liquid. (3) The difference of potential between the electrode and the layer of electrolyte in contact with it must be capable of continuous measurement during the course of an experiment. (4) It was found desirable to have the apparatus arranged so that several successive

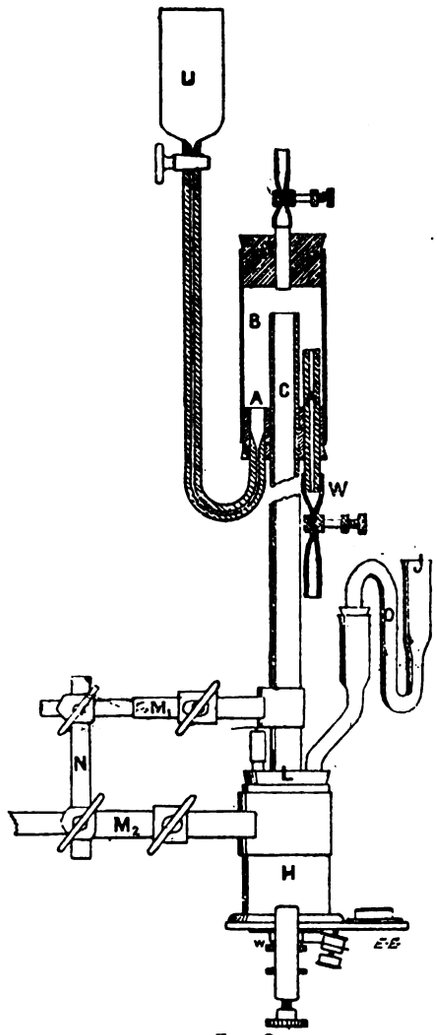

FIG. 2.

determinations could be carried out without taking it to pieces.

Figs. 1 and 2 serve to illustrate the apparatus that was designed to meet these requirements. For the sake of brevity we shall call the electrode under observation the cathode, the other electrode through which the working current enters or leaves the liquid the anode, although there is no reason why our cathode should not be used as anode and *vice versâ*. Making use of these abbreviations, Fig. 1 shows the apparatus with the cathode at the top, that is for liquids that become specifically lighter during electrolysis. In Fig. 2 the cathode is at the bottom, as used for liquids that become specifically heavier during electrolysis. The positions of the anode are indicated in both figures by A. The current passes up the wide tube, B, and then enters the long straight tube, C, of about 1cm. bore. The cathode is approached through a hole, D, in the glass plate, D (as shown in Fig. 1). The E.M.F. between the cathode and the part of the electrolyte on the other

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side of the glass plate, D, is determined, a liquid connection being tapped off here through the annular space, E, and the tubes, F, to the non-polarisable standard electrode, G. We shall indicate by T the place in the electrolyte between the glass plate, D, and the tube, C, where the liquid connection is tapped off to the standard electrode. The E.M.F. actually measured on the potentiometer is that between the cathode and the standard electrode, and this is composed of the following parts: (1) the drop of E.M.F. due to polarisation between the cathode and the layer of liquid in contact with it; (2) the difference of potential between the cathode and T, calculated according to Ohm's law as the product of the resistance between the two and the current strength; (3) any small E.M.F. brought about by contact of the electrolyte examined with the decinormal potassium chloride solution of the standard electrode; (4) the constant E.M.F. of the standard electrode.

The first of these quantities is the one which it is desired to measure; the third was always assumed to be zero, as has been done by other investigators. The fourth may be taken, according to Ostwald and Wilsmore, to be 0·615 volts for the standard so-called decinormal electrode composed of mercury in contact with a decinormal solution of potassium chloride saturated with mercurous chloride. Being constant for all experiments, it need, however, not be taken into consideration. The second difference of potential mentioned may, as a rule, be calculated when the specific resistance of the electrolyte is known. It is better, however, actually to determine the resistance between the cathode and T during the course of an experiment, more especially when there is a possibility of an increase of resistance at the electrode, owing to the formation of badly conducting deposits, gas-bubbles, etc. The electrical method required for this purpose had to be devised in such a manner that no false connections should be introduced, and that it should at the same time be independent of the polarisation of the electrode. As far as I am aware, the only method suitable for this purpose is one described several years ago by Nernst and Haagn. It consists of a modification of the Wheatstone bridge method for alternating currents, two resistances being replaced by standard condensers, and rough condensers being interposed wherever a false connection would otherwise be made. Its application to the present case is shown diagrammatically in Fig. 3. The two resistances compared are the resistance from the anode to T, and the resistance from T to the cathode, plus a known variable resistance, m. These formed two arms of the Wheatstone bridge, the other two being the standard condensers, a and b (Fig. 3). A special box was made up for this determination containing capacities varying from one-thousandth of a microfarad to half a microfarad. In order to form the bridge containing the telephone between the junction of the two condensers and T, a second auxiliary electrode, P, is required in the liquid contained in the annular space, e (Fig. 1). It was found that an electrode of ordinary smooth platinum answered perfectly well for this purpose. The current for these measurements was derived from a small induction coil, a rough condenser being interposed between it and one of the junctions. The method of working consisted in giving the two standard condensers, a and b, suitable values, say 500 and 20 millemicrofarads, and finding the value, m_1, of the variable resistance, m_1, taken from a dial resistance box that produced a minimum in the telephone. The smaller of the two condensers, b—*i.e.*, the one on the anode side—was then altered to its r-fold value, 20 r millemicrofarads, the other condenser being left unaltered. The new resistance, m_2, was now determined, which produced a minimum in the telephone. The required resistance, x, from the cathode to T is then manifestly derived from the equation

$$\frac{x+m_1}{x+m_2}=\frac{1}{r},$$

its value being

$$x=\frac{m_2-r\,m_1}{r-1}.$$

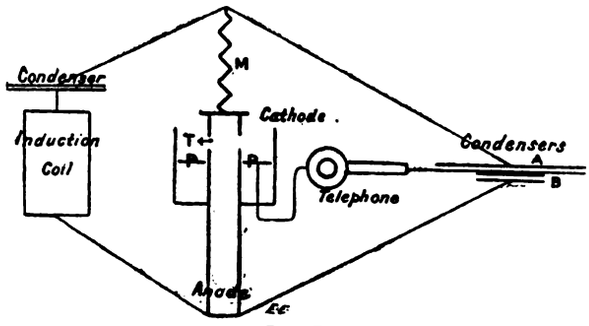

FIG. 3.

The following are details of the apparatus shown in Figs. 1 and 2 that must be specially referred to. The cathode and the glass plate it rests on are both ground perfectly flat. The latter is rectangular in shape, and the edges of the hole, d, drilled in it, are perfectly even and free from chips. The plate is put in position in such a manner that the hole, d, exactly forms the continuation of the tube, C; the way in which it is held on the flanged glass cylinder, h, and the electrode pressed against it by the specially designed clamp, K, will be understood from the Figs. 1 and 2, as also the manner in which electrical connection is made by means of thin copper foil bent round the rubber washer, w (Fig. 2). Practically no leakage took place between the electrode and the glass plate, even when no grease was employed to make a joint. Nevertheless, a small amount of liquid always

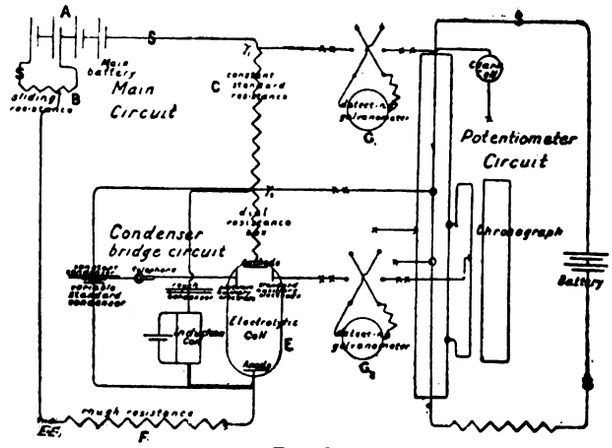

FIG. 4.

creeps up, and this seems to give rise to convection currents owing to evaporation, more especially when alcoholic solutions are employed. A very small amount of vaseline thickened with a little paraffin wax was therefore spread round the edge of the electrode before it was placed in position. In order to guard against its being accidentally moved backwards and forwards over the plate, which would have caused the grease to spread over its surface, a cardboard ring, c, was fixed on the glass plate by means of paraffin wax, and the electrode rotated inside this ring to place it in position. The electrode could easily be levelled both when used as in Fig. 1 and as in Fig. 2, by placing a small spirit-level on the glass plate (Fig. 2), the retort stand, to which the apparatus was attached, being fixed on a levelling stand. The tube, C, the end of which was bevelled, was fixed centrally in the flanged cylinder, H, and was held firmly in position with regard to the latter, not only by the rubber bung, L, but also by means of the two clamps, M and M_2 (Fig. 2), both of which are fastened to a common short rod, n. The clamp M_1 at the same time serves to support the apparatus on its retort stand. The tube, C, ends about ½mm. below the glass plate, thus allowing sufficient room for a liquid connection between the auxiliary electrodes and the liquid through which the working current is passing. The two auxiliary electrodes have already been referred to. The place where the junction between the electrolyte examined and the decinormal solution of KCl of the standard electrode is made, is indicated in both figures by J. The method of filling the tubes, P and O, and keeping the liquid in them by means of cotton-wool plugs before placing the tubes in position will need no further explanation.

Considerable difficulty was at first experienced in

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arranging the anode to satisfy condition (2). The method finally adopted consisted in the employment of electrodes of either copper or mercury, the electrolyte under examination being displaced in the vicinity of the electrode by a solution of metal salt which was run in slowly through the capillary tap funnel, U (Figs. 1 and 2). The displaced electrolyte was generally removed through the tube, W (Fig. 1). The anode solution, employed in conjunction with the copper electrode, when the electrolyte was an acid alcoholic solution, consisted of cuprous chloride dissolved in a mixture of alcohol and hydrochloric acid. When the electrolyte was an alkaline solution containing alcohol, and also in some experiments on alcoholic acid solutions, a mercury electrode was employed in contact with a solution of mercurous nitrate and a little nitric acid. As the latter, however, as a rule, produced a precipitate in contact with the electrolyte under examination, a solution of ammonium nitrate was interposed. The liquids in this case were run under the electrolyte in the following sequence: (1) ammonium nitrate solution; (2) mercurous nitrate solution; (3) mercury.

The requirement that the apparatus should allow several successive determinations to be performed without taking it to pieces was only met satisfactorily when the cathode was at the top, as in Fig. 1. For this purpose it was necessary to renew the liquid at the cathode by stirring, without at the same time causing anode solution to come into the cathode compartment. As will be seen from Fig. 1, the rubber tube, R, with screw clips, T T, and the glass side tube, S, were, therefore, introduced between the tubes, B and C. The method of using them was the following: When a determination was finished, the side tube, S, which was generally left open during the experiment, was closed, about five cubic centimetres of air being left in it. The standard electrode was then removed by undoing the connection at J, and a rubber stopper with a tap funnel introduced in its place. The screw clips, Y Y, were then closed. A considerable amount of electrolyte was thus forced out of the rubber tube, R, and was allowed to escape through one of the taps. The top part of the apparatus was then taken from the retort stand and moved up and down, the rubber tube, R, being used as a hinge. Air bubbles from the side tube, S, could thus be admitted to stir the liquid and afterwards be returned to the tube S. When it was necessary to leave the apparatus overnight, the anode solution was removed through the tube, u, of the tap funnel, U, being replaced by electrolyte run in through the funnel introduced at J. It was thus found possible to keep the cathode compartment perfectly free from anode solution, even when experiments were spread out over several days. The apparatus was also used for single experiments, without the rather troublesome arrangements allowing a repetition. For the purpose of filling the apparatus as illustrated in Fig. 1, both the funnels U and V must be employed, the top being inverted for filling the upper part through the funnel V. A vent-hole with tap (not shown in the figure) allows the air to escape through the bung, L. The last air bubbles are removed from the cathode through the side tube, S. When in use the apparatus was placed on a non-vibrating shelf.

The electrical arrangements are shown completely in Fig. 4. They comprise the main circuit, the condenser bridge circuit already explained, and the potentiometer circuit. The current was derived from a battery of small accumulators, A, and was kept perfectly constant by variation within suitable limits of the original E.M.F. employed as shown at B (Fig. 4). It passed through a known constant resistance, C, then through a dial box, provided for the purpose of introducing when required the resistance m referred to. As a rule this box was, however, kept free from resistance. After this the current passed through the electrolytic cell, E, and finally through a rough resistance, F, of about the same magnitude as the latter. For the purpose of determining the current strength and the cathode potential, the voltage between the ends, g and g_2, of the known resistance, C, and between g_2 and the standard auxiliary electrode, were measured on the same potentiometer circuit. The latter was composed primarily of a slide-wire with a variable back resistance. As several points of the potentiometer had to be tapped simultaneously during an experiment, a system of wires along which mercury-cups could be moved was arranged in parallel with the slide-wire, and the required potentials tapped off from these mercury-cups, the electrical position of the latter relative to points of the slide-wire being arranged by separate determinations before an experiment. The following manipulation and measurements were carried out during an experiment. The current was kept constant at a known value, the potentiometer regulated by occasional comparison with a Clark cell, and the resistance between the cathode and T measured now and again, as already explained. At the same time, the cathode potential had to be determined by measurement of the E.M.F. between g_2 and the standard auxiliary electrode, and the time had to be read. In order to facilitate the last two determinations a chronograph was designed, which contained a slide-wire that was shunted parallel to part of the potentiometer circuit. The slider on the latter was moved by hand, so as to balance the difference of potential to be measured. Its position, however, was automatically recorded on curve-paper moved past it by means of a drum rotated by clock-work.

With regard to the already explained measurement of the resistance from the cathode to T by means of the condenser bridge circuit, it must be pointed out, firstly, that a false connection is introduced unless the galvanometer, G, for measuring the current is thrown out of circuit during a determination; and, secondly, that the rough resistance, F, is required in the main circuit on account of this measurement in order to prevent the greater part of the current from the induction coil from finding its way through the battery instead of through the electrolytic cell. The resistance taken from the dial resistance box must be so small that its effect on the current during the fraction of a minute it is in circuit need not be considered. All the points of the various circuits that were ever interchanged were connected by special wires to a central switchboard of mercury-cups, on which all the connections were conveniently and rapidly made. All such points are indicated in the figure by x x, other switches being indicated by S.

Results obtained with Aqueous Solutions of Copper Sulphate, Silver Nitrate, and Zinc Sulphate.

The first series of experiments we have to refer to is one carried out with aqueous solutions of metal salts, the substances employed being solutions of copper sulphate, silver nitrate, and zinc sulphate. As long as metal salt is left in the layer of liquid touching the cathode, the metal is deposited from such solutions at a cathode potential, probably either identical with or differing only slightly from the potential at which it is in equilibrium with the solution of its salt. But when the salt has been removed from the electrode by the current, a sudden drop of the potential of the electrode takes place. A marked difference is, however, observed in this connection between solutions of copper sulphate and silver nitrate. In the case of the former the cathode potential drops about one volt, and then becomes fairly constant again. At the same time, the resistance of the layer of liquid around the cathode increases by about 175 ohms per square centimetre, the combined effect being that the difference of potential between the standard electrode and the cathode, as measured in the experiments, increases by 1·2 to 1·3 volts above its original value. The increase of resistance is found to be due to the formation of a deposit of copper hydroxide arising from hydrolysis of the copper sulphate at great dilutions. In the case of the silver nitrate, however, when depletion of the silver occurs, a drop of the potential of the cathode, amounting to only about 0·2 volt, takes place, after which the potential approaches its former value again more or less rapidly. The cathode is then found to have become covered with a mass of silver crystals, which grow into the solution. The curves in Fig. 5 show results obtained with a silver nitrate, and with a copper sulphate solution. As has been shown in the previous communication referred to, the diffusion coefficient of the salts experimented on may be calculated when the time is known which elapses until the concentration of the salt in the layer of liquid at the electrode becomes zero, and this time may be taken as that at which the break in the curve takes place. The actual points chosen on this

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break were five centivolts in the case of the silver nitrate, and 50 centivolts in the case of the copper sulphate solutions. The formula employed is:

$$k = \frac{1{\cdot}1284^2}{96{,}540^2} \frac{i^2 t n_a^2}{c^2}$$

k being the diffusion coefficient of the salt in $\frac{\text{cm.}^2}{\text{sec.}}$, when c is the concentration of the solution in $\frac{\text{mg.-equiv.}}{\text{cm.}^3}$, i the current strength in $\frac{\text{milamps.}}{\text{cm.}^2}$, t the time in seconds, and n_a the transport value of the anion. Details of the experiments and results are arranged in the following table.

by Nernst from the migration velocities of the $Ag^{\cdot}$ and the NO_3' ion, and which agrees with values extrapolated from Scheffer's determinations of diffusion coefficients. This fact seems to point to the break in the curve occurring before complete depletion of the silver at the electrode has taken place. The matter is, however, undergoing further investigation. See also remarks below regarding deposition potential of copper.

The numbers given in Table II. may be taken as typical results for the determination of the resistance of the copper sulphate solution between the cathode and the junction, T, described. The experiments 1, *a*, *b*, *c*, *d*, were carried out before the current passed through the solution; experiments 2, *a* and *b*, after the break in the potential of the cathode had taken place.

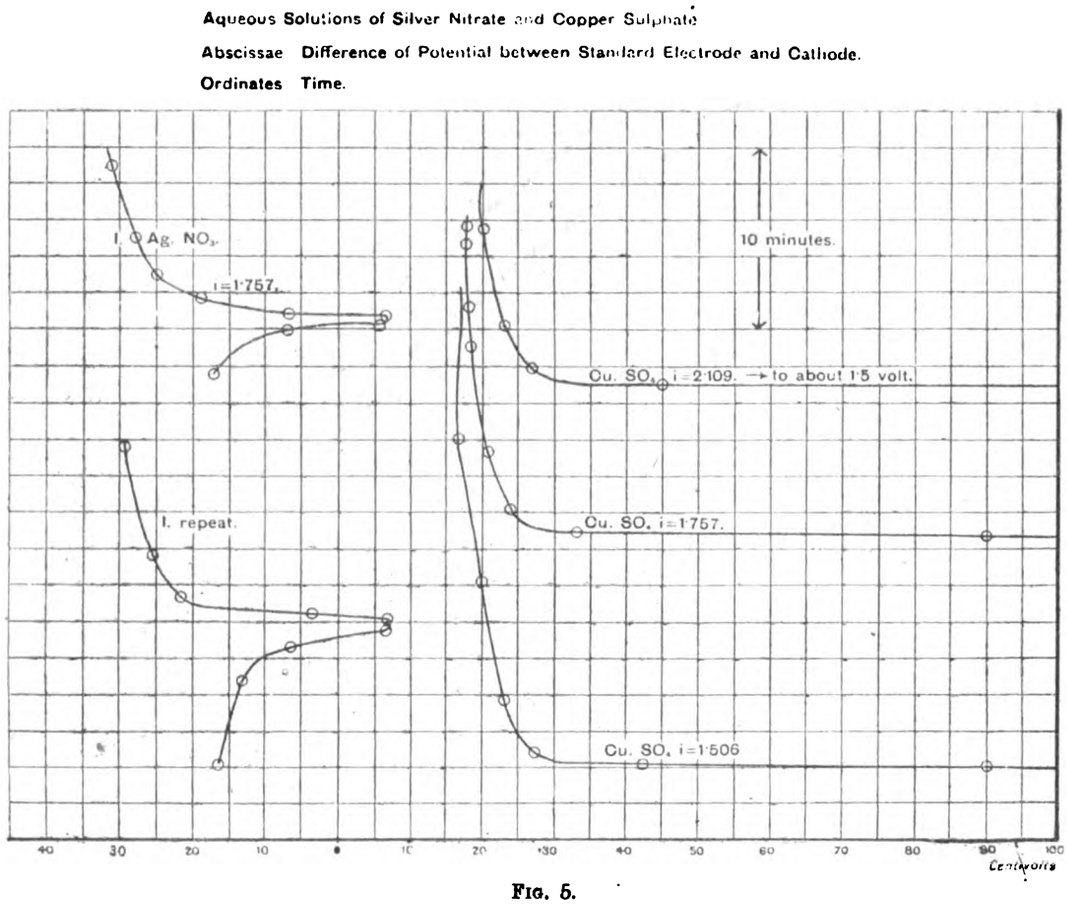

FIG. 5.

TABLE I.

A. Copper sulphate solution concentration 0·204 $\frac{\text{mg.-equiv.}}{\text{cc.}}$ Electrode—platinum-iridium of available surface 0·7589 square centimetre. $n_a = 0{\cdot}63$.

Current density in $\frac{\text{milamps.}}{\text{cm.}^2}$	Time in seconds.	Temperature T in degrees C.	Diffusion coefficient at T degrees in $\frac{\text{cm.}^2}{\text{sec.}}$	Diffusion coefficient at 18deg. by formula $k_{18} = \frac{k\tau}{1+0{\cdot}026\,(T-18)}$
2·109	790	15½	$4{\cdot}58 \times 10^{-6}$	$4{\cdot}86 \times 10^{-6}$
1·757	1,053	16	$4{\cdot}24 \times 10^{-6}$	$4{\cdot}45 \times 10^{-6}$
1·506	1,566	16	$4{\cdot}63 \times 10^{-6}$	$4{\cdot}86 \times 10^{-6}$
1·042	3,297	16¾	$4{\cdot}66 \times 10^{-6}$	$4{\cdot}81 \times 10^{-6}$

B. Silver nitrate solution concentration 0·1 $\frac{\text{mg.-equiv.}}{\text{cc.}}$. Electrode as above. $n_a = 0{\cdot}528$.

1·757	580	18½	$6{\cdot}82 \times 10^{-6}$	$6{\cdot}73 \times 10^{-6}$

According to Wiedeburg, the diffusion coefficient of $CuSO_4$ at 18deg. is $4{\cdot}479 \times 10^{-6}$ for the concentration 0, and $4{\cdot}226 \times 10^{-6}$ for the original concentration of the preceding table. The values in the table thus appear somewhat high. The value found for the diffusion coefficient of silver nitrate is very much too low if we take as correct the number $k_{18} = 12{\cdot}5 \times 10^{-6}$ $\frac{\text{cm.}^2}{\text{sec.}}$, which has been calculated

TABLE II.

No. of experiment.		Ratio of condensers.	Resistance in dial box.	Resistance calculated by the formula.
1	*a*	500 : 20	65	From 1^a and 1^b 77 ohms.
	b	: 40	207	
	c	: 50	278	From 1^a and 1^c 77 ohms.
	d	: 70	425	From 1^a and 1^d 79 ohms.
2	*a*	500 : 50	122	From 2^a and 2^b 218 ohms.
	b	: 100	462	

The potential of the cathode, after allowance had been made for the drop according to Ohm's law between the cathode and the junction, T, was, in the majority of experiments on copper sulphate solutions, found to lie about 10 to 20 millevolts below the potential of equilibrium. This matter, as well as the slight retrogression of potential at the beginning of the experiments which is visible in the copper sulphate curves (Fig. 5), similarly the conditions on which the crystallisation of the silver depends, is undergoing further investigation. Some of the results referred to, if corroborated, would lead to the conclusion that the deposition of metals from solutions like copper sulphate is not an absolutely reversible process, and this again would prove of importance in its bearing on the different nature of metal deposits obtained from different solutions. In a series of experiments on a decinormal zinc sulphate solution with an amalgamated copper electrode similar curves resulted to those obtained with the copper

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sulphate. Owing, no doubt, to the fact that hydrogen is evolved sometimes after all the zinc has been removed from the solution and sometimes before, according to slight differences in the nature of the electrode, the results were somewhat irregular, and have therefore not been reproduced as curves. The values obtained for the diffusion coefficient of zinc sulphate varied between $3{\cdot}5 \times 10^{-6}$ and $4{\cdot}5 \times 10^{-6} \frac{\text{cm.}^2}{\text{sec.}}$. They point to an increase of the diffusion coefficient of zinc sulphate at great dilutions, the value obtained by Weber for solutions of 2·114 per cent.—*i.e.*, 0·26 $\frac{\text{mg.-equiv.}}{\text{cc.}}$ being $2{\cdot}78 \times 10^{-6}$ $\frac{\text{cm.}^2}{\text{sec.}}$ In agreement with this we should expect the diffusion coefficient of zinc sulphate not to differ greatly from that of copper sulphate at great dilution, owing to the fact that the mobilities of the zinc and the copper ion are nearly equal at great dilution.

(To be continued.)

THE CHANGE OF THE SHIFT.

BY SIMPLEX.

Ho, greaser, say, where is the Shift Engineer?
The volts and the amperes are wandering free.
And bid thou the Driver at once to appear,
For no one regardeth the engines but me.
Yea, tell thou the Stoker his shovel to lift,
For fires must not fail at the change of the shift.

The Shift Engineer in the messroom doth lilt,
And steppeth a sword-dance 'mid poker and tongs.
He weareth his shirt in the place of a kilt,
And tyeth a sponge where the sporran belongs.
The Relief E.-in-C. to hysterics doth drift.
For laughter is free at the change of the shift.

The Driver is playing at thrippenny nap
And counteth his winnings with gurglish glee.
The head of the Stoker is under the tap;
The station is left unto Fortune and me.
Ha! Was it the smell of shellac that I whiffed?
Doth danger impend at the change of the shift?

Ah! Help! For the armature burneth apace!
The greaser in terror hath fled from the scene.
The lights are extinguished; the engine doth race,
And Hades hath come where sweet order hath been!
Vain, vain the excuses sad voices uplift.
There's gnashing of teeth at the change of the shift.

LONDON ELECTRICAL CONTRACTORS' ASSOCIATION.

The annual general meeting of the London Electrical Contractors' Association was held at Frascati's Restaurant on Monday last, Mr. E. L. Berry, the president, in the chair.

The PRESIDENT presented his report, which, among other things, dwelt on the forthcoming London County Council omnibus Bill, and urged all members to use their influence to the utmost to oppose the Bill. He spoke of the model specification and on the advantages of the workmen's certificates, and exhorted all members to continue their interest in the association, directing special attention to the manufacturers' agreement.

The retiring secretary, Mr. E. J. Hogan, was awarded a present of £50.

The following officers were elected: *chairman*—Mr. E. L. Berry; *vice-chairman*—Mr. W. Strode; *treasurer*—Mr. Wm. R. Rawlings; *secretary*—Mr. C. W. Charles; *committee*—Messrs. Phipps, Marryat, Lund, Ratcliffe, Trickett, Joseph, Messop, Troup, Woodward, Tate, Duncan Watson, Blackwood, Wardrop, Owen Smith, Seymour, and Soutar; *hon. solicitors*—Messrs. Turner and Co.; *auditors*—Messrs. Bowden, Smiles, and Co.; *delegates to Central Board*—Messrs. Berry, Lund, Phipps, and Strode.

Mr. R. TWEEDIE SMITH then addressed the meeting at some length, dealing with the apathy of the contractors, and urging all present to use every effort to prevent a system of Tammany in London.

Mr. BERRY then proposed: "That the Central Board be requested to immediately inaugurate strong opposition to the London County Council Bills which are detrimental to the rights of contractors, and that every member throughout the United Kingdom be requested to ensure the opposition of their parliamentary representative."

This was carried unanimously.

GREENOCK ELECTRICITY ACCOUNTS.

The accounts of the Greenock Corporation electricity department for the year ended June 30, 1904, show a total expenditure on capital account to that date of £86,174. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	4,781	10	0
Distribution of electricity	290	10	10
Repairs, etc., of public lamps	249	11	11
Rents, rates, and taxes	622	7	3
Management expenses, salaries, etc.	806	6	2
Special charges, insurance, etc.	48	12	9
*Tramways company for current supplied and taken credit for in previous years, but arbiter's award	1,427	3	6
*Arbitration expenses *re* above	753	2	7
	8,979	5	0
Balance carried to net revenue account	3,140	19	11
	£12,120	4	11

* The award given by the Board of Trade arbiter regarding the price of tramway energy applied to all energy supplied since the starting of the tramways in 1901, and as the electricity department had taken credit in the previous two years' accounts for the full price—viz., 1½d. per unit—the whole of the difference between this price and the ·7d. awarded by the arbiter is debited against this year's accounts, in addition to the law expenses. This accounts for the deficit of £2,111. On the year's working there is actually a net profit of £68.

Cr. Income.	£	s.	d.
By sale of current by meter	6,935	13	2
By public lighting	904	10	0
Rental of meters and other apparatus	14	13	9
Sale under contract to tramway company	4,018	16	7
Rents and maintenance of cableways	125	0	0
Installations	105	12	0
Miscellaneous receipts	15	19	5
	£12,120	4	11

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Balance due to Public Works Loan Commissioners	80,166	13	4
Sinking fund for repayment of loan	9,833	6	8
Accounts due	971	0	0
	£90,971	0	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	86,174	16	10
Stores on hand	1,049	14	0
Accounts due for current supplied	1,250	16	3
Due from tramway company for current supplied	381	11	9
Cash balance due by treasurer	2	2	0
Balance at debit of net revenue account	2,111	19	2
	£90,971	0	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,585,206
Quantity sold	Public lamps	71,120	1,413,783
	Tramways by contract	806,457	
	Private consumers by meter	536,206	
Quantity used on works			129,800
Total quantity accounted for			1,543,583
Quantity unaccounted for			41,623
Number of public lamps			53
Total maximum supply demanded (kilowatts)			79

APPOINTMENTS VACANT.

Assistant Engineer, Croydon electricity works. Commencing salary, £2 per week. Applications by Nov. 12. See advertisement.

Assistant Electrical Engineer, Oldham Corporation. Salary, £75. Applications by Nov. 14. See advertisement.

Senior Charge Engineer, £130 per annum; General Office Clerk, £78 per annum; Arc-Lamp Trimmers (2), £1. 10*s.* per week each, Acton Urban District Council. Applications by Nov. 10.

Station Superintendent, Chester Corporation. £130 per annum. Applications by Nov. 14.

Electrical Engineer, Battersea Borough Council, £400 per annum. Applications by Nov. 15.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE WILLESDEN CASE.

The supply of electricity over any area from a central station is attended with many difficulties, and it is to remove these that the Electric Lighting Acts have been passed. Our readers will remember that the provisions of the earliest Electric Lighting Act, while removing the bulk of the difficulties, imposed others which seriously hampered the electrical industry in the days when every encouragement was needed. The subsequent Electric Lighting Acts, by increasing the period for which powers were granted, again improved matters, but still left the local authorities a veto which has in certain cases retarded the development of electricity supply in smaller districts. Further modifications proposed in this year's Electric Lighting Bill would, if they had become law, have lessened the vetoing power of local authorities, but unfortunately this Bill was one of the massacred innocents. With all this legislation on the subject, we regret to say that even electrical engineers are frequently mistaken in their ideas as to the powers conveyed by electric lighting provisional orders. An example of this is to be seen in the action which was decided last week by Mr. Justice Farwell. In this action the Attorney-General, at the instance of the Willesden Urban District Council, sought and obtained a declaration that the Metropolitan Electric Supply Company had no power to supply energy within the urban district of Willesden. The facts of the case are that the company has works at Willesden from which electricity is transmitted in bulk to its London areas. These works are connected by sidings with the North-Western Railway, and the company at the end of last year commenced giving a supply of electricity to the railway company. This the judge decided was beyond the powers of the company, and an infringement of certain clauses in its Electric Lighting Acts which expressly forbid it to supply electricity outside the areas for which the necessary powers were granted. It was contended by the counsel for the company that the Act of 1898, under which the Willesden generating station was erected, was quite general, and conferred upon the company the power of supplying electricity in Willesden. The case is a most interesting one, and is, we are afraid, liable to be misunderstood by some. It clearly shows the difference between the rights of a private individual and those of a parliamentary company. For example, if the Metropolitan Electric Supply Company had bought the land at Willesden and selected their site in such a way that they could get from it a private wayleave from the station to their older works in London, there would have been no need to apply to Parliament for any powers. If, then, these large works had been erected by a separate company, they would, as we understand the law, have been able to supply electricity to the North-Western Railway Company, and to any other large consumer within the Willesden area whom they could reach by means of private wayleaves—*i.e.*, without crossing the public streets. Instead of this, the company were obliged to seek parliamentary powers, and to submit to parliamentary disabilities at the same time. The case is a most satisfactory one as far as the Willesden Council is concerned, but here again the protection is only against the action of a parliamentary company with powers to supply electrical energy. To illustrate our meaning we would refer to the Hampstead case, in which for years there has been competition between the Hampstead Corporation and the Hampstead Electric Supply Company, which is now known as the North-West London Electric Supply Company. This company has no powers from Parliament, but has succeeded in building up a considerable business amongst consumers which it reaches with private wayleaves only. From the above it will be seen

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that there is great similarity between an electric lighting provisional order and the ceremony of marriage. Both give special and exclusive rights, and both are subject to strict limitations.

FORTHCOMING EVENTS.

FRIDAY, NOV. 4.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., "Electric Railways," by Mr. F. O. Mills.

MONDAY, NOV. 7.

Society of Engineers.—General meeting.

TUESDAY, NOV. 8.

Crystal Palace Old Students' Society.—At 7.30 p.m., smoking concert at the Caxton Hall.

Royal Colonial Institute.—At 8 p.m., "The Rhodes Scholarship," by Dr. G. R. Parkin.

Institution of Civil Engineers.—At 8 p.m., "Coast Erosion," by Mr. A. E. Carey; and "Erosion on the Holderness Coast of Yorkshire," by Mr. E. R. Matthews.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., general meeting.

THURSDAY, NOV. 10.

Institution of Electrical Engineers.—At 8 p.m., inaugural address by the president.

FRIDAY, NOV. 11.

Electro-Harmonic Society.—At 8 p.m., concert (ladies' night).

Tramways and Light Railways Association.—Visit to London County Council's power station at Greenwich, etc.

Physical Society.—At 7.45 p.m., council meeting. At 8 p.m., "Investigation of the Variations of Magnetic Hysteresis with Frequency," by Prof. T. R. Lyle; "The Determination of the Mean Spherical Candle-Power of Incandescent and Arc Lamps," by Mr. G. B. Dyke; exhibition of physical apparatus by Mr. Robert Paul.

SATURDAY, NOV. 12.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to Messrs. Mather and Platt's works.

December—Annual dinner of the Institution of Electrical Engineers at the Hotel Cecil.

REGENERATIVE CONTROL.

A paper was presented on the 20th ult. by Mr. John J. Hall to the Tramways and Light Railways Association on the Raworth system of automatic regenerative control for electric traction. The meeting was held at the Society of Arts, with Mr. T. H. How in the chair. Mr. How, in introducing the subject, humorously remarked that we seemed to be approaching the accomplishment of perpetual motion.

An article dealing with the system will be found in our issue of July 29. After describing the regenerative motor, the shunt field, and line pressure, the paper discusses the question of current consumption. The average cost of current is put at 1½d. per car mile, ranging, however, up to as much as 3d. and 3·34d. in some instances. An average reduction in current consumption of 25 to 30 per cent. is claimed, and on very hilly tracks the economy is put at up to 50 per cent. These figures are based on the assumption that the current is measured on the cars. The author explains that the system does not claim to effect such economy when the consumption is measured on the station wattmeters, owing to the cable and distribution losses, leakage, etc. Reference is made to a trial described in our issue of July 29. In descending a gradient of 1 in 11, the energy returned, as shown by a Vulcan recording wattmeter, was 35·75 per cent. The paper claims that this figure fails to do full justice to the system, the instrument not reading correctly on the reverse or regenerative direction of rotation. The following table shows the result of the investigations made by the Brush Electrical Engineering Company into the operation of the system at Devonport. Records were taken on a recording wattmeter by Elliot Bros. The areas were taken of current consumed and regenerated. The results of their investigation show an over-all efficiency of 31·3 per cent. given in favour of regenerative control.

Route.	Watts consumed.	Ratio returned.	Per cent. returned
Mile House to Fore-street	4·570	·790	17·30
Fore-street to Mile House	4·560	1·955	42·80
Fore-street to Penny-come-Quick	3·095	1·825	58·90
Penny-come-Quick to Fore-street	5·612	·405	7·20
Penny-come-Quick to Camel's Head	11·153	1·780	15·95
Camel's Head to Penny-come-Quick	12·086	5·505	45·70
Average	6·846	2·043	31·30

In considering these particulars it has to be remembered that they are obtained from converted series-parallel motors, where the electrical losses are greater, the paper states, by probably 5 per cent. than would exist in motors specially designed for the regenerative system.

The paper gives the following relative costs of motors and currents: A pair of series-parallel motors of about 30 h.p. costs approximately £150. These operating 100 miles per day on hilly lines absorb on the average 1·5 units per car mile, or 150 units per day. For a year of, say, 300 days the consumption would be 45,000 units, which at an average cost of 1·5d. per unit would cost £281. 5s. At the end of 12 months those motors, with the cost of current added, would therefore amount to £431. 5s. A pair of regenerative motors for similar work would cost, say, £170. For this extra expense the motors can work all day long and do 40 per cent. more work, and at the same time save, say, 25 per cent. of energy required by the series-parallel system. Now 25 per cent. of £281 5s. = £70. 6s. 3d.; and £281. 10s. – £70. 6s. 3d. = £210. 18s. 9d; the regenerative motors costing, say, £170, the current costing, say, £210. 18s. 9d., makes a total of £380. 18s. 9d. Therefore, the series motor and 12 months' current cost £431. 5s.; the regenerative motor and 12 months' current cost £380. 18s. 9d.; showing a saving at end of 12 months of £50. 6s. 3d. as compared with the series-parallel system. The regenerative motors have been taken as costing £20 more than the series motors, "but we see that the makers of this class of motor use the same rated power machine for descending grades when using the electromagnetic brake, therefore there is no need to use a larger machine for regenerative work, so the saving of £50. 7s. 6d. on the first year's work can be increased to £70. 7s. 6d." The braking being effected principally by the motors, the life of the brake gear is greatly extended. Wheel blocks on level track, as a rule, last about six weeks; on hilly routes the life is reduced in some cases to as much as two weeks. In track brakes the shoes in some cases are renewed as often as once a day, and in some very hilly districts as often as twice daily All that involves the use of labour and materials. The life of the wheels is also extended in regenerative control. Where the brake gear is constantly being worn out the labour in the car-shed is correspondingly increased. On braking mechanism and car maintenance generally the author puts the economy roughly as follows: brake blocks and mechanism generally, saving per annum per car = £10; general car-shed labour and attendance = £5; wear and tear of cars, rewheeling, and trueing up = £10—making a total of £25.

In regard to generating plant, the author takes as an example of the saving in first cost a scheme of 100 cars requiring plant of 1,300 kw. capacity. The station, at £40 per kilowatt, would cost £52,000 on the series-parallel system—on the regenerative system the station could be reduced to 910 kw. capacity, securing an economy of £15,000. Further, it is possible to add to the rolling-stock by 30 per cent. without increasing the generating power.

The paper anticipates that in no branch of traction will regenerative control have so far-reaching effects as in railway operation, both for main-line and especially on metropolitan and suburban railways. The same benefits that are apparent in tramway operation will be obtained, but in a more marked degree, for where in this class of work only single cars are dealt with, the higher powers of railways will afford correspondingly greater economies.

The principle of regenerative control having been enlarged upon by Mr. J. S. RAWORTH, a discussion ensued, of which we give a summary.

Mr. H. W. SAYERS, referring to the tests carried out at Devonport, thought that it would be instructive to have more particulars, and remarked that the resistance in the

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regenerative system appeared somewhat abnormal—of the order of 300 ohms. He thought that the lack of accelerating power, as compared with the S.P. motor, was a serious handicap. In regard to heating of the motors, while conceding that the tests generally applied to the S.P. motor were merely conventional, it appeared quite clear that the shunt motor was not capable of operating at full load as long as its rival. Consequently, it would either do less work or wear out quicker, signifying increased maintenance costs. The promised saving in power to the extent of 25 per cent., representing little more than ¼d., or possibly ½d., per car mile, might soon be absorbed in higher repair and maintenance charges.

Mr. S. SHARP observed that in the Devonport trials the quantity of energy returned showed a wide range, but taking the routes in pairs a pretty uniform mean resulted—30 to 33 per cent.—under similar conditions in regard to grade. Respecting the heating of the motors, he imagined that if Mr. Raworth were having a shunt motor specially constructed, instead of converting an S.P. motor, the windings would be arranged to obviate abnormal heating.

Mr. W. M. MORDEY, after recalling the fact that Sir Wm. Siemens had dealt with this difficult problem over 20 years ago, stated that the figure given in the paper for current consumption was rather overestimated. Taking the average of a number of lines, the consumption worked out at about 1¼ units per car mile. Under certain conditions there was a possibility of saving about 20 per cent. by the use of regenerative control. The system would be much easier of application to alternating currents, but these were not likely to be employed for tramways in the lifetime of the present generation of engineers.

Mr. HUMPHRIES, of the Thanet Light Railway, questioned whether a reduction of current consumption would mean a proportionate saving in the generating plant, as stated by the author. He was not convinced that the slower speed of the shunt motor uphill was compensated by greater speed on the decline, because with the S.P. motor you simply had to work the regulator. Even assuming that a higher speed was obtainable, it was not of much use when the Board of Trade interposed with a limit. Then in regard to the greater safety claimed for the shunt motor in descending hills, he did not think this was demonstrated in the paper.

Mr. HOW, the chairman, then delivered some observations. He thought there was a general disposition to regard the subject favourably, but further demonstration of the advantages claimed would be welcome. Traversing the author's figures for current consumption and charges, he joined with other speakers in considering these somewhat overstated, as also the outlay for S.P. motors. With regard to the economy in current consumption, how was this to be measured? He was not quite sure that we had yet obtained a thoroughly reliable instrument for car service. There were several excellent wattmeters, but he doubted their reliability for tests of high efficiency. Further, the skill and care exercised by the driver was an important factor. Acceleration was not of so much account with tramways, but it would be of the greatest moment with railways. Maintenance promised to be high. Even, however, if the net saving through regenerative control amounted to but half that stated in the paper, he thought it would be admitted that the system was worthy of further consideration.

Mr. RAWORTH admitted that the acceleration achieved under regenerative control was not equal to that of the S.P. motor under all conditions, but in many cases it was quite as good. He emphasised the fact that so far demonstrations had been made only on rewound existing motors. Notwithstanding this, cars driven by regenerative control had always kept schedule time. He gave figures in support of the estimate for power costs. At Southport it cost the Corporation 1·1d. per car mile for energy, while the company, using regenerative control, only stood at an outlay of ·56d.

Mr. HALL, replying, stated that the economy in current consumption was based upon actual tests under service conditions. In regard to sparking, so long as the operating current was kept within 3 per cent. of the armature current the commutation was quite satisfactory. On the question of maintenance, he referred to a letter from Mr. J. Lloyd, manager of the Southport Tramways, which states: "With reference to Demi-car, our experience of the regenerative control is that we have less trouble with it than with any of the S P. cars. The driver himself takes charge of the controller, which takes him about 15 minutes each morning. The shed men examine the under gear each night to screw up any loose bolts; they do not find one a week loose. With the S.P. cars we have one man to clean the controllers each night. We have 13 cars on the road every day, and they take him about 20 minutes to each car. The wheels on the Demi-car have run in service 8,000 miles and 2,000 miles for testing purposes. When the wheels were first put under they were 30in. in diameter, now they are $29\frac{15}{16}$th. The pinions and gear wheels show no signs of wear at all. The commutators show about $\frac{1}{64}$th, and that was made mostly in the extensive trials originally made." Mr. Hall concluded by claiming that when the reduced expense in the general upkeep of the car is added to the decreased current consumption, a substantial economy in favour of regenerative control is shown.

A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITIES OF GAS-TURBINES.*

BY MR. R. M. NEILSON, ASSOCIATE MEMBER.

(Continued from page 636.)

CYCLE I., CASE 4.

It will be interesting to find what efficiency can be obtained with a maximum temperature of 2,000deg. C. by increasing the compression till the ratio of negative work to gross work is 0·4—the same as in Case 1. This ratio will be attained when $t_c = 909$ absolute C., which corresponds to a pressure of 818lb. absolute. Then

$$E = \frac{909 - 290}{909} = 0{\cdot}68.$$

The pressure-volume and entropy-temperature diagrams for this case are given in Figs. 9 and 10. The line B C is shown in dotted lines on Fig. 10 to allow Case 4 to be compared with Case 1. The sharp corner at M would likely be rounded off in practice. This would reduce the efficiency slightly. It would also, however, reduce the maximum temperature, and for this reason it might be advantageous in some cases to round off the corner intentionally.

In every case it has been assumed that the compression is adiabatic; it is usually important that it should be at least nearly so. If, for example, in Figs. 1 and 2, the compression instead of being along the adiabatic A B had been along the line A B_1, which is below the adiabatic line—that is, if heat had been allowed to escape during the compression—the heat absorbed by the fluid for the same value of T would have been increased by the area $b_1 B_1 B a$ in Fig. 2, while the heat converted into work would have been increased only by the relatively small area, A B_1 B. E would, therefore, have been reduced. If, on the other hand, the compression had been along the line A B_2, which is above the adiabatic—that is, if heat had been put into the fluid during compression—the heat absorbed and the heat converted into work would both have been reduced by the same amount—namely, the area A B B_2. E would, therefore, obviously be reduced in this case also, assuming that the heat put into the fluid during compression is obtained by the combustion of fuel. If, however, the heat put into the fluid during compression is obtained for nothing—if, for example, it is heat that would otherwise be radiated away or carried away by convection—the effect on E is not obvious.

A compression along the line A B_2 (Figs. 1 and 2) will give a higher value to E than a compression along the line A B if the heat absorbed during the compression A B_2 is got for nothing, and if the two cases are otherwise the same; but a compression along the line A B_2 produces a higher ratio of negative work to gross work. This will be clear from Fig. 1. Now, with this ratio of negative work to gross work a still higher efficiency could be obtained by

* Paper read before the Institution of Mechanical Engineers.

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keeping the compression adiabatic and continuing it further. A hot compression, such as along the line $A B_2$ when the heat is got for nothing, may be advantageous in a few cases—viz., when T_1 is low compared with t_c; but generally such a compression will be harmful. It is in general disadvantageous to heat the air or fuel before compression, no matter what be the source of heat.

If gas is allowed to enter a water-cooled turbine at a high temperature, such as 2,000deg. C., there will necessarily be a great amount of heat carried away by the water. In a reciprocating engine the metal surface with which the gas comes into contact is very small compared with that in a multiple-expansion turbine, and in a reciprocating engine the bulk of the gas may expand and fall from its maximum temperature to the temperature at exhaust without ever coming near a metal surface. In a multiple-expansion turbine, on the other hand, every particle of gas must practically slide along a metal surface immediately it comes to the first ring of blades. With turbines employing gas which enters the turbine casing at such a temperature, the heat lost through the walls and

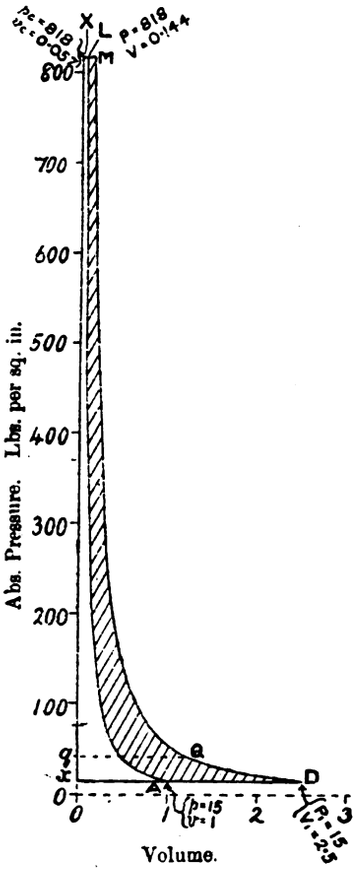

FIG. 9.—Cycle I., Case 4. Pressure-Volume Diagram.

carried away by the water must necessarily be very great indeed. It is true that the metal surface in contact with the gas can be allowed to be at a much higher temperature than the inside of the cylinder walls of a reciprocating engine; but, in spite of this, the heat lost through the walls and carried away by the cooling water (or other cooling medium) will probably be much greater with a turbine actuated by gas entering the turbine casing at about 2,000deg. C. than in a reciprocating engine in which the maximum temperature is 2,000deg. C. This loss of heat will cause the actual work done by the engine to be very much below the ideal. This is not only important in itself, but, as will be explained later on, it prevents us usefully employing a high ratio of negative work to gross work. The question of utilising this lost heat will be discussed later on.

CYCLE I., CASE 3A.

Instead of employing cooling arrangements for the metal, some or all of the available heat energy of the gas can be converted into kinetic energy before causing it to act on the turbine, so that the latter is not exposed to an unduly high temperature. This can be done by allowing the gas when at the maximum temperature to expand in a divergent nozzle till its temperature falls to a degree that the turbine can stand. More than one nozzle can be employed, but to reduce the radiation losses the nozzles should be large and few in number. Suppose that the gas is compressed adiabatically to 300lb. absolute, and then is heated at constant pressure to a temperature of 2,273deg. absolute C., as in Case 3. If now the gas be allowed to expand in a suitable nozzle, adiabatic expansion can be obtained, and if this be continued till the pressure falls to 15lb. absolute, the temperature will be 966 absolute C. (693deg. C.). This is just below the temperature which was fixed on as a maximum for a turbine without artificial cooling. The entropy-temperature diagram will be the same as in Case 3 (Fig. 8), and E will therefore be the same—namely, 0 58 The ratio of negative work to gross work will also be the same as in Case 3—namely, 0·3.

Referring to the pressure-volume diagram for Cycle I., Case 3 (Fig. 7), the area z Z H K represents the kinetic energy of the gas leaving the nozzle, which kinetic energy equals 33,840 foot-pounds. This is for a quantity of gas that measures one cubic foot at A. The velocity is 5,290ft. per second. It may be advantageous to mention for the sake of comparison the velocities of the steam jets employed in De Laval steam-turbines. If saturated steam at 50lb. absolute pressure is expanded adiabatically to a pressure of 0·6lb. absolute, which corresponds to a temperature of 85deg. F., and its heat energy turned into

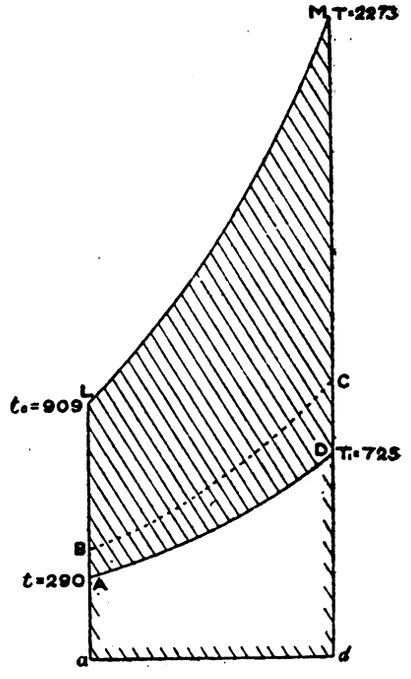

FIG. 10.—Cycle I, Case 4. Entropy-Temperature Diagram.

kinetic energy, the velocity acquired works out at 3,690ft. per second. If saturated steam at 300lb. absolute pressure were treated similarly, the velocity would be 4,380ft. per second. The velocities actually obtained in practice must be somewhat less than these figures, owing to friction in the nozzles.

To get the best results from a fluid velocity such as 5 290ft. per second would require, with a single turbine wheel, a vane speed which cannot be obtained at present for want of a sufficiently strong and light material—the stresses produced by centrifugal force are too great. This difficulty is experienced with De Laval turbines. The obvious way out of the difficulty is to employ several wheels in series, the gas passing through the several wheels with diminishing velocity, but with nearly constant pressure. This has been done in steam-turbines. With the same object of reducing the vane speed, a device has been proposed whereby the nozzles are mounted on a wheel which rotates in the opposite direction to the wheel carrying the vanes. If the two wheels rotate at the same speed (in opposite directions) this speed will be half of that of the single wheel if the nozzles were stationary. The centrifugal force is therefore only one-fourth of what

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it would otherwise be. The frictional losses in the nozzles of a gas-turbine will probably be less than those in a steam-turbine for the same velocity of exit from the nozzle.

Cycle I., Case 4A.

Let us now try working to the same entropy-temperature diagram as in Case 4 (Fig. 10), but employing a divergent nozzle, as in Case 3A, to reduce the maximum temperature to 700deg. C, so that the gas can be used in a turbine without cooling arrangements. T_1 in this case will be 723deg. absolute C. (452deg. C.). It is not necessary, therefore, to perform all the adiabatic expansion in a divergent nozzle, but a portion of it can be performed in the turbine. If the fluid is expanded in the nozzle only till its temperature falls to 700deg. C., the pressure will then be 42lb. absolute; so that 27lb. can be dropped in the turbine

Referring to the pressure-volume diagram for Cycle I., Case 4 (Fig. 9) the line q Q is drawn to represent the pressure at which the gas leaves the nozzle. The kinetic energy of the gas leaving the nozzle is represented by the area X M Q q. This we can find amounts to 33,660 foot-pounds (for one cubic foot of gas measured at A), and the velocity works out at 5,280ft. per second. E will be the same as in Case 4, and so will the ratio of negative work to gross work. It seems to the author that an engine working on this cycle, according to Case 3A or Case 4A or between these, has good prospects. The ideal efficiency is high, from 0·58 to 0·68. How near one could approach this efficiency in practice would depend, of course, both on the losses in the motor proper and on the losses in the pump.

The losses in the motor proper may be taken to include the losses in the combustion chamber if such is employed and in the nozzles. The motor losses will then consist of (1) loss of heat by radiation and conduction; (2) fluid friction; (3) friction in turbine bearings; (4) loss due to incomplete expansion. The first loss will be large, but should be less than in reciprocating engines, owing to the higher velocities employed and to the higher temperatures allowable in the metal. The second loss will be considerable, but much less than in turbines using saturated steam. It has been found by experiment that hot dry air causes much less friction than wet steam. (The steam is always wet in a De Laval turbine casing, unless it enters the nozzles with a large amount of superheat.) The third loss will be trifling, and the fourth loss should be moderate. The discharge of heat with the exhaust gases is here only considered as a loss in so far as it exceeds that of an ideal engine.

It is difficult to estimate the pump losses. Rotary compressors on the turbine principle seem to have been employed only up to about 80lb. pressure. Whether or not they are suitable for high pressures is a point which we want very badly to know about. One would be inclined to believe that the fluid frictional losses with such machines would be very great if attempts were made to obtain high pressures. It by no means follows, however, that a fairly efficient rotary air-compressor cannot be devised. A reciprocating compressor always has the disadvantage that the air when drawn in becomes heated by contact with the hot metal surfaces before compression commences. This evil is reduced by compounding. It is an evil that occurs to a serious extent with reciprocating gas-engines working on the Otto cycle With a reciprocating compressor it will be difficult to avoid the necessity of jacketing the cylinder if high compressions are employed. This will bring the compression curve below the adiabatic and reduce the efficiency, as before explained. In any case, whatever be the nature of the pump, there is bound to be a certain amount of heat passed through the walls of the pump cylinders or casing. If this loss is made up by friction or impact within the pump, the compression may be along an adiabatic curve, but the loss will still have to be paid for.

The ratio of negative work to gross work is somewhat high—0·3 to 0·4. In the case of a turbine one need not fear the increase in the bulk of the engine due to this high ratio, for the bulk of the turbine will probably be very small for the power. Frictional and other losses become, however, of much greater importance when the ratio is high. To show this forcibly, consider an extreme case. Suppose that the ratio of negative work to gross work in an ideal engine is 0·5, or, in simpler language, suppose that the pump requires half the gross power of the machine, there being no friction. If, now, the machine is not ideal, and if the mechanical efficiency of the pump is only two-thirds, and that of the motor proper only three-quarters, no useful work whatever will be got out of the machine—all the work will be absorbed by friction. For if the power of the motor proper, including that spent on friction, is 100, the pump will require 50, and as its efficiency is two-thirds, it will take 75. This is exactly what the motor will give out after deducting friction. There will therefore be no power got out of the machine.

When there is a high ratio of negative work to gross work, success will therefore be dependent largely on the efficiency of the pump. Unless the pump is at least fairly efficient, success cannot be expected. In the Diesel engine the bulk of the air is compressed to about 500lb. per square inch, and the air which carries the oil into the cylinder is compressed from 100lb. to 200lb higher.* It would be interesting to know with what efficiency the air is compressed in the Diesel engine.

Otto cycle reciprocating engines having ideal efficiencies of 0·4 to 0·45 have given practical efficiencies of half that amount. By practical efficiency is meant ratio of brake horse-power to thermal units in gas consumed, calculated on the higher calorific value. When the ideal efficiency is increased above 0·45 the ratio of practical efficiency to ideal efficiency usually falls below 0·5—the greater the ideal efficiency the greater are the losses. With a turbine the losses ought also to increase when the ideal efficiency is increased, but whether to the same extent as with an Otto engine it is difficult to say. When considering high compressions it is well to note that the Diesel engine with a high compression and an incomplete expansion has given some of the highest practical efficiencies yet attained. The compression should not cause the same trouble in starting a turbine as in starting a reciprocating engine, as with a turbine we should be able to arrange that at every instant the gross work is greater than the negative work. With a reciprocating engine having a single cylinder working on the Otto cycle we have, of course, periods when the negative work exceeds the gross work.

Cycle II., Case 1.

With regard to explosion turbine engines, suppose that the fluid is compressed adiabatically to, say, 101lb. per square inch absolute—that is, to a temperature of 500deg. absolute C. Let it now be heated at constant volume by explosion, and let there be a mixture of such a strength that the temperature will rise to 2,000deg. C. (2,273deg. absolute C.). The pressure will then be 459lb. absolute. If the gas is now allowed to expand adiabatically till its pressure is atmospheric (when its temperature will be 855deg. absolute C.), and then cooled at that pressure till it resumes its original state, the pressure-volume and entropy-temperature diagrams will be as shown in Figs. 11 and 12. In Fig 12 the heat supplied to the fluid is represented by the area a R T s, the heat rejected by the area a A S s, and the heat converted into work by the area A R T S.

$$E \times \frac{\text{area A R T S}}{\text{area } a \text{ R T } s} = 0{\cdot}55.$$

The negative work can be compared with the gross work in Fig. 11. The ratio of negative work to gross work $= \frac{\text{area } v \text{ V R A}}{\text{area } v \text{ V R T S}} = 0{\cdot}23$. Cycle II., Case 1, very nearly resembles common practice to-day with reciprocating explosion engines. The expansion is, however, continued to atmospheric pressure. This, as a rule, is not desirable in a reciprocating engine on account of the extra length required to be given to the engine cylinder. This not only increases the loss by friction, but increases the loss of heat by the expanding gas, and if the same length of stroke is employed for drawing in the fresh charge, increases the heating of the charge before compression. The case, however, is very different with turbines, and there seems

* "The Diesel Engine," by H. Ade Clark. Paper read before the Institution of Mechanical Engineers at Leeds in July, 1903, p. 395.

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no good reason why with these the adiabatic expansion should not be carried practically to atmospheric pressure. In practice the maximum pressure and the average maximum temperature throughout the gas would be less than the values here indicated owing to radiation losses.

Cycle II., Case 1A.

The gas could not be allowed into an uncooled turbine at the maximum temperature in Cycle II., Case 1; but if the expansion were performed wholly or nearly wholly in a divergent nozzle, the temperature of exit from the nozzle

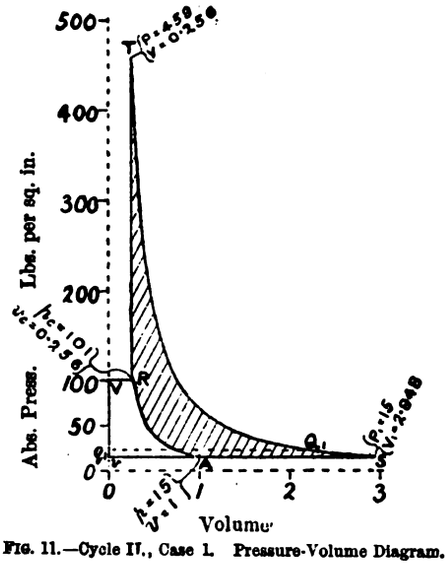

Fig. 11.—Cycle II., Case 1. Pressure-Volume Diagram.

would be sufficiently low to allow of the gas entering an uncooled turbine. For example, if the gas at the maximum temperature of 2,273deg. absolute C. and the maximum pressure of 459lb. absolute were expanded in a perfect divergent nozzle till the temperature fell to 700deg. C. (973deg. absolute C.), which was fixed on as the maximum allowable temperature in an uncooled turbine, the mean pressure on leaving the nozzle would be 23·5lb absolute.

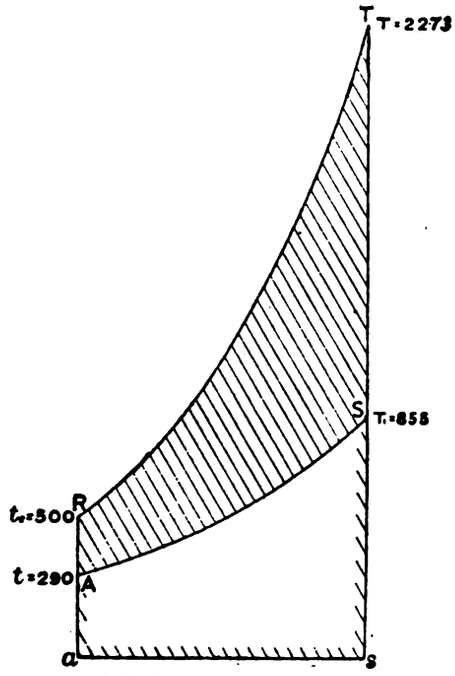

Fig. 12.—Cycle II., Case 1. Entropy-Temperature Diagram.

The kinetic energy of the gas (one cubic foot at A) on leaving the nozzle would be represented by the area V R T Q_1 q_1 in Fig. 11, and would amount to 20,500 foot-pounds. The mean velocity (the square root of the mean square) would be 4,120ft. per second. On comparing Cases 1 and 1A of Cycle II by reference to the table with Cases 2, 3, 3A, 4, and 4A of Cycle I., which have the same maximum temperature, it is found that the efficiency is very much greater than Cycle I., Case 2, is nearly as great as Cycle I., Cases 3 and 3A, and is considerably below Cycle I., Cases 4 and 4A. The ratio of negative work to gross work is, however, greater than in Cycle I., Case 2, and less than in Cases 3, 3A, 4, and 4A of Cycle I.

There are two objections to the user of turbines of a cycle such as Cycle II., and these objections must be set against the advantage which turbines would possess over reciprocating explosion motors in being able to make better use of the tail end of the pressure volume diagram. One of the objections is that explosions at constant volume have to take place intermittently, while a turbine desires a continuous supply of fluid. If the supply is not continuous, the power of the turbine is less than it would otherwise be for a given size of machine, and the initial cost, the bulk, and—most important—the loss by friction are greater in proportion to the power developed than they would otherwise be. The other objection is that the fluid must leave the explosion chamber at varying pressure. This necessitates, unless special means are provided to prevent it, the fluid entering the turbine casing either at varying pressure or at varying velocity. This, of course, is objectionable, as the speed of rotation of the turbine cannot during the period of a cycle be made to vary correspondingly.

The second objection might be met by employing in a parallel-flow turbine of the De Laval type long radial blades, and causing the nozzles to be altered in position according to the pressure, so as to direct the gas on to the outer ends of the blades at high pressures and on to the inner ends of the blades at low pressures. The difficulty could also be met by an arrangement of reciprocating engine combined with a turbine, the gas being first expanded in the reciprocating engine to a certain pressure and then passed on to the turbine to complete its expansion. If several reciprocating cylinders were employed, the first objection also would be got over. It is true that with such a combination some of the most important advantages of the turbine would be lost. The idea is, however, in the author's opinion, worthy of consideration. Reciprocating steam-engines have been successfully combined with steam-turbines in this manner.*

Cycle II., Case 2.

An explosion engine in which a very high compression pressure is employed will now be considered. If compression be carried to 818lb. absolute as in Cycle I., Case 4, one obtains with a maximum temperature of 2,000deg. C. a maximum pressure of 2,045lb. absolute, and a very high ratio of negative work to gross work. If a much lower compression—namely, 417lb. absolute—is adopted, this will give a temperature of compression of 750deg. absolute C. Working on the same cycle as in the last case, and arranging the explosive mixture to give a maximum temperature of 2,000deg. C. (2,273deg. absolute C.), a maximum pressure of 1,265lb. absolute is obtained, and the pressure-volume and entropy-temperature diagrams will be as shown in Figs. 13 and 14. Referring to Fig. 14,

$$E = \frac{\text{area A U W W}_1}{\text{area } a\,\text{U W } w} = 0{\cdot}68.$$

Referring to Fig. 13,

$$\frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area } u_1\,U_1\,U\,A}{\text{area } u_1\,U_1\,U\,W\,W_1} = 0\,38.$$

E is the same as in Cycle I., Case 4, and the ratio of negative work to gross work is also the same. The compression is lower than in Cycle I., Case 4, but the maximum pressure is very much higher. The excessively high maximum pressure is an objection to this case.

Cycle II., Case 2A.

If the expansion took place in an ideal divergent nozzle, as before, till the temperature fell to 700deg. C. (973deg. absolute C.), the gas would still have a pressure of 70lb. absolute, while the mean velocity of exit from the nozzle would be 4,300ft. per second. If the gas were expanded in the nozzle down to 25lb. absolute, the temperature would then be 741 absolute C., and the mean velocity of the gas leaving the nozzle would be 4,830ft. per second.

* See paper by Prof. Ratean read before the North of England Institute of Mining and Mechanical Engineers at Newcastle-on-Tyne, Dec. 13, 1902; or paper by the same author read at the Chicago meeting of the Inst. of Mech. Engineers, 1904.

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Cycle III., Case 1.

It has been proposed, when a water jacket is employed, to utilise the heat passed into the jacket water by causing this heat to generate steam from this water. This steam could then receive further heat from the products of combustion, which would therefore be reduced in temperature, while the steam would be superheated. The steam and products of combustion could then expand adiabatically, doing work in the same or in separate turbines. The carrying out of this idea would affect the efficiency in the several cases considered of Cycle I. Cooling arrangements are not required in Cycle I., Case 1, so this case need not be further considered. In Cycle I., Case 2, let it be supposed that the combustion chamber is jacketed, and that the

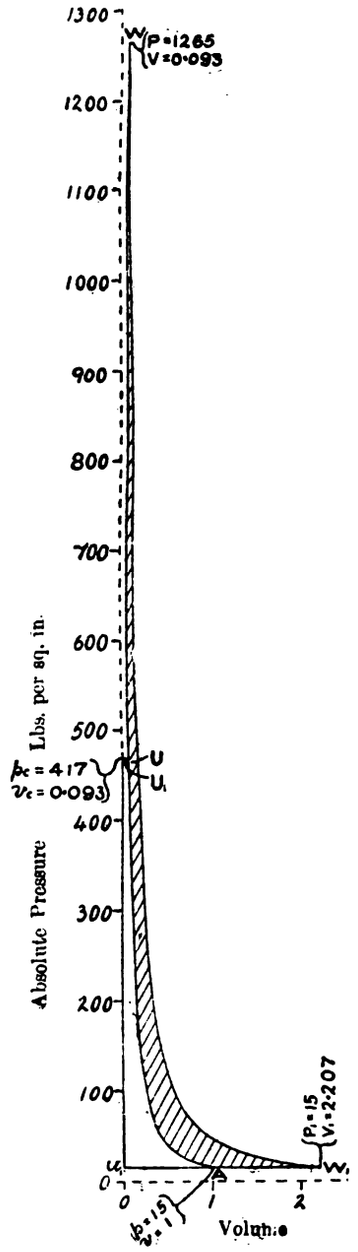

Fig. 13.—Cycle II., Case 2. Pressure-Volume Diagram.

jacket water is heated and converted into steam by heat taken from the products of combustion, which have their temperature thus lowered from 2,000deg. C. to 700deg. C.—that is, to the temperature at which they can safely be allowed into an uncooled turbine, the steam being superheated up to 700deg. C. Let this be called Cycle III., Case 1.

Referring to Fig. 6, the heat in the products of combustion which is converted into work is now represented by the area A B C D instead of by the area A B E F. The heat represented by the area *d* C E *f* has, however, been employed in heating water and generating and superheating steam. The fraction of this heat which is converted into work will not now be as great as in the original scheme of working. That is to say, the net work got out of the heat put into the water and steam will be less than the area D C E F. By transferring heat to the water and steam from the gas, E is, therefore, reduced. There must, however, in any case, as already mentioned, be lost in practice a large amount of heat from the products of combustion when these products of combustion enter the turbine casing at a temperature such as 2,000deg. C., and, by adopting this combined steam and gas scheme, a much

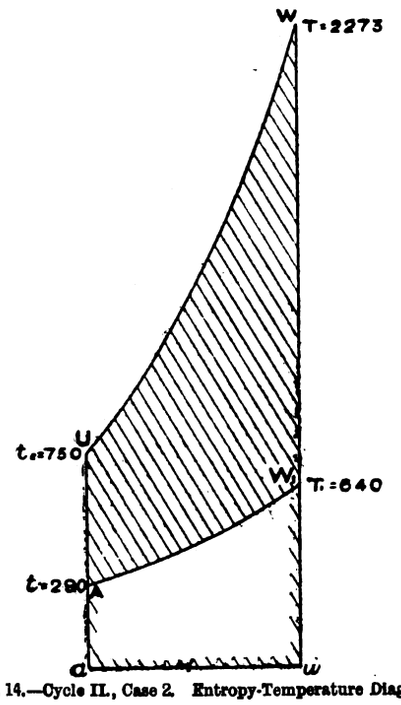

Fig. 14.—Cycle II., Case 2. Entropy-Temperature Diagram.

higher practical efficiency may possibly be obtained than would otherwise be possible. As the net work ideally is less than in Cycle I., Case 2, and as the negative work is not less (and may be greater by the amount of work required to pump the water into the jacket if under pressure), the ratio of negative work to gross work is increased. In Case 2 of Cycle I., the ratio of negative work to gross work is low, and it will be, therefore, allowable to increase this ratio.

Cycle III., Case 2.

Case 3 of Cycle I. could be modified in the same way by reducing the temperature of the products of combustion from 2,000deg. C. to 700deg. C., and by employing the heat so given up in heating water and generating and superheating steam. The steam could be generated at 300lb. pressure absolute (the same pressure as the products of combustion) and superheated to 700deg. C. at this

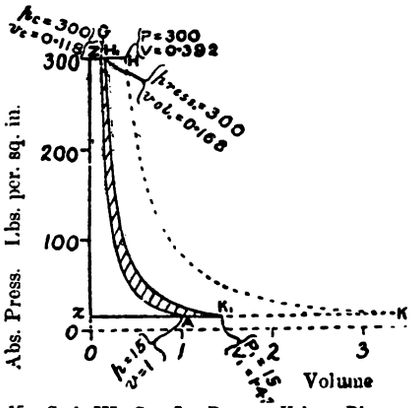

Fig. 15.—Cycle III., Case 2. Pressure-Volume Diagram—Gas.

pressure. The steam and gas could then be expanded adiabatically in the same or in separate turbines. As in the previous case, E would be reduced, and the ratio of negative work to gross work increased. As in the previous case also, the practical efficiency might be largely increased.

The pressure-volume and entropy-temperature diagrams for the gas in this case (called Cycle III., Case 2) are shown in Figs. 15 and 16 respectively. The gas is compressed along the line A G as in Cycle I., Case 3,

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till its pressure is 300lb. absolute, and its temperature is 409·5deg. C. (682 5deg. absolute C.). It is then heated by combustion at constant pressure along the line G H as in Cycle I., Case 3, till its temperature is 2,000deg. C. (2,273deg. absolute C.). Heat is now withdrawn from the

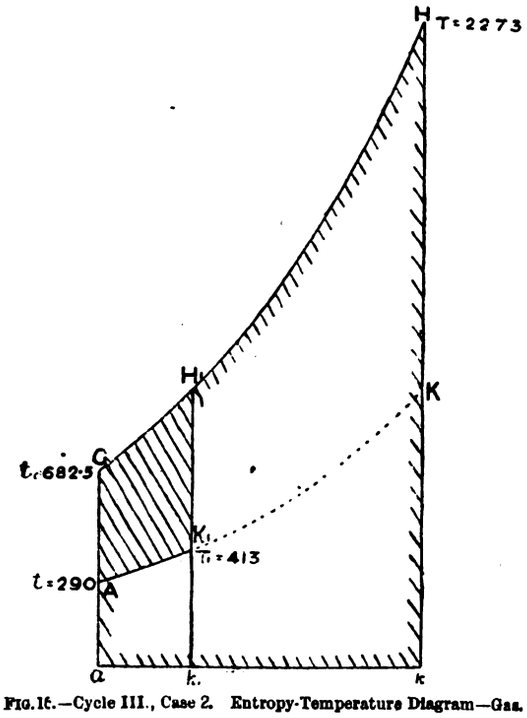

FIG. 16.—Cycle III., Case 2. Entropy-Temperature Diagram—Gas.

gas at constant pressure and transferred to the water and steam, the temperature of the gas falling along the line H H_1 to 700deg. C. (973deg. absolute C.) at H_1. The heat transferred from the gas to the water is represented (Fig. 16) by the area k_1 H_1 H k. The gas now expands adiabatically along the line H_1 K_1 till the pressure is 15lb. absolute, when the temperature will be 140deg. C. (413deg. absolute C.). The contraction of the gas at constant pressure along the line K_1 A completes the cycle. Dotted lines have been placed on Figs. 15 and 16 to illustrate Cycle I., Case 3, where this differs from the present cycle. The two cycles can thus be compared.

Pressure-volume and entropy-temperature diagrams for the water are shown in Figs. 17 and 18. Referring to Fig. 18, the water is heated at a constant pressure of 300lb. per square inch absolute along the line f c from 100·6deg. C. (373·6deg. absolute C.) to 214deg. C. (487deg. absolute C.), which is the boiling point at this pressure. The water is now converted into steam, this process being represented by the line c g; and the steam is superheated at constant pressure as represented by the line g d till its temperature is 700deg. C. (973deg. absolute C.). The steam is then expanded adiabatically along the line d e till it falls to 15lb. pressure absolute, its temperature then being 184deg. C. (457deg. absolute C.). The steam is now exhausted and cools along the line e h. At h it is saturated, its temperature being 100·6deg. C. (373·6deg. absolute C.), and thereafter it condenses along the line h f, and is compressed to its initial state. Fig. 17 shows the work done by the steam in its generation, superheating, and adiabatic expansion. The work done in forcing the water into the chamber at 300lb. pressure is not shown in Fig. 17, and is negligible in an investigation of the nature of the present.

The heat required to raise the water from 373·6deg. absolute C. to 487deg. absolute C. is represented in Fig. 18 by the area f_1 f c c_1. The area c_1 c g g represents the latent heat of steam at a pressure of 300lb. absolute (the temperature being 487deg. absolute C.), and the area g_1 g d e_1 represents the heat required to superheat the steam from 487deg. absolute C to 973deg. absolute C. The area f_1 f h h_1 represents the latent heat of steam at a pressure of 15lb. absolute, and the area h_1 h e e_1 represents the heat required to superheat this steam from 373·6deg. absolute C. to 457deg. absolute C.

Comparing this case with Case 3 of Cycle I., it is found that the total heat absorbed is the same in both cases, being represented by the area a G H k in Fig. 16. The portion of this heat which is converted into work in Case 3,

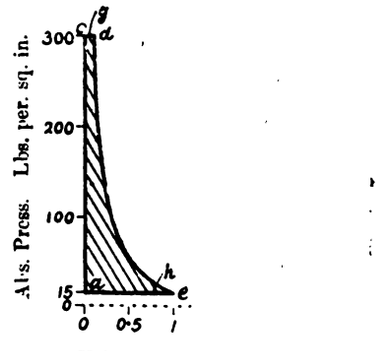

FIG. 17. - Cycle III., Case 2. Pressure-Volume Diagram—Steam.

Cycle I., is represented by the area A G H K, while the corresponding portion in the present case is represented by the sum of the areas A G H_1 K_1 (Fig. 16) and f c g d e h (Fig. 18). This sum is less than the area A G H K, and E in this case is only 0·33 as compared with 0·58 for Case 3 of Cycle I. The fall in the value of E is due to the relatively low efficiency of the steam portion, which has an ideal efficiency of only 0·28. (This is really not low for a steam-engine.)

The feed water has been taken at a temperature corresponding to atmospheric boiling point. It has been assumed that the steam is exhausted into the atmosphere, and is not condensed for use over again. It would, therefore, be necessary, in order to follow the cycle, to heat the feed water to 100deg. C. It should not be difficult to approximately accomplish this by utilising the heat of the exhausting gases. By heating the feed water still more

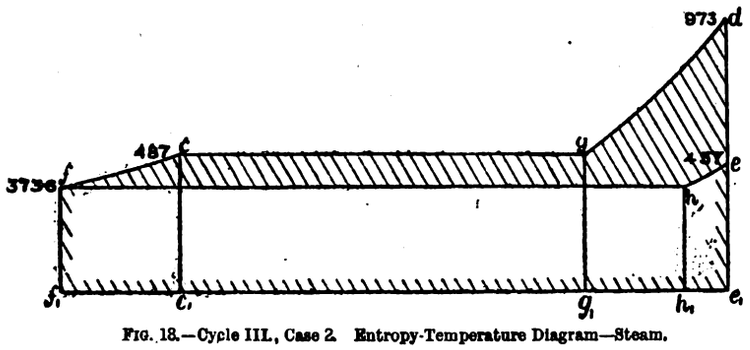

FIG. 18.—Cycle III., Case 2. Entropy-Temperature Diagram—Steam.

the efficiency could be improved; but the improvement would be slight (less than in an ordinary steam-engine), and the feed water would have to be under pressure. As, moreover, any increase of exhaust or back pressure is a serious matter with a turbine, and as feed-water heaters must to a certain extent affect this back pressure, any prospect of gain by heating the feed water beyond 100deg. C. need not be considered.

The gross work in the present case is represented (Figs. 15 and 17) by the area z Z H_1 K_1 + the area a c d e. This is less than the gross work in Cycle I., Case 3, which is represented by the area z Z H K. The negative work in Cycle I., Case 3, was represented by the area z Z G A. In the present case it is also represented by this area, neglecting the work of pumping the water into the jacket.

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The ratio of negative work to gross work in the present case is 0 41, as compared with 0·3 in Cycle I., Case 3. This ratio (0 41) is rather high. It will, however, probably not be so objectionable in the present case as the ratio 0 40 in Case 4 of Cycle III., as the real efficiency in practice will come nearer to the ideal in this case than in Case 4 of Cycle III. We could in the present case reduce the ratio by lowering the compression. This would reduce E.

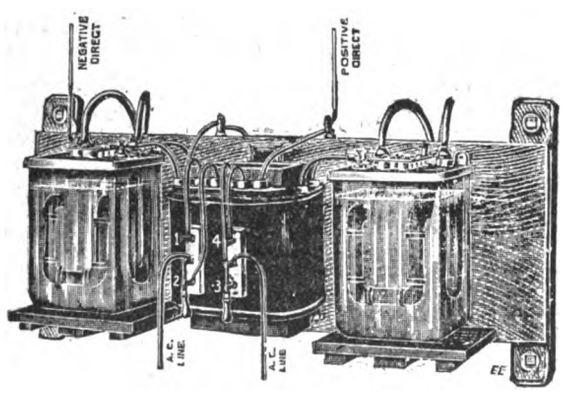
As the mass of the water employed is not the same as the mass of the air and fuel, the scale for entropy in Fig. 18 has been made different from that in the other entropy-temperature diagrams, so that in all these diagrams areas represent quantities of heat to the same scale. In all the pressure-volume diagrams the scales are the same, except in Fig. 19, which will be referred to hereafter. It might be mentioned here that all the numerical results given in this paper have been obtained by calculation and not by scaling the diagrams.

(To be continued.)

THE CHURCHER ALTERNATING RECTIFIER.

We take from our American contemporary, the *Journal of Electricity, Power, and Gas*, the following interesting description of the Churcher alternating-current rectifier, which is a decided departure :

Much hard work must be done, difficulties overcome, methods of manufacture and sale perfected, before any real success is achieved. Such has been the case with the alternating-current rectifier, about which more or less has been written in the last few years. It is not a newly discovered fact that aluminium and some other metals have the faculty of developing upon their surfaces an insulating film when in contact with certain solutions, and while electrically positive to another electrode in the same solution, but it has remained in an unperfected state.



The Churcher Alternating Rectifier.

The Churcher alternating-current rectifier is a decided departure from anything before constructed, and is now in marketable and practical shape. The best that has been accomplished heretofore was a very inefficient and crude device. A single cell with a pair of suitable elements will rectify part of the cycle of an alternating current, but this is not a true unidirectional current. It is still an alternating current in character with one alternation of greater amplitude than the other, and giving an efficiency of perhaps 20 per cent. when charging a storage battery. This poor result is partially caused by the return or leakage current passing through the rectifier and through the battery in the wrong direction, hence discharging it. To charge a storage battery under this condition, it is evident that an excessive charging current must be used to overbalance the excessive discharge that takes place during one-half of the cycle. For example, in figures that are approximately correct, to charge a battery of cells aggregating 50 volts a potential of about 60 volts is ordinarily required. Supposing, for illustration, that this potential will pass 10 amperes through the cells on direct-current circuit. In order to charge at this rate from an alternating current with a single old-type rectifier, it will be necessary to raise the charging potential sufficiently, say to 75 volts, to force 50 amperes through the cells—an excessive charge. This is because of the fact that the potential of the return wave of the alternation will be added to that of the battery, and produce a serious leak through the insulating film on the aluminium electrode. The average discharge potential would be 50 plus 75, or 125 volts. Average, because at the peak of the alternation the actual potential would reach about 150 volts against the film, which is approximately its breakdown point. This high return potential, as it may be termed, will cause a discharge of about 40 amperes—an excessive discharge rate. This leaves a net charging current of 10 amperes It is presupposed that a battery requiring 10 amperes would have capacity of about 100 ampere-hours, and hence it will be seen that in order to charge at 10 amperes from the old type of rectifier it was necessary to charge at 50 and discharge at 40 amperes, leaving the required margin for charging. At this rate the rectifier would be rapidly destroyed, and the best storage battery would be served likewise. A rectifier of that type is not worthy of further consideration, as it is of no more real value for other purposes than for charging batteries.

The next step was the combination of four rectifying cells, known as the Graetz method of connection. This combination was somewhat better, in that it rectified both waves of the cycle, and hence gave a true unidirectional current. The efficiency was necessarily low, because of the fact that the resistance in the path of the useful current was double, and leakage was also double that of a single rectifier. The old type of single cell being inefficient to start with, the combination of four was nearly four times as bad, to say nothing of the wear and tear on four sets of electrodes and four solutions. The only gain was a really unidirectional current produced, so that in charging a storage battery all of the energy passing through it was available for discharge, barring, of course, inherent losses peculiar to storage batteries.

The next step was the perfection of the Churcher rectifier. This device rectifies both waves of any alternating current and requires but one jar, one solution, and one set of electrodes to do so. In this way the internal resistance is reduced to a very low point—in fact, it is only limited by mechanical necessities to prevent short-circuits. This loss is almost negligible. The principal loss that does take place is the leakage current. This current does not pass through the apparatus operated by rectified current, but is expended in heating the solution. This loss is largely dependent upon the electrode potential at the film, the purity of the aluminium and solution, and its temperature. Where continuous service is required of the rectifier, it is therefore imperative to prevent this initial rise in temperature by the use of water-cooling pipes or radiation of some sort.

This form of rectifier requires the use of a transformer with a secondary of twice the direct-current voltage required, plus the resistance loss. This secondary coil is tapped in the centre, and by virtue of the action of the rectifier this tap remains positive at all times to one or the other extreme terminal. The active electrodes are attached to each of the extreme secondary terminals, the number depending upon the phase of the alternating supply. Owing to the peculiar properties of the films on these electrodes, no appreciable current passes from either to the other. Electrodes of inactive material, such as platinum, carbon, etc., would short-circuit the transformer. Between these active electrodes, but insulated from them, is placed an inactive electrode, preferably platinum. Connected between this electrode as one terminal and the centre tap of the transformer as the other is connected the battery to be charged, direct-current motor or other apparatus to be operated. In operation the current passes from the centre tap of the transformer to the motor, from the motor to the inactive electrode in the rectifier solution to one or the other active electrodes, depending on which is at that instant negative to the centre of the transformer. Inside the rectifier the current, therefore, passes from the inactive electrode first to one, then to the other active electrode, as the alternations of the cycle take place, the centre of the transformer remaining positive at all times. It will be understood from this that one side of the transformer is active while the other is inactive, and then reversed during the next alternation.

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The regulation of direct current is best attained by placing an adjustable inductance between the transformer terminals and the active electrodes of the rectifier. This regulation can also be very efficiently attained by an inductance in the main alternating supply, or by varying the number of turns of wire in the primary of the transformer. Either form of regulation is, of course, much more efficient than placing resistance in series with storage batteries when charging from 110-volt direct-current mains. It is also a well-known fact that a pulsating unidirectional current is especially desirable for charging storage batteries. Just why it is so is not very well understood, but the fact remains.

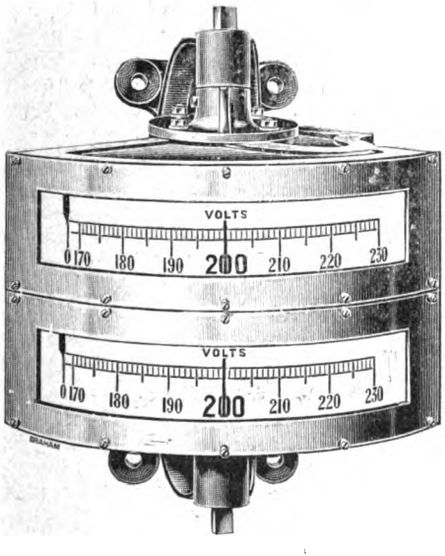
The practical limit of voltage of one cell of the Churcher rectifier is about 50 volts direct current at full ampere load or a difference of potential across the active electrodes of about 130 volts. Somewhat higher voltage may be obtained under favourable condition, but the efficiency is generally much lower because of the increased leakage from one transformer terminal to the othes. Through the use of two cells and two secondaries in the one transformer twice the voltage can be obtained; three cells with three secondaries in the one transformer will give three times the voltage, etc.

Thus it is evident that the Churcher system of rectifiers will deliver any potential of direct current from any alternating current. This statement may seem very broad, but it is perfectly true. Potential, phase, cycles, direct current are all matters of detail, readily worked out by anyone familiar with the system.

TRADE NOTICES AND NOVELTIES.

Nalder Duplex Station Voltmeter.

Messrs. Nalder Bros. and Thompson, Limited, of 34, Queen-street, E.C., have recently placed upon the market a new form



of station voltmeter which possesses some novel and most useful features. It is of the "edgewise type," and consists of two similar instruments fixed together and mounted on a hinged bracket, so that the voltmeters may be turned in any desired direction. These instruments can be illuminated if required. The advantage of such an instrument for paralleling purposes is evident, as it is much easier to determine when both the voltages are the same than is the case by using two distinct instruments. Also, for reading the voltage on each side of a three-wire system, the instrument is a distinct advance on anything that has appeared hitherto. Such an instrument will be highly appreciated by all central-station engineers, as it is of use in both alternate-current working and three-wire continuous-current systems. We have also to announce that Messrs. Nalder Bros. and Thompson have been awarded a gold medal for electrical measuring instruments exhibited at the St. Louis International Exhibition.

Underfeed Stokers.

From Erith's Engineering Company, 70, Gracechurch-street, London, we have a catalogue in which are fully described the principle and working of their patent underfeed stokers. Illustrations included of installations already at work prove that the merits of the system have won for it extensive recognition of a practical order. The good reports which we have from time to time obtained from users confirm the theory of underfeed as being substantially correct, while the above-mentioned firm have shown us that the difficulties attending its practical application have been successfully overcome.

LEGAL INTELLIGENCE.

AREA OF SUPPLY.

The Attorney-General and Others v. The Metropolitan Electric Supply Company, Limited.

In the Chancery Division last week Mr. Justice Farwell had before him an action in which the Attorney-General at the instance of the Willesden Urban District Council sought a declaration that the Metropolitan Electric Supply Company had no power to supply energy within the urban district of Willesden.

Mr. Upjohn, K.C., and Mr. J. W. Greig appeared for the Attorney-General, and the company were represented by Mr. Cripps, K.C., Mr. Jenkins, K.C., and Mr. C. H. Sargant.

The defendant company was incorporated under the Companies' Acts, and its articles of association provided for the unrestricted acquisition of land on which to erect power stations and the supply of electrical energy. By Section 5 of the Act passed in 1889 in favour of the defendant company it was directed that "the undertakers shall not, at any time after the passing of this Act, supply energy or (except for the purposes of this Act) erect or lay down any electric lines or works beyond the area of supply otherwise than under the authority of Parliament or under a license granted by the Board of Trade under the principal Act, provided that where the undertakers were on May 20, 1889, supplying, or under any binding agreement to supply, energy to any premises beyond the area of supply they may continue to supply or supply energy to such premises until Sept. 29, 1890." The area of supply mentioned in the first schedule was a district situated within the administrative county of London. By three subsequent provisional orders as confirmed by Parliament, the defendant company was given similar powers in three other districts all situated in the said administrative county, and each order contained a prohibition similar to that contained in Section 5 of the Act of 1889. In 1898 the defendant company secured the passing of another private Act of Parliament, which authorised them to construct a generating station at Willesden, owing to the lack of land within the areas which they were authorised to supply. This Act contained the following further provisions: "It shall be lawful for the company to hold and use as a station for generating electric current or electrical energy certain lands recently acquired by them in the parishes of Willesden and Acton . . . and to establish and work on those lands plant for generating electrical energy and for other purposes incidental to or connected with their undertaking or business"; and "It shall be lawful for the company to use any of their cables or wires and any mains or cables connected therewith for the transmission of electric current or electrical energy from their works on the said lands at Willesden and Acton to the several distributing stations of the company in their Paddington, St. Marylebone, and Mid-London areas defined by the several provisional orders hereinbefore mentioned and the area in St. Martin-in-the-Fields and the neighbourhood defined by the Metropolitan Electric Lighting Act, 1889, and to use the generating station on the said lands for the purpose of supplying electric current or electrical energy within the several areas or districts over which the company have now powers of supply or over which they may hereafter have such powers under any special Act or provisional order." In 1898 the Willesden Urban District Council obtained powers to supply electricity within its district. In December, 1903, the defendant company commenced to supply the London and North-Western Railway Company, who have sidings adjoining their generating station at Willesden, with electrical energy from the said station. It was now contended that such supply was a violation of the statutory prohibition in the Act of 1889 and the subsequent orders.

Mr. Upjohn, K.C., contended that the prohibition in the defendants' private Act and in the orders was general, and meant that they could supply electricity only within the limits of the statutory districts. The Act of 1898 did not confer any power upon the company to supply electrical energy in Willesden; it merely allowed their generating station to be used for the purpose of supplying the statutory districts and no others.

Mr. Cripps, K.C., said that the defendants were, under their memorandum of association, a company with unlimited powers of supplying electrical energy. Their private Act and the orders gave the company special powers, and put them under special disabilities in certain districts. The prohibition was not a general one, preventing them from exercising their general powers; it meant that the company, as undertakers under the special Act or order, should not raid neighbouring districts and compete with other companies. "Undertakers" meant undertakers under the Act and exercising the powers conferred by the Act, and not the company with its general powers of supply. Alternatively, it was contended that Section 2 of the Act of 1898 was quite general, and conferred upon the company the power of supplying electricity in Willesden.

In delivering judgment, his **Lordship** examined the provisions of the Act of 1889, which defined the "undertakers" as the defendant company. He thought it germane to enquire what the Legislature had in view in passing that piece of legislation. He was entitled to put himself in the position of the Legislature with the knowledge which it had acquired at that time. It appeared that the object of that

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and similar legislation was to allot certain metropolitan districts to certain companies—sometimes one in a district and sometimes two, but never more than two. Further, it was clear from certain clauses that Parliament took into consideration the financial condition of the companies which asked for statutory powers. The Legislature would naturally take pains to see that every company had sufficient funds not only to carry out the necessary works, but to carry on the undertaking when once they had started active operations, and certain clauses were inserted with that view. Now he was asked to say that the prohibition contained in Clause 5 of the Act of 1889, and repeated in the subsequent provisional orders, was not a general prohibition, but only applied to the company as undertakers under the particular Act. He agreed that some qualification was necessary, and that was that the undertakers, so long as they were undertakers working that particular undertaking, must not supply electricity outside the statutory area—the prohibition was not meant to extend to the company for all time. But he could not interpret the prohibition so as to limit it in the way the defendants wished. Further, the proviso to the clause excluded the idea of limitation, for if this was not a general prohibition the proviso would be unnecessary. The result was that he could not insert limiting words in Clause 5. Then he came to the Act of 1828, the object of which was clear from the preamble. Parliament had thought proper to have a number of electric districts complete in themselves. But in this preamble Parliament was told that the system had broken down and could not work in this particular instance, owing to the increase in the consumption of electricity. The company appealed to Parliament to relax its policy so far as to allow them to erect a generating station for supplying their statutory areas outside those areas. That was the plain meaning of the Act; it was intended to benefit customers of the company within their areas. Section 2 was in general terms, and what it would mean if the company at any time relinquished its areas he would leave to someone else to decide when the case arose. But the section did not authorise the company to supply electrical energy from that station indiscriminately, while Section 16 enabled them to supply their districts, and was consistent with the recitals in the preamble. He could not find anything in the Act giving the defendants power to supply electricity in Willesden. On all these grounds it seemed to him that the company were acting in contravention of legislation, and must be restrained by injunction; but he would suspend the injunction for a month to allow the railway to make other arrangements for a supply of electricity, and if the defendants appealed within a fortnight then it would be suspended until the hearing of the appeal. There must also be a proviso to the effect that the declaration and injunction should not apply in the event of the company parting with its statutory undertakings, as to which event the Court expressed no opinion.

DISPUTED ELECTRIC LIGHT ACCOUNT.

At Aston Police Court on Friday last, William Hunter, cab proprietor, was summoned by the Aston Manor Corporation for the non-payment of £3. 1s. 11d., of which £2. 10s. 10d. was for the supply of electrical energy, and 11s. 1d. for rental of fittings. The electrical supply was from March 5 to May 26, when defendant ceased to use the current.

Mr. R. B. Leech, assistant engineer to the Corporation, stated that the current for which defendant had been charged had been consumed, and defendant was the only consumer who had not paid his account.

Defendant's plea was that the charge was not just, and that the Corporation had not carried out their agreement. He was quite willing to pay on the meter reading.

Mr. Leech replied that the number of Board of Trade units shown on defendant's account was true.

Defendant did not dispute the rental charge, and as to the charge for current, complained that on the bill the state of the meter was not shown.

Mr. Leech said that the gross amount was shown.

Defendant said that on the first reading of the meter he went down the cellar with a youth, and asked what current he had consumed, and the youth replied 32. The meter bore the word "units," and when he received his bill he found that the number of Board of Trade units for which he was charged was 128.

Mr. Leech explained that each division shown on the meter was equivalent to four Board of Trade units.

Defendant asked why the man did not tell him that this was so, and expressed the opinion that that was because he did not know.

Mr. Leech: A number of the consumers engaged an expert in Birmingham. That expert came to the works, and was perfectly satisfied that the meters had to be multiplied by four.

The **Chairman** said the magistrates could see the Corporation's difficulty, but, technically, Mr. Hunter had cause for complaint. The view of the Bench was that if the meter was not intended to register Board of Trade units, proper notice should have been given to the defendant before it was fixed. If that were not done, a man might go on using the light under a wrong impression.

Mr. Leech said the reason Mr. Hunter had not received that notice was that the Council expected the meters to be adjusted to the Board of Trade scale early in February, but some delay occurred.

Ultimately the case was adjourned for a fortnight, and the Bench suggested that the meter should then be brought into court.

STREET OBSTRUCTION.

Mr. R. Fitz-Rogers, manager of the Middlesbrough and Stockton tramways, was charged at Middlesbrough Police Court the other day with allowing tram No. 15 to stand longer than was necessary to take up and set down passengers.

According to the Chief Constable, three officers observed that No. 32 car, which was going along Newport-road in the direction of Stockton, was overloaded. Mr. Fitz-Rogers asked the inspector to remove the excess passengers, but the inspector declined. He, however, would be glad to assist their servants to do so, which was in accordance with his instructions.

Meanwhile, No. 15 car came up from the opposite direction, and Mr. Fitz-Rogers said he would refuse to allow it to proceed until the police cleared the overloaded car of its excess passengers. This the police declined to do, and there was a delay of five minutes, and an obstruction to the street traffic, as a large crowd collected.

The Bench inflicted a fine of 20s. and 21s. costs. Notice of appeal was given.

TRAMWAY FARES.

Montagu John Blatchford, a member of the Town Council, was charged at the Halifax Borough Court, at the instance of the Tramways Committee, with having refused to pay a tramway fare. The amount involved was ½d., the fare from the railway station to the stopping stage near the post office. Originally the stage was opposite the post office, but it has been moved for purposes of convenience about 20 yards nearer George's-square. Mr. Blatchford, who was going to Highroad Well, boarded the car at the old stopping place, and the conductor demanded the fare as from the railway station. The defendant said the case was a trumpery one, and might have been obviated by a little explanation and courtesy. A fine of 1s., inclusive of costs, was imposed.

At the Nottingham Summons Court John Mellers was summoned for refusing to pay a penny tram fare.

Mr. H. W. Day, of the town clerk's department, prosecuted, and said that defendant boarded a St. Ann's Well-road car at the bottom of Market-street and travelled to Parliament-street. When asked for his fare, defendant said that he had got on the wrong car. The conductor said that he must either pay a penny fare or leave his name and address, but the defendant thrust his hand in the conductor's face, causing his mouth to bleed. A constable had to be fetched before the defendant would give his name and address. Mr. Day pointed out how necessary it was that conductors should be protected in the discharge of their duty, and said that each car bore boards plainly stating the destination.

The **Defendant** said that he only got on the car in Queen-street, and added that as soon as he found his mistake he attempted to get off.

A fine of 10s. was imposed.

LINCOLN TRAMWAYS COMPANY.

In the King's Bench Division, before the Lord Chief Justice, Mr. Justice Kennedy, and Mr. Justice Ridley, sitting as a Divisional Court, the case of the Lincoln Tramways Company *versus* Dickinson came on for argument, on appeal by the defendant from a decision of Judge Sherston Baker at Lincoln County Court.

Mr. Hugo Young, K.C., for the defendant, said that the whole question turned on the construction of certain letters. The defendant was asked by the plaintiffs to make a report on their lines. He did so, but was unable to give evidence in the impending arbitration. After his initial fee of 50 guineas had been paid, the plaintiffs alleged that he was bound to give evidence, and that as he had failed to give evidence, they were entitled to recover back the fee they paid him to report. The arbitration never became necessary, as the parties came to an agreement. Meanwhile, however, Mr. Dickinson had declined to give evidence, and the plaintiffs engaged another gentleman, in view of the possible arbitration, paying him also 50 guineas. Plaintiffs sought to recover the fee from the defendant, who contended that there was no contract to give evidence, and that he had done what he was paid for—namely, made an examination and reported on the lines, with a view to assisting plaintiffs to see what price they ought to ask. The county court judge decided in favour of the plaintiffs, and defendant now appealed.

Their Lordships reversed the decision of the Court below, judgment being entered for the defendant, with costs.

COMPANIES' MEETINGS AND REPORTS

BRITISH COLUMBIA ELECTRIC RAILWAY.

The annual meeting of this Company was held at Winchester House on Friday last, Mr. E. L. Evan-Thomas presiding. Particulars of the report appeared in our last issue.

The **Chairman** stated that the gross earnings for the past year had increased since the enlargement of the capital two years ago by 65 per cent. from the lighting and from the railway 40 per cent. Their net earnings had during the same period increased 54 per cent. from lighting and from power 50 per cent. In connection with the anticipated extensions, the engineer's estimate was that the next 6,000 h.p. would only cost an additional £37,000.

The **Hon. M. R. Gifford** seconded the motion, and the report was adopted.

NORTH-WESTERN ELECTRICITY AND POWER-GAS.

The meeting of the shareholders of this Company was held at the North-Western Hotel, Crewe, Mr. T. W. Twyford occupying the chair. The chairman having explained the position of the Company, it was decided to increase the capital with a view to paying off the liabilities incurred in obtaining the two Acts of Parliament, and for other purposes. A sum of nearly £6,000 was promised at the meeting. The

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Company will make an appeal to the public for capital when the money market is in a favourable condition.

NEW COMPANIES REGISTERED.

Horstmann Gear Company, Limited. — Capital, £1,000. Object: to acquire from S. A. Horstmann, A. Horstmann, E. H. Horstmann, G. O. H. Horstmann, and W. T. Edgar the benefit of a certain existing invention relating to speed gear of motorcars, cycles, and other machines (Patent No. 11,614 of 1904).

Falkirk Electric Construction Syndicate, Limited.—Capital, £100,000. Object: to acquire the control of the statutory rights under the Falkirk and District Tramways Order Confirmation Act, 1901, for the construction of tramways in Falkirk and district, and for that purpose to enter into an agreement with the Scottish Electric Traction Company. Registered office: 37, Castle-street, Edinburgh.

Darlington Wire Mills, Limited.—Capital, £20,000. Objects: to acquire and carry on that part of Messrs. Dunford and Elliott (Sheffield), Limited, business which is carried on at the Skerne Wire Mills, Darlington, formerly known as the Darlington Steel Wireworks, as steel-wire drawers, makers of steel and iron wire, tramway, electric light, and other wire, etc.

Liens Registered.

Electric Law Press, Limited, London, E.C.—Lien registered Oct. 20 for £140 7 per cent. debenture, part of £500; amount previously issued, £100; no trustees; charged on the undertaking and all the property and assets, including the uncalled capital, stock-in-trade, and book debts for the time being.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Vienna.—The Government Railways require tenders for telegraph tape for 1905. Tenders by Nov. 5.

Melbourne.—The Federal Postmaster-General requires tenders for 6,000 yards of telegraph cable. Tenders by Nov. 15.

Crejour (Roumania).—The Municipality require tenders for construction and working of tramways for 50 years by Nov. 7.

Porto Alegre (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Banza (Spain).—The Municipality requires tenders for the electric lighting for five years. Particulars from the Alcalde, Banza (Jaen).

Guirgia (Roumania).—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Hammersmith.—The Council invites tenders for the supply of (1) extra high-tension feeder mains and (2) draw boxes, frames, covers, etc. Tenders by Nov. 16. See advertisement.

Erith.—Tenders are invited for material and work in connection with the installation of electric light at the Education Committee's offices at Picardy, Belvedere. Tenders by Nov. 11. See advertisement.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Liege.—Tenders are required for the construction and working (concession) of three electric tramways. A deposit of £400 is required. Particulars from the Provincial Government, Liège. Tenders by Nov. 14.

Hammersmith.—The Guardians invite tenders for a complete wiring installation for the electric lighting of their new workhouse and infirmary at Wormwood Scrubbs. Tenders to the Clerk to the Guardians by Nov. 15.

Musselburgh (Scotland).—The Town Council invite tenders for electric wiring and fittings for town hall and offices. Specification may be obtained from the Burgh Surveyor. Tenders to Mr. George Landale, burgh surveyor, by Nov. 5.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Rotherham.—The Corporation invite tenders for wiring the new isolation hospital buildings in Badsley Moor-lane. Specification and forms of tender at the office of the Borough Electrical Engineer, Rawmarsh-road. Tenders to be sent to Mr. W. J. Board, town clerk, Town Hall, Rotherham, by Nov. 21.

Ballinasloe (Ireland).—The Committee of the District Lunatic Asylum invite tenders for wiring the temporary buildings for 35 incandescent lamps of 16 c.p. each, at a pressure of 200 volts, and the necessary overhead cables to connect same with engine-house, and all else necessary. Tenders by Nov. 14.

Madrid.—An application has been received from Don José Xinxo for a concession for an electric tramway starting from the Plaza Rovira in Gracia and terminating at San Juan de Horta. The notice is published with a view to eliciting any applications for the same concession on more advantageous terms; such applications to be made by Nov. 10.

Craiva (Roumania). — The *Moniteur des Intérêts Matériels* (Brussels) announces that the adjudication will take place at 4 p.m. on Oct. 25 (Nov. 7) at the Mayoralty of Craiova, of the concession for construction and working of a line of tramways (mechanical traction) in the town of Craiova. The duration of the concession is fixed at 50 years. A provisional deposit of £200 is required.

Brussels.—Tenders are invited for the construction of an electric generating station and other works in connection with the establishment of a goods station at Brussels. The estimated cost of the work is about £4,367. A deposit of about £280 is required to qualify any tender. Specifications (price 1s. 10d.) and further particulars may be obtained from M. De Rudder, Administrateur des Voies et Travaux, 11, Rue de Louvain, Brussels.

Burslem (Staffs).—Tenders are invited for the supply and erection of the following electric lighting plant at the workhouse, Chell, for the Guardians of Wolstanton and Burslem Union: (Section A) water-tube boilers, with fittings; (B) feed-water heater, feed pumps, piping, etc.; (C) two 25-kw. steam dynamos and booster; (D) switchboard; (E) cables and wiring; (F) accumulators; (G) arc lamps. Tenders to Mr. J. A. Lowndes, clerk, by 12 noon on Nov. 15.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Tenders by March 31.

Dundee.—The Town Council invite tenders for the relaying of the present copper strip feeder main throughout the town with insulated cables. Specifications may be had on application to Mr. H. Richardson, A.M.I.E.E., city electrical and tramways engineer, Dudhope-crescent-road, Dundee, on payment of 40s., which will be returned only on receipt of a bona fide tender. Tenders to Mr. W. H. Blyth Martin, clerk to the Council, City Chambers, Dundee, not later than first post on Nov. 12.

Sydney.—Tenders will be received at the office of the Acting Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 28, for the supply and delivery at the Departmental Stores, Sydney, of telegraph, telephone, and electric light material. Specifications and general conditions may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth. Samples may also be seen at Sydney, Melbourne, Brisbane, and Adelaide.

Manchester.—The Electricity Committee invite tenders for the whole of the work required in connection with the wiring for arc and incandescent lighting of Stuart-street generating station. Specifications may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester, on payment of a fee of £2. 2s., which amount will be refunded on receipt of a bona fide tender. Tenders to be addressed to the Chairman of the Electricity Committee, and delivered at the Town Hall, Manchester, by 10 a.m. on Nov. 11.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegragh Office Yard, Thursday Island, of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Falkirk.—The District Tramways Company have accepted the tender of Bruce Peebles and Co., Edinburgh, at £81,000, for permanent way, 8¾ miles, complete electrical equipment, cables and overhead construction, rolling stock, car-shed, etc.

Accumulators.—The A.B.P. Accumulator Company, Limited, Stockton-on-Tees, report the following recent contracts: Handsworth Urban District Council—256 19-plate cells of their standard S. type; Exmouth—230 17-plate cells; St. Andrews, Fifeshire—230 17-plate cells.

Richmond (Surrey).—The Guardians have received the following tenders for the installation of telephones at the workhouse, Grove-road:

	£	s.	d.
Tamplin and Makovski, Limited, Brighton-road, Redhill.	184	3	9
W. Wallace and Co., Limited, 151, Curtain-road, E.C.	169	10	0
Installation Company, Limited (less £1. 5s.)	152	7	0
Reynolds and Co., George-street, Richmond	137	15	0
Electrical Engineering and Maintenance Company, 5, Eastcheap, E.C.	137	0	0
T. Potter and Sons	132	0	0
J. G. Clack, 4, Trafalgar-road, Twickenham	130	0	0
Ditto (alternative)	116	0	0
London and Provincial Telephone Company, 11, Queen Victoria-street, E.C.	122	3	7
Ditto (alternative)	110	16	5
Hemingway and Pritt, Eton-street, Richmond (accepted).	120	0	0
National Telephone Company, Limited	110	0	0

Mortlake.—From the 19 tenders sent in, that of the Brush Electrical Engineering Company, Belvedere-road, London, has been accepted for providing and erecting certain electrically-driven centri-

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fugal pumps, dynamos, cables, pumping main, etc., for the Richmond Main Sewerage Board.

Barking (Essex).—The Urban District Council have accepted the following tenders for the construction of light railways: D. T. Jackson, Ripple-road, Barking, at £8,117. 4s. 3d., Sections 1 and 1A, 2 and 2A, and 4 and 4A; Dick, Kerr, and Co., Abchurch-yard, Cannon-street, E.C., at £694. 15s. 8d., Sections 3 and 4A.

BUSINESS NOTES.

TRACTION.

Leicester.—The Humberstone-road section has been opened.

Warrington.—Four top covers, at £80 each, have been ordered.

Brighton.—Another electric omnibus has been added to the Brighton-Hove service.

Wakefield.—The light railway connecting Wakefield with Leeds and other places was opened yesterday.

Halifax.—The construction of the length of tramway line from Sowerby Bridge to Styles Triangle has been commenced.

Wrexham.—It is reported that arrangements are in progress for the extension of the tram service from Johnstown to Rhos.

Gloucester.—The total cost of the lately-constructed electric tramways (£147,000 to £148,000) represents a saving of £26,000 upon the original estimate.

Bury.—At its meeting last week the Corporation formally sanctioned the promotion of a Bill in the next session of Parliament for power to construct several extensions.

Falkirk.—The tramway scheme has been hung up owing to the action of a member of the original syndicate in commencing legal proceedings to interdict the new scheme.

North-Eastern Railway.—Sir George Gibb received a deputation on Wednesday, and promised that express electric trains, with first-class carriages, should be run to the coast during the busiest parts of the day.

Sheffield.—As the result of the report upon regenerative control presented by Mr. H. E. Yerbury, the borough electrical engineer, the Corporation have decided to expend a sum of about £160 in experiments.

Flintshire.—It is reported that the project mooted last year of constructing a tramway from Connah's Quay, along the side of the Dee estuary to Holywell, and thence to Mold and Buckley, is not likely to be proceeded with this year.

Cardiff.—The Corporation have passed the following resolution: "That a halfpenny additional fare be charged on the Cathays and Cowbridge-road extensions when opened for traffic." The proposal to introduce advertisements on the cars has been abandoned.

Pontypridd.—The Pontypridd stipendiary magistrate has sanctioned the appointment of Mr. Togarmah Rees, of Newport (Mon.), as surveyor under the Lands Clauses Act to value certain properties which the Council had parliamentary powers to take over for the purpose of the tramway.

Wigan.—The tramways engineer (Mr. Jas. Slevin) suggests that the Council should apply for powers in their forthcoming Bill for the completion of the New Springs route as far as Springs Bridge; also that a clause be inserted in the Bill for the purpose of extending the Pemberton line to Abbey Lakes, Upholland.

Barnet Light Railway.—The Herts County Council have adopted a recommendation of the committee that the county surveyor be directed to prepare the necessary plans, working drawings, and specifications, and that the necessary steps be taken to acquire the lands needed for widening the main road at Barnet, and also for a site for a generating station.

Belfast.—The Corporation have approved the tramways specifications as amended by the consultating engineers, Messrs. Lacey, Sillar, and Leigh, and the town clerk has been instructed to advertise for tenders, to be sent in not later than two weeks from the date of the advertisement. It has been decided to transfer the electric lighting undertaking from the Gas and Electricity Committee to the Tramways Committee.

New York's Underground.—The City Hall to West 145th-street section was opened on the 27th ult. Between 7 p.m. and midnight 127,381 passengers were carried. Express trains are to be run every few minutes during the busy hours of the morning and evening, local trains being dispatched every three minutes. There will be a 10 minutes' service throughout the night. When the further trains now in course of construction are ready the service will be increased.

Batley.—At a meeting of the Tramways Committee, Mr. Paris, of the British Electric Traction Company, attended respecting the construction of the Bradford-road tramways. The committee informed Mr. Paris that they had no objection to the reconstruction of the line as a double line, and were prepared to recommend the Council not to press for the rearrangement of the terms of the agreement between the Corporation and the company as to the maintenance. The company are to communicate with the Council.

West Fife.—In connection with the proposed tramway for the Dunfermline and district tramways it was reported at a meeting of the Kirkcaldy Committee of Fife County Council on Saturday that the road surveyor had been instructed to visit several places where tramways had recently been laid down in country districts before any arrangements were come to. No definite decision was arrived at by the authorities concerned at the conference the other day, but the Kirkcaldy Committee have adopted an encouraging attitude.

Perth.—As already announced in our columns, the municipal tramways are to be converted to electric traction, the consulting engineers being Messrs. Kincaid, Walter, Dawson, and Manville. After a protracted delay, the decision of the Town Council appears to have been accelerated by the exuberance of the experimental motor 'bus, which developed a tendency to gravitate towards the Tay and to precipitate the City Fathers into its rapid waters.

Rowley Regis.—On Wednesday Colonel Yorke, on behalf of the Board of Trade, made an inspection of the tramway which has been constructed by the District Council from Old Hill to Blackheath at a cost of about £28,000. The District Council have leased the line to the British Electric Traction Company, and it is expected that the cars will be running in the course of the next few days, the Board of Trade inspector's pronouncement being highly favourable. It is probable that the complete system, including the lines of the neighbouring authorities, will be opened at the same time.

Birmingham.—At Monday's meeting of the Corporation the necessary authority was given to the Parliamentary Committee for presenting the Bill dealing with tramway extensions next session. Except for the deletion of the Harborne route, the Bill will embody all the routes provisionally agreed upon by the Corporation some time ago, a proposal to withdraw the Corporation-street and Martineau-street route being defeated. We learn that Raworth's Traction Patents have received instructions to equip 40 new cars for the Birmingham and Midland Tramways with regenerative control.

Swindon.—The Town Clerk reported that the Board of Trade had issued their certificate approving of the new tramways, but the certificate was issued on condition that the present canal bridge in Regent-street be only used for one year, except with the approval of the Board of Trade. On the report of the electrical engineer it was resolved that the through service of cars from the corn exchange to Gorse Hill be discontinued, and that all regular cars run to and from the Centre, but that when the traffic demands it an additional car be run through from the corn exchange to Gorse Hill. Two additional cars are to be ordered from Messrs. Dick, Kerr, and Co.

King's Norton.—The Urban District Council have decided to apply for a provisional order for an extension of the tramway from the present terminus to the King's Head at Alcester Lanes End, a distance of six furlongs. The Tramway Committee's report stating that they had passed a resolution rescinding the appointment of a sub-committee to confer with the city of Birmingham in reference to the future working of the trams in the Council's district, and recommending that a special committee be appointed with full power to negotiate with the Corporation, has been approved. This new committee will also prepare and submit a special report as to the present position of all the Council's negotiations as to the future working of the tramways.

Croydon.—At the last meeting of the Town Council the Tramways Committee recommended in connection with the extension of the tramway system to Upper Norwood that powers be sought for a further extension from the borough boundary at Church-road, Upper Norwood, along Crystal Palace-parade, and terminating near the high-level entrance to the Crystal Palace. This extension will be partly within the urban district of Penge and partly within the metropolitan borough of Camberwell. Alderman Taylor, in moving the adoption of this report, referred to the questions asked at a previous Council meeting with regard to the cost of the extensions. The whole of the tracks would cost £70,000; the electric equipment, £25,000; enlargements and new depôt, £20,000; 40 cars, £30,000; contingencies, £10 000; streets improvement, £25,000. The total would come to £180,000. The report was adopted.

Newport.—An informal trial trip was run on the Stow-hill section on Tuesday. The large party included several members of the Corporation, and Messrs. R. H. Haynes (borough engineer). H. Collings Bishop (electrical engineer and tramways manager), L. D. R. Du Verge (deputy electrical engineer and tramways manager), and Fox (deputy borough engineer). The trip gave every satisfaction. The cars which the Corporation intend running on the Stow-hill route are of the latest design, and can carry 55 passengers. They have very powerful motors, and are fitted with a hand brake, slipper brake, a rheostatic brake, and a running back brake, the latter being intended to prevent the car from attaining any speed in a reverse direction. During the trial it was proved that any one of these brakes is sufficient to hold the car on the steepest part of the gradient, while, if necessary, they can all be applied at the same time. The Board of Trade inspection will probably take place in a day or two.

London County Council.—The Highways Committee recommended (*a*) that expenditure on capital account of sums not exceeding £19,280 in all be authorised in respect of (1) the erection of the superstructure of the first portion of the Streatham car-shed required in connection with the electrical working of the London County Council tramways, and (2) the execution of paving works, the laying of rails, and the construction of conduits in and in connection with the car-shed; (*b*) that the erection of the first portion of the Streatham car-shed be carried out without the intervention of a contractor, and that the drawings, specifications, and estimate of £16,180 be accordingly referred to the Works Committee for that purpose; (*c*) that the paving works, the laying of the rails, and the construction of the conduits required for the first portion of the Streatham car-shed be carried out by the Council's permanent-way staff under the supervision of the chief officer of tramways. The committee also recommend that powers be sought to divert the route of the Lewisham and Forest Hill tramway, on the ground that the route selected would entail a large amount of street widening. As the result of a petition from the local tradesmen, the Lewisham Borough Council will probably make representations to the Council with a view to an extension of this line. In regard to the Edgware-road station of the Baker-street and Waterloo Railway, the committee recommend that the plans submitted in regard to entrances and exits

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be provisionally approved. The Islington Borough Council have decided to offer no opposition to the overhead system on the Moorgate-street to Manor House route.

Bradford.—At a special meeting of the Bingley District Council a report was given of an interview held between representatives of the District Council and a sub-committee of the City Council on the proposed extension of the city tramways from Allerton to Wilsden. The project has been mooted by the residents of Wilsden, and they have secured the promise of the land required for the widening of the road from Allerton to the city boundary at Wilsden free of cost, and have good hopes of securing that required for the remainder of the route (within the Bingley district) to Ling Bob, if an undertaking can be secured for the extension of the tramways to that point. The Bradford sub-committee asked that Bingley should bear half the expense of widening the road in the city to the Wilsden boundary, the total cost of which is estimated at about £5,000, and suggested that Bradford would bear half the cost of the improvement forward to Ling Bob, this part of the work being estimated to cost £1,000. In other words, the Bradford proposal was that the two authorities should be at the joint expense of the highway improvement. The Bingley Council decided that these terms could not be accepted, but expressed willingness to widen the portion of the road in the Bingley district if an undertaking were given that the tramways would be laid to Ling Bob, and on condition that the Wilsden people were able to secure the land required free of charge to the Council.

Aston.—At the meeting of the Council on Friday last the Public Works Committee reported that the work of reconstructing the Lichfield-road tramway was proceeding. It was hoped that it would be completed at the beginning of this week. The committee were continuing the negotiations with the railway company in reference to the rebuilding of the Aston Station railway bridge. Cars are now running to Witton, both up the Witton-lane and round Trinity-road, and also along the Victoria-road to Six Ways. The committee have decided to issue 1d. return fares for workmen along the Victoria-road and Aston Cross route. The same will be done with regard to Witton and Aston Cross, and also in the portion between Salford Bridge and the Cross. Halfpenny fares for children will probably be instituted, but the question of such fares for passengers generally is in abeyance. The men on the steam cars are qualifying in order to take positions on the electric cars. Colonel Yorke, R.E., on behalf of the Board of Trade inspected the system on Wednesday. A large party, including several members of the Corporation, Mr. G. Conaty, Mr. Barling (Birmingham Electric Traction Company), Mr. R. Green (consulting engineer), Mr. Lawson (electrical engineer), Mr. G. Trentham (contractor), Mr. F. W. Richardson (deputy surveyor), and Mr. Foster (electrical engineer to the Council), participated in the trial trip. The inspection commenced from Aston Cross, and in a double-deck car the party proceeded along Park-road and Witton-lane to the depôt. From here the car was taken along Witton-road, Bevington-road, and Trinity-road to Aston Church. Afterwards the lines in Victoria-road from Six Ways to the Vine, and from there along the Lichfield-road to Aston railway station were traversed. A single-deck car was waiting at the station for the purpose of passing under the bridge, and in this the journey was continued to Gravelly Hill and back to Aston Cross. Colonel Yorke expressed satisfaction at the manner in which the work had been carried out, and granted a maximum running speed of 12 miles an hour along Trinity-road, and of 10 miles an hour along all the other routes.

Tramway Accident.—The Stalybridge coroner held an enquiry last week into the death of a little boy named Thomas McCabe, who was killed on the 11th ult. through the derailment of a car belonging to the Stalybridge, Hyde, etc., Board. The jury unanimously returned the following verdict: "The accident was due to the slippery state of the rails at the top of Ditchcroft; the driver is exonerated from blame, and is commended for doing his duty." As the driver was completely exonerated from all blame, his narrative of the accident will doubtless give a very fair account of how it occurred: "I pulled up at the corner of the Guide Post for the guard to set right the switch and loop, and got round the curve all right, but in order to do so I had to apply sand to the rails on account of the wheels skidding. On the way from there to Park-hill I noticed the wheels were greasy, and about twice I used sand up to the stopping place at the top of Ditchcroft. The sand acted. When at the stopping place I brought the car to a standstill with the power brake, but could not tell for how long. Upon receiving a signal to start, I placed the controller of power brake from the fifth notch to the third notch, released the hand-brake, and applied sand to the rails. There did not appear to be any effect from the power brake, and I continued to use sand by means of the hopper. Still there was no effect, and I bent down with the sand bag in my hand and threw sand on the rails, and whilst in that position I could not hear the wheels revolving. I had left the power brake at No. 3 notch during the time I was down on the step, and as soon as I noticed that the car was gliding like a sleigh I returned to the brake, took off the power brake, and momentarily placed the controller to the first notch of power to release the wheels. At this time I was quite certain the trolley was on the wire. I continued to use the sand hopper. The brake was absolutely useless unless the wheels would revolve, but I cannot say whether I released the wheels after my attempt. The car was then going at a great speed. I looked down the road to see if anything was in the way, and I noticed a woman running, and a horse and lurry near the Royal Oak. I then placed the power brake on the second notch, then a third notch, and yet there was no effect. We were then about to enter the curve, and I reversed the motor as a last resource, but this had no effect. I seized the handle of the hand brake, and I remember no more until after the collision, except that the car jumped." From other evidence it appeared that the car left the rails at the curve opposite the Royal Oak. After going at a great speed down the hill it ultimately dashed into the house at the corner of Hartley-street, where the deceased lad was sitting. The driver also sustained considerable injuries.

Newcastle.—The following letter from Mr. Le Rossignol was read at the meeting of the Corporation: "Gentlemen,—At the meeting of Council held on Wednesday last, Oct. 26, a discussion arose upon the letter which I had asked to be read, and in that discussion Alderman Newton is reported in the Press to have made the following statements: (1) horses had been bought and the committee knew nothing about; (2) motorcars had been bought, also without authority; (3) cars were built, although they had an ample supply of cars, simply in order to give men in their employment permanent work; (4) the increase in Mr. Le Rossignol's salary was given under misinformation—he might use a stronger word. Regarding the first statement, on April 26, 1901, the committee by minute approved of the plans for the reconstruction of the sheds at Haymarket and Gosforth, these plans showing stables, etc., for horses and on April 26 instructed me to carry out the work. On May 8, 1902, the committee confirmed the special minute of the Finance Sub-Committee of May 7, 1902, sanctioning the purchase of the first six horses of the stud, and every horse since purchased has been passed in the ordinary way through the pay bill which comes before the committee of which Alderman Newton is a member. On Oct. 20, 1902, the committee, after a survey on the spot, 'instructed the general manager to prepare and submit to them plans for stables at Byker with about four stalls and two loose-boxes, a shed in which to keep the tower repairing wagon and carts,' and on Nov. 6, 1902, instructed me to proceed with the work of construction. In July, 1903, I reported to the committee and Council in my annual report that the Tramways Committee then had 15 horses and the necessary carts, vans, and did their own carting work. In face of this it is idle for Alderman Newton to assert the committee's ignorance. As regards the second statement, that motorcars had been bought, also without authority, the minute of the Tramways Committee meeting of May 22, 1902, states, 'It was agreed that the general manager should purchase a small motorcar to be kept at the power station in readiness for use of officials.' This is the only motorcar the committee possess, but one motor tower wagon has been bought by the committee under their minute of June 12, 1902. As regards the third statement, that 'cars were built although they had an ample supply of cars, simply in order to give men who were in their employment permanent work,' the minute of the Tramways Committee meeting of July 10, 1902, states 'the general manager was instructed to submit designs of proposed new cars, and after the design had been approved, to get the 40 additional cars built.' Only 20 additional cars were built by me under this minute, and the committee's minute of May 12, 1904, instructs me to push on as quickly as possible for race week the construction of the new cars then building. All the cars the committee at present possess, and perhaps more, will be wanted to maintain a proper service next race week. As regards the fourth statement, 'the increase in Mr. Le Rossignol's salary was given under misinformation—he might use a stronger word,' I can only refer to the Council proceedings of Jan. 13, 1904, and repeat what I stated in my letter to the Council that 'during 1903 I had the heavy work of designing and constructing all the extensions to the power station, pumping station, car works, car-sheds, and lines authorised by the 1902 Act, thereby saving you £4,000, which the city otherwise would have had to pay in fees. For this service the Corporation unanimously granted me an increase of £100 a year in my salary, and I very naturally regarded this increase of salary as evidence of the confidence of the members of the Corporation had in me, and also as a tangible proof of the satisfaction which my work had given.' The Council ought to remember that this increase was given after I had been four years in their service. I think the Council will agree that, as I cannot answer for myself in this chamber to Alderman Newton's inaccurate statements, it is only fair that this denial should have the same publicity as his accusation received." Alderman Newton intimated that, so far from modifying anything he had said, he could greatly amplify it. The letter was referred to the Tramways Committee.

LIGHTING AND GENERAL.

Stockton.—The Town Council have resolved to extend the electric light cable to Hartburn.

Hessle.—The Urban District Council intend to apply for an electric lighting provisional order.

Goole.—An application has been made for a further extension of time of the Urban District Council's electric lighting order.

Northwood.—The Northwood Electric Light and Power Company are about to lay their mains in the chief roads in Northwood.

Belfast.—The electrical engineer, Mr. V. A. H. M'Cowan, will report at the next meeting with regard to a short extension of a main.

Eastbourne.—The Council intend to apply for a provisional order authorising them to supply electric energy in the parish of Willingdon.

Bacup.—The Lancashire Electric Power Supply Company are about to proceed to open up the streets and lay the trunk mains within the borough.

Removal.—The Johnson-Lundell Electric Traction Company have removed their offices to their factory at Spencer-street, Southall, Middlesex.

Barton.—The Lancashire Electric Power Company intend to apply for a provisional order to supply electric power in the Rural District Council's area.

Gillingham.—Sanction has been obtained to the proposal of the Town Council to borrow an additional £19,754 for the purpose of electric light extensions.

Woolwich.—The Council have resolved to apply for a provisional order authorising the Council to supply electric light and power throughout the borough.

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Wimborne.—The Rural District Council will support the Bournemouth and Poole Electric Supply Company's application for an order to supply the district with electricity.

Llangollen.—The Urban District Council are about to consider a petition from ratepayers for an extension of the Llangollen electrical light installation to include Church street.

London County Council.—On Tuesday it was agreed to lend the Battersea Borough Council £11,314 for electric light installation and meters. Several notices to lay mains were agreed to.

Barnsley.—In consequence of the Electricity and Lighting Committee's annual inspection of the public lamps in the borough, a number of additional lamps are to be placed in various streets.

Llanelly.—The Urban District Council are still considering the electric light and traction question. It appears that Mr. J. C. Howell, electrical engineer, Llanelly, has been asked to report.

Award.—We are informed that Messrs. John Davis and Son, Limited, Derby, have been awarded both a gold medal and a bronze medal for their special surveying and mining instruments exhibited at the St Louis Universal Exhibition.

Barnstaple.—An articled pupil has been accepted at the electric light station on the following terms: that a premium of £100 be paid in respect of the pupil, that he serve three years, and that he be paid £20 the second year and £40 the third.

Longton.—The number of units generated for the three weeks ended Oct. 15 was 7,525, against 6,833 for the corresponding period of last year, being an increase of 10 per cent. During the past three weeks 168 additional lamps have been fixed.

Stock Exchange.—Application has been made to the Stock Exchange Committee to allow the Calcutta Tramway Company's further issue of 2,732 ordinary shares of £5 each, fully paid, Nos. 102,269 to 105,000, to be quoted in the official list.

St. Marylebone.—An agreement has been prepared between the Council and the trustees of the Emmanuel Schools for the acquisition of the present site of the schools, a portion of which is required immediately for the purposes of the new generating station.

St. James's and Pall Mall Electric Light Co.—The amount of electricity sold by the company for the quarter ended Michaelmas is returned at 1,338,880 units, estimated to produce £19,873, as against 1,277,469 units, which produced £20,652, for the corresponding period of last year.

Croydon.—The County Council have instructed the General Purposes and Sanitary Committees to make provision in next year's estimates for the installation of electric light in place of gas in all those buildings that are under their supervision other than those they have already decided to instal.

Loughborough.—On Saturday afternoon a trial run of the plant at the new electricity power station was made with satisfactory results, and on Monday the station commenced supply to Messrs. Morris and Bastert, at the Empress Works, with current for motive power as well as lighting. Only one engine has been put down, and the public supply will not be available for some time yet.

Swindon.—The proposed feeder cable to the Gorse Hill district is to be laid in the conduits as early as possible, at an estimated cost of £380. On the report of Mr. Griffin, it has been resolved that a Lancashire boiler be put in at the electricity works. The last monthly report of the electrical engineer shows 245 consumers connected, as compared with 114 a year ago, and 157 street lamps, as against 79 last year.

Bradford.—The work of fixing boilers and electrical plant has been proceeding for some time at the Sunbridge-road destructor, and the actual generation of electricity has now begun, although the installation is not yet completed. A 300-kw. set is now at work, and the current generated is being used for lighting. The ultimate intention is to use it for traction purposes, which will probably be done about Christmas.

St. Pancras.—It is proposed that, in regard to the laying of cables and service pipes for the supply of electric current, the present arrangement of the trenches being opened up by workmen employed, controlled, and paid by the electricity and public lighting department be continued, but that in future the works department follow up the work of laying down cable and services by reinstating the trenches permanently on the same day.

Mirfield.—An enquiry has been held into an application by the Urban District Council for power to borrow £4,948 for the purpose of carrying out an electric lighting undertaking. It was proposed to charge 6d. per unit for lighting, and 2d. per unit for power purposes. It had been under consideration to obtain the current from the Huddersfield Corporation, but at last it was decided to take it from the Yorkshire Electric Power Company, Limited.

St. Helens.—A scheme of extension of the electricity works, involving an outlay of £8,000, is necessary. The engineer has informed the Council that on two nights last winter the capacity of the station was tested to its utmost, and if anything had gone wrong it would have been necessary to disconnect some of the lighting, or to cut off the supply from one or two sections of the tramways. He hoped they would get through this season without any trouble, but they would be pinched.

Portsmouth.—Application is to be made for sanction to borrow £1,200 to complete the proposed Portsmouth telephone extensions, in addition to the £635 already sanctioned by the Council, and £20,000 to cover future extensions of the telephone system, the estimate being for 1,000 lines at £20 per line. This is exclusive of the extension to Southsea, and the money will only be spent as further extensions are found desirable, which, before being carried out, will be submitted to the Council for approval. The committee anticipate to exhaust this money in two years.

Perth.—The Electric Lighting Committee have adopted Mr. Lambert's report on the extensions necessary at the electric station to enable that department to provide electricity for the tramways. Mr. Lambert stated that a 440-kw. dynamo with foundations costing £3,200, steam-piping £150, tramway switchboard £1,400, and additions to the present switchboard £250 would be necessary, making a total of £5,000. The committee will recommend the Council to call for tenders for this additional plant.

Diesel Engines.—The Mirlees-Watson Company, Limited, engineers and founders, Scotland-street, Glasgow, who are now manufacturing Diesel oil-engines, have issued an illustrated pamphlet describing the engine and pointing out its numerous advantages. They state that over 900 Diesel oil-engines, having a total aggregate power of 45,000 b.h.p. are now in use, and that three Diesel engines made by them can be seen running in their own works driving miscellaneous machinery, cranes and dynamos, and they are highly satisfied with the results obtained from them.

Gloucester.—At the last Electricity Committee's meeting the engineer reported that 101 new arc lamps had been fixed, and presented plans and estimates of the proposed extension of plants at the electricity works, for which a special meeting of the committee will be summoned to consider. At the last meeting of the City Council Alderman Fielding, chairman of the Electricity Supply Committee, said it was yet early to predict, but they had every reason to expect that after paying all expenses, interest, and payment of loans, they would have a surplus on the year's working.

Wrexham.—Arrangements have been made for advances up to £5,600 for electric light extension purposes. The electrical engineer, in his last report, gives the following particulars: Current used for tramways in September, 1904, 11,413 units; September, 1903, 14,442 units; for lighting, etc., September, 1904, 21,511 units, as compared with 23,414 units in 1903; total consumption September, 1904, 32,924, September, 1903, 37,856 units. New consumers connected September, 1904, one, September, 1903, two; total number of consumers September, 1904, 140; September, 1903, 134.

Wandsworth.—The Borough Council have adopted a report of the General Purposes Committee on a scheme prepared by Mr. W. P. Adams for utilising the Tooting dust destructor for the generation of electricity. The committee recommended that the County of London Electric Supply Company, Limited, should be informed that the Council contemplated applying for a provisional order for the supply of electricity in the borough, but before taking steps with that object, they would be glad to learn whether the company would be prepared to hand over to the Council the Streatham area of their undertaking upon terms, and whether they would be prepared to purchase in bulk the electricity generated at the Tooting dust destructor.

Whitstable.—At a special meeting of the Council on Tuesday, Mr. W. C. C. Hawtayne said the cost of lighting the town by electricity would probably be £15,000, as the town was of a straggling nature. The interest on the cost of the installation would be about £940, and the cost of manufacture about 2d. per unit. Taking as a basis an annual sale of 130,000 units, their working expenditure would amount to £1,080, which with the £940 would make a total of £2,020. Against this they would have a revenue of £2,700. This they should be able to do with 250 connections. He advised the Council to apply for a provisional order at once. After hearing the report the Council decided to adjourn the discussion until the November meeting.

Awards.—Messrs Everett, Edgcumbe, and Co., 151 and 152, Great Saffron-hill, Holborn-circus, have been awarded a gold medal for their exhibit of electrical instruments at the St. Louis Exhibition. We are informed that the Allis-Chalmers Company, Milwaukee, Wis., have obtained the highest honours at the St. Louis Exhibition with each of their three exhibits—steam-engine, electrical, and mining plant. The 5,000-h.p. engine popularly known as the "Big Reliable," and the huge generator built by this company's electrical department, otherwise known as the Bullock Electric Manufacturing Company, each won a grand prize. In the department of mines and metallurgy the Allis-Chalmers exhibit was also awarded a grand prize, the highest honour given by the international jurors. The Bullock Electric Manufacturing Company's grand prize also covered all their alternators, synchronous motors, direct-current generators and motors, and rotary converters. In addition, the Bullock system of multiple-voltage control of motors won a gold medal.

Russia.—The *Journal de St. Pétersbourg* of Oct. 8/21 states that for more than 20 years researches have been made with a view to fixing on a waterfall capable of furnishing sufficient power to supply St. Petersburg with electricity. Hitherto, the most suitable for this purpose appeared to be a cataract in Finland, which it was proposed to utilise for the working of an electric tramway (see Board of Trade *Journal* of Sept. 8, p. 436). Further researches, however, have resulted in the discovery of the Kiviniemi waterfall on the River Voksen (46 miles from St. Petersburg), with energy equivalent to 25,000 h.p. This waterfall is about 45 miles closer to the metropolis than the one in Finland, and is offered for sale at a considerably smaller price. Unless the difficulties of conveying the current prove insuperable, the Kiviniemi waterfall will be purchased. This, remarks the *Journal*, will ensure the supply of electricity to private houses at a moderate rate, a consummation which was held to be impossible so long as the source of power was situated in Finland.—*Board of Trade Journal.*

Dundee.—The Works Committee on Monday considered an application from the National Telephone Company for permission to lay underground cables through several of the city streets. It is understood that there is a great difficulty to cope with underground wiring over a considerable area of the city, owing to the multiplicity of cables for electric and traction purposes, and it was resolved to recommend the Council to sanction the extension of the existing lines, but that no additional streets be opened for the purpose. A report was submitted

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relative to the proposed establishment of a kiosk to serve the purpose of a telephone call office in High-street, and it was remitted to the committee to ascertain whether a suitable niche might not be found within the line of The Pillars at the Town House.

Village Telephones.—The directors of the Notts and Midland Merchants' and Traders' Association on Monday passed the following resolution: "That this meeting congratulates the Postmaster-General on the experiments now being made with regard to village post offices serving the purposes of telephone call offices, and is of opinion that such service will be of great benefit not only to people residing in villages, but to traders generally; that, considering the arrangement made with the National Telephone Company, it cannot be expected that that company will undertake the extension work; and that a letter be written to the Postmaster-General expressing the hope that the principal villages in Nottinghamshire and Derbyshire may be connected with the existing system at an early date."

Islington.—At to-night's meeting the Lighting Committee will recommend the laying of a low-tension distributing main at a cost of £90. They will also report on an application from the Underground Electric Railways Company, Limited, for a supply of electricity upon special terms for lighting purposes at the tube railway stations in the borough in consideration of a guaranteed load factor of 23 hours per day all the year round. Inasmuch as this proposal has the exceptional advantage of ensuring what would practically be a continuous use of current, the committee recommend that the lowest rate already authorised by the Council for motive power—viz., 1½d. per unit—be charged for the supply of electricity to the Underground Electric Railway Company's stations in the borough where such supply can be taken from existing mains.

Hammersmith.—The Electricity and Lighting Committee in their last report state that the premises of 14 additional consumers, representing a maximum of 300 8-c.p. lamps, have been connected to the mains; that nine consumers have been disconnected; and that the present number of consumers taking current from the mains is 1,511. The borough surveyor has submitted plans showing the proposed third extension of the electric installation buildings, consisting of additions to the boiler-house. It is proposed to carry the structure on steel stanchions, coal bunkers for the storage of 450 tons of coal being provided. For the present the sides will be covered with corrugated iron. The floor provided over the boilers will be used to carry the economisers. A slate roof will cover the boilers, and a corrugated iron roof will cover the coal bunkers, both roofs being provided with glass skylights at top. The estimated cost of the work is £2,000. The cost of providing a new cable and excavating and laying a new pipe for the new workhouse is £1,462. Tenders for these works and for connecting Olympia are being invited.

Tiverton.—At Tiverton Mercantile Association last week the president, Alderman John Thorne, according to the *Western Morning News*, challenged the hon. secretary to produce any minute showing authorisation to the committee to organise an opposition to the present electric light scheme. It would be utterly impossible for public bodies to continue to do public work if at the last moment without any notice opposition were organised and utterly misleading statements made by a body which took no responsibility for its actions. The committee had gone behind the association and misrepresented facts to the Local Government Board's inspector, inasmuch as it had said so many people were in favour of the loan and so many against, whereas its unauthorised canvass was absurd, and not worth the paper it was written on. He was not called upon, and yet his name was on the list. He did not wish to see the association made the laughing-stock of the town by such actions. He moved "that the action of the committee in organising opposition to the application of the Town Council for a loan for installing the electric light was unwarranted, mischievous, and not such as would commend the work of the association to the public generally." Mr. Henson, a member of the Town Council, seconded the motion, which was not carried.

London Gazette.—A receiving order has been made out on creditors' petition in the estate of Arthur E. Brooks, electrical engineer, 110, Cheapside, London. The first meeting will be held at 11 a.m. on Nov. 7 at Bankruptcy-buildings, London. A general meeting of the British Electric Traction (Pioneer) Company, Limited, will be held at Donington House, Norfolk-street, Strand, London, W.C., on Wednesday, Nov. 30, 1904, at 11.30 a.m., for the purpose of having the liquidator's accounts, showing the manner in which the winding up has been conducted and the property of the company disposed of. The South Lancashire Electric Traction and Power Company, Limited, has been wound up voluntarily, and Henry D. Eshelby, of 24, North John-street, Liverpool, chartered accountant, appointed liquidator. A general meeting of the British Schuckert Electric Company, Limited, will be held at Clun House, Surrey-street, Strand, London, on Friday, Dec. 2, 1904, at 12 noon, for the purpose of having laid before the meeting the account of the liquidator, showing the manner in which the winding up has been conducted and the property of the company disposed of. An adjudication order has been made out in the estate of James Marsden, electric fittings manufacturer, 39, Woodcock-street, Birmingham.

Stoke-on-Trent.—The new electricity and destructor works which have been erected by the Corporation have just been formally opened. A combined scheme of refuse destruction and electricity production has been carried out. The streets of the town are lighted with gas from the Corporation's own works, and the electricity supply will be mainly to private consumers for lighting and power purposes. The continuous-current three-wire system, with a pressure of 240 volts between conductors, has been adopted. The engine-room contains two 240-i.h.p. Willans engines direct coupled to 150-kw. Dick-Kerr dynamos. The battery-room contains a battery of 242 Tudor cells having a maximum total capacity of 350 ampere-hours. About six miles of cables have been laid in wooden troughs. The destructor works contains complete duplicate sets of refuse destructor plant, each capable of consuming under average conditions 30 tons of refuse per day. The estimated cost of the whole scheme is £30,640, divided under two heads, that for the electricity works being £17,840, and that for the destructor £12,800. The buildings have been designed and carried out by Mr. A. Burton, borough surveyor, who has also superintended the erection of the destructor plant, and the electrical portion of the work has been directed by Mr. P. J. S. Tiddeman, the Council's electrical engineer.

Ripon.—The Electric Lighting Committee are considering an application from Messrs. Foote and Milne, Limited, Westminster, for consent to the application to the Board of Trade for a provisional order for the district. The firm offer to enter into an agreement with the Council embodying the following points—viz.: (1) The compulsory area to be named in the order to be the same as in the existing order held by the Corporation. (2) The powers to be contained in that order only to be exercised by a company to be approved by the Board of Trade, and in which company residents in the area of supply shall be given the opportunity of subscribing. (3) The maximum price for current to be named in the order to be 7d. per unit. The actual charges not to exceed the following: to the Corporation for lighting, 5d. per unit; to the Corporation for power, 2½d. per unit; to ordinary consumers for lighting, 6d. per unit; to ordinary consumers for power, 3d. per unit. (4) The Corporation to have the right to requisition the company to lay down distributing mains for the purpose of a general supply throughout any street, or part of a street in which the Corporation have the control and management of the public lamps, but such requisition not to be binding upon the company unless the Corporation give a written undertaking at the time of service to take a supply of energy for lighting the public lamps in such street or part of a street for a period of not less than three years; and it shall not be binding upon the company to supply energy to public lamps outside the compulsory area named in the order, unless such public lamps be placed at intervals of not more than 75 yards from each other, or from any existing distributing main of the company.

Cheltenham.—The report of Mr. Swinburne on the history, position, and prospects of the Cheltenham electricity undertaking has been received by the Council, and will come before the meeting on Nov. 9. At the last meeting of the Lighting Committee, Mr. Kilgour submitted a proposal for expending £1,900 in machinery in connection with the tramway extensions. The *Cheltenham Chronicle* understands that the mayor (Alderman Waghorne) and the town clerk have recently paid a visit to London to interview the Local Government Board with reference to the procedure to be adopted for the repayment of the accumulated deficit on the revenue accounts of the electric department, now represented by an overdraft from the bank, but which the Corporation have deprived themselves of the power to place upon the rates. The result of the interview was that the permanent officials conditionally pledged the Local Government Board not to oppose the Council's application for a provisional order, empowering them to raise a loan for the gradual redemption of the debt, but intimated that it must be accompanied by a guarantee that such a thing should not again occur. To this the visitors replied that they would give the pledge of the Council not to repeat this irregularity, but it was pointed out that they could not pledge future town councils of which they would possibly not be members. They therefore suggested the incorporation in the provisional order of powers for the appointment of a chartered accountant as auditor of the borough accounts. This idea also failed to commend itself, and in the end the condition laid down by the Board, if the provisional order is to be carried through, is that the Government system of audit must be applied to all the borough accounts.

Fulham.—The borough electrical engineer (Mr. Arthur J. Fuller) in his recent report on the advantages of opening a workshop recommends a 6in. screw-cutting gap bed lathe for the workshop at the electric lighting works, at an estimated cost of £50, in order that the smaller repairs at present carried out by neighbouring engineers may be carried out by the Council's staff. Regarding the first section of the electric lighting extension scheme authorised by the Council, the borough electrical engineer has submitted a report as set out below as to the date on which the various portions should be ordered: (1) generator switchboard, ordered (estimated date of completion of work, December, 1904); (2) 1,000-kw. Belliss set, December, 1904 (July, 1905); (3) chimney, December, 1904 (July, 1905); (4) boiler-house, buildings, and alteration, including new rectifier room (part ordered), December, 1904 (August, 1905); (5) coal bunkers, elevators, etc., December, 1904 (September, 1905); (6) four boilers and accessories (portion already ordered), December, 1904 (September, 1905); (7) boiler pumps, December, 1904 (September, 1905); (8) condenser, sump, and river work, January, 1905 (September, 1905); (9) wiring motors, March, 1905 (September, 1905); (10) exciter set, January, 1905 (July, 1905); (11) pipes (portion already ordered), February, 1905 (September, 1905); (12) economisers, March, 1905 (September, 1905); (13) turbo-alternator, ordered; (14) extra buildings, (15) connections, and (16) contingencies as required. Provision having been made in the extension scheme approved by the Council for new mains and connections to the extent of £6,000, we are of opinion that the Council would be well advised to adopt the borough electrical engineer's proposals for side street lighting, particularly having regard to the fact that in many of the streets referred to the paving has not yet been laid. It is recommended that electric mains be laid in Finlay-street, Stevenage-road, Harbord-road, Woodlawn-road, Creswell-street, Inglethorpe-street, Chipstead-street, Quarrendeon-street, Studdridge-street, Gliddon-road, Talgarth-road, Glazbury-road, and Palliser-road, as shown upon the plan submitted by the borough electrical engineer dated Oct. 24, 1904, at an estimated cost of £875. It is also recommended that incandescent lamps be installed in the streets as recommended by the borough electrical engineer as and when occasion requires.

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PROVISIONAL PATENTS, 1904.

OCT. 24.

22832 **Apparatus or means for automatically operating and controlling electric motor starters, particularly when used in connection with pumps which require to be automatically started and stopped.** The Tangye Tool and Electric Company, Limited, and Alfred Hewson Bate, 11, Burlington-chambers, New-street, Birmingham.

22838. **Improvements in or relating to electric arc lamps.** The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

22839. **Improved method of supporting electric tramway overhead power transmitting or trolley wires.** James William Allen, Abbotsford, Livingstone-road, King's Heath, Birmingham. (Complete specification.)

22903. **Improvements in and relating to controllers for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22904. **Improvements relating to electrical measuring instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22905. **Improvements in electro-thermic fans.** Frederic de Mare, 72, Cannon-street, London. (Complete specification.)

22908. **Multiple connecting system for telegraphic and telephonic communication.** Oskar Arendt, 216, Friedrich-strasse, Berlin, Germany. (Date applied for under Patents Act, 1901, Oct. 24, 1903, being date of application in France.) (Complete specification.)

OCT. 25.

22914. **Improvements in switch lampholders for electrical purposes.** Harold Ashton, 8, Bull's Head-yard, Manchester.

22915. **Improvements in the construction of single and two-way electric switches.** Clement Brown Folk Olai and Brown and Barlow, Limited, 16, Loveday-street, Birmingham.

22930. **Improvements in insulated bolts for electric tramway systems and the like.** James Haydock and Thomas Smith Jones, Penny Bank-chambers, Halifax.

22944. **Mercurial, electrical, and hydraulic automatic gas extinguisher in cases of fire by accident or otherwise and of steam or water.** John Poyzants Pavis and William Henry Edwards, 16, Lyndhurst-road, Peckham, London.

22959. **Improvements in electric incandescent candle lamps.** Arthur William Pitt, 34, Carmenia-road, Balham, London.

22963. **Improvements in connection with vacuum brake apparatus for electrically-operated and other trains.** James Gresham, Harry Edward Gresham, and George Kierman, 18, Southampton-buildings, Chancery-lane, London.

22964. **Improvements in gas or vapour electric apparatus.** James Reid Baker, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 6, 1903, being date of application in United States.) (Complete specification.)

22966. **Improvements in the construction of dynamo and like brushes.** Frederick John Chaplin and Robert Chaplin, 77, Colmore-row, Birmingham.

23001. **Improvements in automatic electric switches.** William M. Scott, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23009. **Improvements in or relating to intercommunication telephone systems.** Isidore Bernard Birnbaum and Herbert George White, 322, High Holborn, London. (Complete specification.)

23015. **Improvements in devices for automatically switching electric cars from one line to another, also applicable for other vehicles running on rails.** Robert Franklin Jones and Charles Joseph Jones, 6, Lord-street, Liverpool.

OCT. 26.

23027. **An improved terminal for resistance coils.** John Arthur Hirst and Percy Smith Brook, the Northgate Electrical Engineering Works, Victoria-road, Chester.

23031. **Improvements in fuse heads for electric blasting.** Frederick Render, 6, Bank-street, Manchester. (Complete specification.)

23032. **Improvements in hangers or cars for electric trolley wires.** Levi Thomas Allen and Richard Edgar Sharples, 6, Bank-street, Manchester.

23050. **Improvements connected with electric railways.** Oscar Sayle Gill, 139, Dale-street, Liverpool. (Complete specification.)

23056. **Improvements in electrical switches particularly applicable for use on motor cycles and the like.** Charles Walter Hathaway and Triumph Cycle Company, Limited, 18, Hertford-street, Coventry.

23064. **Improvements in switches for reversing the current in electric motors.** George Herbert Whittingham, 52, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 29, 1903, being date of application in United States.) (Complete specification.)

23090. **Improvement in methods of increasing the effective radiation of electromagnetic waves.** John Stone Stone, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Oct. 30, 1903, being date of application in United States.) (Complete specification.)

23093. **Improvements in contact breakers for overhead systems of electric traction.** Herbert Victor Mitchell, 55, Chancery-lane, London.

23094. **Improvements in and relating to shields and projectors for X-ray tubes.** Charles Wray Maunsell and Frederick Rowland Butt, 70, Chancery-lane, London.

23095. **Thermo-electric generators.** Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (William Edwin Haskell, United States.) (Complete specification.)

23097. **Improvements in electrical measuring instruments.** Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

23109. **Improvements in and connected with electro-capillary apparatus.** James Tarbotton Armstrong and Axel Orling, 61, Chancery-lane, London.

OCT. 27.

23118. **Electromagnetic device for automatically applying sanding apparatus on electrically-driven vehicles.** Mark Cummins, 8, Peel-terrace, Chester-road, Old Trafford, Manchester.

23128. **Improvements relating to the trolley pulleys of electric tramcars and the like.** Samuel Richardson Thompson, 55, Market-street, Manchester.

23150. **Improvements in apparatus for the distribution of alternating electric current.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 29, 1903, being date of application in France). (Complete specification.)

23165. **Improvements relating to electric gas igniting and extinguishing apparatus.** George Hill, 6, Bream's-buildings, Chancery-lane, London

23182. **Improvements in electric fire-alarms.** William Butterworth Hopkinson, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 15, 1904, being date of application in United States.) (Complete specification.)

23201. **Improvements in or connected with the third-rail insulators of electrical railways.** Edward John Chambers, 7, Staple-inn, London.

23203. **Improvements in contacts for electric controllers, reversing switches, and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23204. **Improvements in electric heating apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23205. **Improvements in and relating to the regulation of alternating electric distributing systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

OCT. 28.

23219. **Improvements in the caps of electric lamps, adapters, and similar fittings.** Harold Ashton, 8, Bull's Head-yard, Manchester.

23222. **Improvements in electric stop motions for drawing and roving frames** William Muir, George William Somerville, and Howard and Bullough, Limited, Globe Works, Accrington.

23253. **An improved construction of section insulator for electric trolley wires or the like.** Thomas Ernest Raymond Phillips, 11, Finsbury-square, London.

23254. **An improved construction of trolley head for collecting electricity from electric trolley wires or the like.** Thomas Ernest Raymond Phillips, 11, Finsbury-square, London.

23276. **Improvements in electrical apparatus and methods of manufacturing and operating the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23279. **Improvements in electrical resistances.** Hermann Aron 47, Lincoln's-inn-fields, London. (Complete specification.)

OCT. 29.

23302. **Improvements in or connected with magnetic or electromagnetic mechanism.** Louis Heathcote Walter, 92, Victoria-street, London.

23352. **Improvements in and relating to carbons for electric arc lamps and the like.** Otto Hellstern, 35, New Broad-street, London.

23377. **Improvements in dynamos.** Isidor Deutsch, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23380. **A process for smelting nickel ores in an electric furnace and an improved crucible therefor.** La Société Electro-Métallurgique Française, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 30, 1903, being date of application in France.) (Complete specification.)

23392. **Improvements in alternating-current motors, also relating to generators and direct-current machines.** Valere Alfred Fynn, 70, Chancery-lane, London.

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COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 17, 1904.

1903.

22758. Voltage-regulated electric system for lighting railway and other carriages, for ventilating, heating, and other purposes. Dalziel.

22858. Electrically-synchronised clocks and the like. Chandler and Bonniksen.

22911. Alternating-current motors. Carolan. (General Electric Company.)

22913. Alternating-current motors and methods of controlling the same. Carolan. (General Electric Company.)

23521. Loose-handle automatic magnetic blow-out circuit breakers. Whipp.

23608. Electric switches. Tomlinson and Lomax.

24799. Electric motor systems applicable to electric railways and like purposes. British Thomson-Houston Company, Limited. (General Electric Company.)

25482. Apparatus for obtaining variable electrical ignition applicable to gas-engines. Mellor.

25527. Electric train-control sytems. British Thomson-Houston Company, Limited. (General Electric Company.)

25591. Induction coils and transformers. Delves, Broughton, and Cole.

25855. Electric switches. British Thomson-Houston Company, Limited. (General Electric Company.)

26851. Voltage-regulating devices for alternating-current electric lines. Fitzi.

27446. Form of mechanical ear for suspending overhead lines or wires especially for electric traction purposes. Rea and Reindorp.

27506. Dynamo-electric machinery. Wright and Midgley.

28192. Ball-bearing for use on motors, dynamos, and other machines. Haynes and Gowing.

28453. Electrical motor-starting switch. Crowther and Horsfall.

1904.

461. Means for securing wires on insulators Benedikt and Macek.

786. Means or apparatus for forming the joints in conduits for electric cables. Sutton and Gregson.

2093. Means for the excitation and regulation of induction machines. Leblanc. (Date applied for under International Convention, Jan. 28, 1903.)

7208. Controlling systems for electric motors. Westinghouse and Aspinwall. (Date applied for under International Convention, May 1, 1903.)

9340. Means for carrying overhead trolley wires of electric tramways. Morris.

11857. Electric switches. Stevens.

12007. Regulating apparatus for automatically maintaining electric accumulator charging currents constant. Akt.-Ges. Brown, Boveri, et Cie.

12643. Control of continuous-current electric motors for use in electric traction. Mégroz. (Date applied for under International Convention, June 4, 1903.)

14526. Electric motor controllers. Barrett.

15382. Sub-station connecting arrangement for telephone systems. Birnbaum and White.

15952. Electrode for electrical accumulators. Berg. (Date applied for under International Convention, July 18, 1903.)

17046. System of electric traction for railways and tramways. Marshall.

18098. Wireless telegraphy and apparatus for carrying out the same. Dymond. (Ges. für drahtlose Telegraphie m. b. H.)

18181. Telegraph transmitters. Roussel and King.

19561. Trolleys or collectors for electric tramways. Honnette and Gebhardi.

19683. Electric igniters for explosion engines. Eisemann.

20007. Supports for incandescent electric lamps. Romain and d'Ayguesvives.

20278. Electric switch. Hunter and Warren.

20791. Device for supporting electrical conductors. Bettmann and Zapp.

20975. Electric incandescent lamps. Boult. (Ad. Wagner S. Brechtel und Co.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	5/16-7/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5½-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5½-6
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	3½-4
—— 4 per cent. Mortgage Debenture Stock	100	..	87-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1-1½
—— 4½ per cent. 1st Debenture Stock	100	..	94-97
—— 4½ per cent. 2nd Debenture Stock	100	..	70-75
Callender's Cable, Debentures	100	..	105-106
—— Ordinary	5	..	9-10 xd
—— 5 per cent. Pref.	5	..	5-5½
Crompton and Co.	5	..	14-2
—— 5 per cent. Debentures	100	..	90 95
Edison and Swan United, "A" Shares, 1-98,261	5	..	¼-¾
—— "A" Shares, 01-017,139	5	..	1-2
—— 5 per cent. Debentures	100	..	79-84
—— 4 per cent. Deb. Stock, Red.	100	..	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1-1½
—— 7 per cent. Cumulative Pref.	2	..	2-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-9¾
—— 4 per cent. 1st Mort. Deb. Stock	100	..	91-96
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	..	108-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	19½-20½
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	36-39
—— 5 per cent. Bonds	100	..	101-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9½-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock. Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co.	5	..	5½-5¾ xd
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103 xd
Brompton and Kensington, Ordinary	5	..	10½-11
—— 7 per cent. Preference	5	..	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	7½-8
—— Nos. 20,001-30,000	5	..	7-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	12½-13½
Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	8½-9
—— 70,001-80,000	5	..	8-8½
—— 4½ per cent. Cum. Pref.	5	..	5¾-5⅞
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 40,001-80,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	103-106
Chelsea Electricity Supply	5	..	6½-7
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10½-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	103-106
County of London Electric Supply, Ordinary	10	..	9-10
—— 6 per cent. Cum. Pref.	10	..	11¾-12½
—— 4½ per cent. Debentures Prov Certs. All pd. Rd.	100	..	100-103 xd
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-6⅝
—— 6 per cent. Cum. Pref.	5	..	6¼-6¼ xd
—— 4½ per cent. First Mort. Deb.	100	..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	1¼-2½
—— 5 per cent. Debenture Stock, Red	100	..	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	101-104
Havana Electricity, Limited, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Limited, Ord., 1-15,000	5	..	7½-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	..	99-101 xd
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	..	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-31,000	5	..	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10½
London Electric, Ordinary	5	..	2-2½
—— 6 per cent. Pref.	5	..	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-99
Metropolitan Railway	10	..	15¾-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	112-117
—— 4½ per cent. Cum. Pref.	5	..	5¼-5½
—— 3½ per cent. Mortgage Debenture, Red.	100	..	96-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	..	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	..	100-103
Notting Hill Electric Lighting	10	..	14¼-15¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	99-102
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310	5	..	5¾-6¼
—— 4 per cent. Debenture Stock	100	..	98-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	..	93-101
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2¾-3¼
—— 4 per cent. Debenture Stock	100	..	93-101
South London, Ordinary		..	4¼-4¾
South Metropolitan Electric Light and Power Co., Ord.	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1¼-1½
—— 4½ per cent. 1st Mort. Deb.	100	..	106-110
—— Ditto, June, 1901		..	
St. James's and Pall Mall, Ordinary, 101-80,000	5	..	14-15
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4¼-5
Westminster, Ordinary	5	..	12½-16½
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	5-5¼
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	..	5⅜-5⅝
—— Ord.	5	..	6¼-7¼
—— Permanent 5 per cent. Debenture Stock, 1888	100	..	139-142
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	104-106
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-95
Bath Elec. Tramways., Ld., Pref. Ord. Shs., 75,001-150,606	1	..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	..	13¾-13⅞
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3¾-4¼ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	98-101
British Columbia Electric Railway Co., Ord. Def.	100	..	103-105
—— Ord Pref.	100	..	102-105
—— Non. Cum. 6 per cent. Pref.	10	..	10¼-10¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	..	102-104 p et
—— 4½ per cent. Vancouver Power Deb.	100	..	97-100
British Electric Traction Ord. 1-500,000 & 60,001-80,000	10	..	9¾-10¼
—— 6 per cent. Cm. Pt., 50,001-60,000	10	..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	116-119
—— 4½ per cent. 2nd Deb. Stock	100	..	94-97 xd

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5		3¼-4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	6½-6¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5¼-5⅝
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	102-105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7-7⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways, Nos. 1-480,000	1	–	1⅛-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4⅞-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	101-104 xd
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5		3⅞-4⅛
—— 4 per cent. Debenture Stock	100	–	90-93
Kidderminster and District Lighting and Traction, Pref.	5	–	8-8½
London United Trys. (1901). 5 per cent. Cum. Pref.	10	–	10½-11
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100-105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	⅛-⅜
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	⅛-1
—— 4½ per cent. Deb. Stock, Red.	100	..	102-104
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	–	¼-1½

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	2-12¼
—— 5 per cent. Cum. Pref.	10	–	9⅜-9⅝
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	–	103-105
Potteries Electric Traction, Ordinary 20,001-40,000	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8½
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		⅛
—— £101,132 6 per cent. Preference	1		1
—— £528,093 4½ per cent. Debenture Stock	100	p.c.	p.c.

Electric Railways.—

Central London, Ordinary	100	–	91-94
—— 4 per cent. Pref.	100	–	100-102
—— " " deferred	100	–	81-83
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	107-110
City and South London, Consolidated Ordinary	100	–	46-48
—— 4 per cent. Debenture Stock	100	–	104-107 xd
—— 5 per cent. Pref. Stock '81	100	–	122-125
—— " " " '86	100	–	117-120
—— " " " '01	100	–	113-117
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10¼
—— Ordinary, 1-50,000	10	–	3⅜-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	–	98-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	–	99-99½
Waterloo and City, Ordinary	100	–	87-90

Telephones.—

National Telephone, Preferred	100	–	106-108
—— Deferred Stock	100	–	96-98
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅝
—— 5½ per cent. Deb. Stock, Red.	100	–	97-99
—— 4 per cent. Deb. Stock, Red.	100	–	104-106
—— 4 per cent. Prov. Cert.	—	..	67-69
Oriental Telephone and Electric Company	1	–	15/16-1 1/16 xd
—— 6 per cent. Cum. Pref.	1	–	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 29	1,152	1,227	– 74	— h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	—	—	—	—	—	8	8	,, 15	14,160	3,201,586	336,049	1·03	10·11	1,770	5·04
Barking Corporation	,, 29	43	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 30	960	1,050	– 90	—	23·55	23½	March 31	56,0 3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Tramways	,, 29	5,382	5,208	+ 174	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 28	911	783	+ 123	+ 3,015	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·59
Blackpool Corporation	,, 27	435	378	+ 57	+ 5,825	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	Sep. 5	1,463	1,368	+ 95	– 40	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	Oct. 10	1,682	1,790	– 108	—	38	38	March 31	94,151	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 26	954	876	+ 78	+ 2,003	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 29	4,518	3,723	+ 795	+25,271	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 30	833	851	+ 22	+ 3,277h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 28	4,833	4,625	+ 203	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 29	1,043	820	+ 223	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 30	304	356	– 52	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·84	1,570	7·67
Cardiff Corporation	,, 22	1,964	1,927	+ 36	+ 1,763	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 29	170	200	– 30	+ 207	—	—	Dec. 31g	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 29	6,776	6,746	+ 30	– 252h	6	6	,, 31	362,471	44,933,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 30	2,618	2,799	– 181	– 1 658h	6½	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	Sep. 14	321	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Oct. 27	450	480	– 30	– 2 533	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 23	228	230	– 2	– 98	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·66	1,707	9·36
Dover Corporation	,, 24	195	184	+ 8	– 285	4½	4½	,, 31	11,255	2,871,332	280,901	0·91	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 28	100	98	+ 2	– 254	7	6¾	Dec. 31g	6,234	688,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 28	3,740	3,622	+ 118	—	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 28	838	741	+ 97											
Dundee City Tramways	,, 26	833	820	+ 13	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 29	628	612	+ 16	+ 1,511	10·77	10·75	March 31	34,312	12,950,259	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 29	14,619	13,996	+ 623	— h	143	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	Sep. 21	342	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	Oct. 19	2,636	2,535	+ 100	+ 3 5 6	33	30½	March 31	68,289	16,333,054	1,387,885	1·00	11·79	2,059	8·77
Huddersfield Corporation	,, 29	1,212	1,225	– 13	+ 2,774	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 29	2,136	1,935	+ 200	+ 8,879	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 29	383	354	+ 29	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 26	164	180	– 16	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 26	202	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 29	5,420	5,303	+ 112	+10,900	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	Sep. 3	1,506	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 22	10,437	10,051	+ 405	+15,047	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 30	1,521	1,588	– 67	– 1,268h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— e
London County Council	,, 22	12,844	9,901	+2,943	+70,818	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 23	160	175	– 15	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 20	143	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 29	12,0 8	11,591	+ 467	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 28	1,812	1,170	+ 641	+ 8,616h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 29	113	92	+ 21	+ 1,176	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 29	3,560	3,669	– 109	—	45	38½	,, 25	185,027	39,715,120	4,059,807	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	,, 29	465	444	+ 21	—	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	29	,, 31	91,448	18,204,426	1,928,193	1·15	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 27	449	437	+ 12	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 29	89	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 30	4,559	4,499	+ 59	+ 2,925	34¼	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 27	899	869	– 69	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	,, 19	272	243	+ 29	+ 1,292	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 28	527	340	+ 187	+ 7,350	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 30	1,125	1,072	+ 53	+ 637	19·54	18·48	,, 31	62,505	14,348,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	,, 1	312	—	—	—	3¼	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 24	669	634	+ 35	+ 1,464	10·5	10·5	,, 31	35,864	6,554,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 27	1,075	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 25	711	444	+ 266	—	7½	—	,, 31g	20,378	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. e Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
j Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Wireless Telegraphy.—It is reported that a Bill will be shortly introduced in Canada for the governmental control of wireless telegraphy, the military authorities urging the expediency of such control in time of war.

Willesden Polytechnic Electrical Engineering Society.—A meeting of the above was held on Saturday evening last, when an interesting paper was read by Messrs. Hayman and Lawrance on the subject of the lighting and power arrangements in the new building. The subject was treated in a very complete manner, and led to considerable discussion. A vote of thanks to the authors concluded the meeting.

Society of Arts.—The Society of Arts will commence its fourth half-century on the 16th inst., when Sir William Abney, as chairman of the society's council, will open the one hundred and fifty-first session with an address. The subjects on which papers will be read at the meetings before Christmas include British trade, canals, the St. Louis Exhibition, patent law, Burma, and street architecture. There will also be a course of lectures on wind instruments, with musical illustrations.

Royal Society.—The council of the Royal Society have bestowed the Copley medal upon Sir William Crookes, F.R.S., in recognition of his extensive researches into spectroscopic chemistry, electrical and mechanical phenomena in highly rarefied gases, radioactive phenomena, and other subjects. Prof. Ernest Rutherford, F.R.S., receives the Rumford medal for his researches into radioactivity, particularly for his discovery of the gaseous emanations from radioactive bodies and their properties. The Davy medal is awarded to Prof. W. H. Perkin, jun., for his discoveries in organic chemistry. Sir Joseph W. Swan gains the Hughes medal for his invention of the electric incandescent lamp and various improvements in the practical application of electricity.

Permanent-Way Institution.—We have received a pamphlet relating to this institution, which was founded by Mr. W. L. Meredith, C.E., and has been doing useful work during the last 20 years in furthering the education of inspectors and others concerned in the permanent-way work of railways by the reading and discussion of papers. There are numerous local sections, and Colonial centres are in contemplation. The council have decided to award gold and silver medals for the two best papers sent in each year. The membership roll has been steadily increasing, and now approaches to a total of 500, which it is hoped to still further increase in the near future. We note that a council meeting will be held at Nottingham on the 12th inst., when new members will be elected and the officers of 1905 nominated. The hon. secretary is Mr. G. E. McLewin, and the London offices are at 9, Gracechurch-street, E.C.

The Effect of Pressure on the Light from an Electric Arc.—In a paper presented to the American Physical Society, of which an abstract appears in the New York *Physical Review*, Mr. W. J. Humphries describes some further tests carried out by him. An electric arc was enclosed in a steel cylinder provided with a quartz window, and the light as produced in air of high pressure examined by means of a Rowland concave grating of 21½ft. focal length. The decrease in wave frequency, detected and measured by Mohler and the author some years ago at the Johns Hopkins University, has been confirmed, and the observations, with the same results, have been extended to many other lines and to a somewhat higher pressure. This work is being done through the aid of the Rumfor Fund, and apparatus is nearly ready by which the investigation can be extended to fully 300 atmospheres pressure if necessary.

St. Louis Awards.—We are glad to see that this country has come in for a considerable share of awards in connection with the St. Louis Exhibition. Amongst those who have been successful in the electrical engineering and kindred branches, we learn that Messrs. Kelvin and James White, Limited, have been awarded a gold medal for the various measuring instruments for switchboard, test-room, and laboratory use exhibited by them. Messrs. Crompton and Co. have gained a similar award. Messrs. Sherard Cowper-Coles and Co., Limited, have been awarded two gold medals—one for electro-chemistry and the other for metallurgy. We also note that Messrs. W. F. Stanley and Co., Limited, 4 and 5, Great Turnstile, Holborn, have obtained a gold medal for surveying and drawing instruments; and that Messrs. William Simons and Co., Limited, Renfrew, have been awarded the grand prize for their exhibit of dredging plant.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Tuesday afternoon, Sir James Crichton-Browne, treasurer and vice-president, in the chair. H H. the Raj Rana Bhawani Singh Bahadur of Jhalawar, Mr. J. Jennens, and Mr. E. J. Preston were elected members. It was announced that the institution had received a bequest of £100 under the will of the late Miss Harriet Jane Moore. The special thanks of the members were returned to Dr. Ludwig Mond for his donation of £755 for the purpose of erecting a lift from the basement to the second floor of the institution, and any surplus after the completion of the work to go to the research fund. During the recess the entrances and exits of the lecture-room of the Royal Institution have been materially improved by the erection of two covered-in iron staircases, and the widening of the doorways, and the ceiling has been considerably raised. A Christmas course of lectures, adapted to a juvenile auditory, will be delivered by Mr. Henry Cunynghame, C.B., on "Ancient and Modern Methods of Measuring Time" (experimentally illustrated). The dates of the lectures are Dec. 27, 29, and 31, 1904; Jan. 3, 5, and 7, 1905.

Long-Distance Transmission.—California is the home of long-distance high-voltage transmission, which is due to the fact that water power is abundant, while coal is dear and transport facilities few. We have recently received from the Stanley Electric Manufacturing Company, of Pittsburg, a most interesting map showing the long-distance transmissions now actually working in California. From this we note that energy is being transmitted commercially from a number of power-houses over a very extensive area, the present longest distance transmission being 232 miles — from De Sabla power-house to Sausalito, *viâ* Cordelia. A total of 10,000 h.p. is being regularly delivered into San Francisco from the Electra power-house, *viâ* Stockton and Mission San José, a distance of 147 miles. The map is ornamented by some photographs of transmission lines and power-houses, which make it more complete and of considerable interest to electrical engineers. Owing to the cheapness of coal in England, similar long-distance transmission plants are out of the range of commercial politics here. It is worthy of note that these long-distance lines are invariably overhead, which keeps the cost down to a point quite impossible with underground conductors.

Patent Law.—The subject of "The Effect of Patent Law on Modern Civilisation," selected by Mr. C. T. A. Haussen last week for his presidential address to the Civil and Mechanical Engineers' Society, possessed additional interest from the approach of the new regulations which

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come into force on Jan. 1. A strong plea was advanced for the greater protection of inventors, who have conferred extensive benefits upon the public without in many cases reaping a fair share of the prosperity themselves. Mr. Haussen instanced the case of James Watt, who would have obtained little return for his patent had not the term been enlarged, although owners of property contiguous to railways have had the value of their holdings enhanced enormously. He advocated more liberal legislation so as to render patent grants more secure and to increase their duration, which would give inventors a better chance of making their patents successful. In regard to the duty payable on grants, Mr. Haussen suggested that, in lieu of fixed fees, a tax should be levied upon the income derived, thus furnishing a substantial source of revenue. The advantages of such a system from the inventor's point of view are not quite obvious. It can hardly be the moderate fees payable to the Patent Office for the grant that handicap struggling inventions, while in the case of successful patents the proprietors presumably pay income tax already.

Street-Lighting.—Hearsay evidence, which is not accepted in courts of law, is published freely in the daily Press. We have before us at the present time a cutting from a paper containing an extract from the *Pall Mall Gazette* on the question of street-lighting. The extract is from the letter of a correspondent, and the newspaper which publishes this extract does not trouble to give even the name of the correspondent, so that the value of his opinions may be gauged. We are therefore obliged to draw our own conclusions as to his fitness to give an unbiassed opinion as to the relative merits of gas and electricity for street-lighting. He says: "The fact that Kingsway and Aldwych are to be lighted by gas and not by electricity will come as a surprise to 'the man in the street.' But incandescent gas under pressure has made such headway during the past few years that electricity as a street illuminant has been badly beaten both on the score of cheapness and efficiency. The arc light is ruinously expensive, and when the contract period for lighting the City's streets has expired, incandescent gas will certainly be substituted." We presume that neither the editor of the paper from which we take this extract—the editor of the *Pall Mall Gazette*—nor the correspondent whose epistle the latter journal publishes is aware of the extensive trials, ranging over some years, which have been carried out by Mr. Bradley, the engineer to the city of Westminster. These trials conclusively prove the incorrectness of the views expressed in the above letter, and show that electric arc lighting is the cheapest and most efficient method of illuminating public streets.

Electric Lamps.—The question of the supply of electric lamps by the electrical undertaking is one which has exercised the minds of a large number of central-station engineers. These engineers have to work undertakings in competition with gas companies, and are handicapped by the fact that users of electricity are very prone to buy their lamps in the cheapest market. The result is that their bill for energy goes up, while the light actually obtained from these lamps goes down, and electric lighting is discredited. The obvious solution, which, unfortunately, is not easy of adoption, is that electrical undertakers should supply consumers free with electric lamps of high quality. We have recently received an interesting circular from the City of London Electric Lighting Company, which clearly shows that this matter is appreciated by the engineer of this company. In this circular consumers are urged to use only lamps of the best English manufacture, and the company offer advice gratuitously as to the best makes obtainable. The lamps actually in use will be also inspected by the company's expert free of charge. This move is in the right direction, and is worthy of noting by electric light undertakers who do not already adopt some such methods in order to maintain their position against gas competition. It is the more necessary from the fact that gas companies throughout the country almost invariably undertake the maintenance of incandescent gas-burners. In the same circular an offer is made to carry out insulation tests of consumers' wiring at the low fee of 10s. per test, which includes a report as to any alterations or repairs that may be required.

Electricity and Fire.—The Manchester Corporation recently introduced in its fire department a self-propelling engine fitted with a dynamo, air-pump, and telephone system. This arrangement is intended primarily to assist the fireman in rescuing persons overcome by smoke, and to fight the flames in situations where the absence of such apparatus would render his position untenable. The fireman's headgear comprises a hood, to which is attached an air-pipe, telephone instrument, and an incandescent lamp. Thus provided, our fire guardians can operate in situations where the absence of such an outfit would mean prompt asphyxiation. The fireman obtains a supply of pure air, enabling him to breathe in the foulest atmosphere; the incandescent lamp provides illumination; and the telephone establishes communication with the chief of the party. A great feature of this innovation is that, like most ingenious devices, it is comparatively simple. The additional equipment on the fire-engine is not large, consisting of a small dynamo and the telephone apparatus. The dynamo, which supplies current for eight 32-c.p. lamps, is driven, like the air-pump, from the flywheel of the steam pump. Such an apparatus may reasonably be expected to soon pay for its relatively small cost in the property, to say nothing of the lives, saved. We do not know whether this equipment has yet been called upon to undergo the practical test of a heavy fire, but it certainly promises to be of no little utility. This is evidently the view of some of our Transatlantic friends, and one of the American technical journals frankly asks whether in this instance, at any rate, that land of enterprise cannot learn a lesson from outside. Manchester seems to have scored.

Societe Industrielle de Mulhouse.—This society is offering a number of medals and awards for competition in the early part of next year. The competition is open to the world, but all engineers sending in apparatus or designs should do so before Feb. 15. These should be addressed to the president of the society at Mulhouse. As an example of the awards which are open, we give the following. The society offers a silver medal for the best new application of electricity in the bleaching industry, or in painting or printing. Again, a silver medal is offered for the best essay treating of the comparative expense of installing in a given factory an electric light plant, a gas plant, an acetylene plant, and a water-gas plant. The installation must consist of at least 300 lamps, and the scheme must be worked out in detail. First cost and cost of maintenance should be gone into, and a comparison made of the intensity of the illumination obtained with the different systems. The society also offers a medal of honour and a sum of £20 for the best scheme for controlling a printing machine, or any other machine requiring variable speeds, by means of a three-phase motor supplied at constant frequency and voltage. Certain limits are laid down, as, for instance, the efficiency must not be less than 40 per cent. under any conditions, nor must the power factor be lower than ·4. The horse-power required may be assumed at 10, and the variation of speed about five times the lowest

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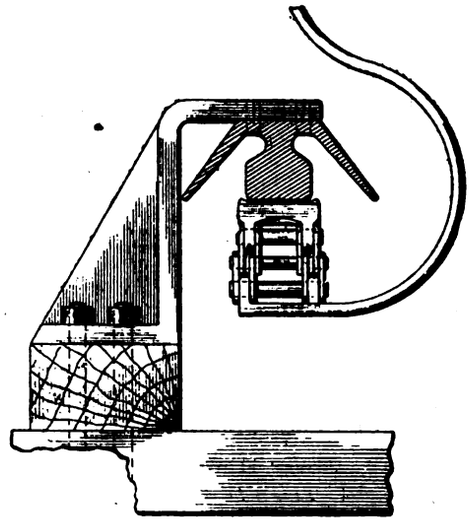
speed. In this case, unfortunately, the competitor must have had his devices working for at least six months in a factory in Alsace. The results of this last competition should be interesting to electrical engineers, but we doubt if the value of the award is quite sufficient to secure a representative entry.

Electrical Enterprise in South Africa.—Our contemporary the *British and South African Export Gazette* gives in a recent issue an interesting interview with Mr. R. A. Dawbarn, M.I.E.E, of the firm of Mordey and Dawbarn, who are responsible for the new electrical works of the Johannesburg Corporation. Mr. Dawbarn's remarks on the British manufacturer are worthy of reproduction, and will be appreciated by the hardly-used class of electrical engineers. In this respect Mr. Dawbarn said, speaking of the design and manufacture of single-phase alternating plant: "The English makers are undoubtedly holding their own in regard to design, price, and quality alike, and nowadays they are also quite able to deal with three-phase problems as efficiently as their foreign competitors. The fact is that the Englishman is by no means behind the foreigner, and it sometimes happens that a new idea is quietly utilised in England long before it is suddenly discovered and boomed elsewhere. For instance, you have the Liverpool Overhead Electric Railway, which has been running quite 13 years, though many people are under the impression that this means of locomotion is purely American. Another example is the City and South London Railway's Greathead tunnel for deep-level electric trains, which was the pioneer of its type. The Englishman is not given to advertising his achievements so much as some of his competitors, and the world often accepts the widest claims of adept advertisers without question." Mr. Dawbarn went on to criticise our manufacturers in one respect—*i.e.*, they were content to be poorly represented in South Africa. He added that "American and Continental representatives of machinery houses in the majority of cases possess a far better technical education than their English rivals, and they are consequently able to carry more conviction and to better realise local requirements. I feel convinced this influences British trade very prejudicially." The rest of the interview deals with questions concerning the Johannesburg scheme, treated by us in former issues.

Proposed L.C.C. Overhead Line.—Though the majority of the metropolitan borough councils have proved obdurate in the matter of consenting to the overhead system north of the Thames, it is not likely that the County Council will encounter similar opposition from the Camberwell and Lambeth boroughs in regard to the proposed tramway extension from South Norwood to the Crystal Palace. The Croydon Corporation, whose system is on the overhead principle, are seeking powers to extend their lines so as to provide a service to the Palace, and as the last two or three hundred yards of the line will come within the metropolitan area, they have approached the County Council with a view to the latter body undertaking the construction of this short length, and either leasing it to the Corporation or granting through running powers. At Tuesday's meeting of the County Council the Highways Committee made a favourable recommendation, so that as the two boroughs within whose districts the route is situate are scarcely likely to withhold their consent, the next few months will probably witness the introduction of the overhead system on the lines owned by the County Council. Another matter before the Council was the vexed question of carrying the tramways over Blackfriars and Westminster Bridges and joining them by way of the Embankment. As the City Corporation is apparently disposed to reconsider its attitude on this point, there is a fair chance of the Council's perseverance being rewarded, especially if the trend of events during the past two or three years has had the effect of modifying Lord Halsbury's æsthetic susceptibilities in accordance with public requirements. In such an urgent matter as this, it is surely unnecessary to wait until the Royal Commission has waded its way through the enormous mass of evidence on the whole London traffic problem, particularly when hitherto uncompromising opponents like the City Fathers evince a tendency to recognise both the need and the reasonableness of the proposal.

New Third-Rail Design.—A patent has been granted in the United States to Mr. A. F. Chase for a third-rail design, of which a description, with the accompanying diagram, appears in the *Electrical Review* of New York.



The depending portion of the rail has its widest part at the under-face thereof, and this width is proportionate to the face of a contact shoe, intended to receive the propelling current from the rail. The upper part of the depending portion, which is the rail proper, preferably narrows toward the top into a neck-like form, terminating in a flat top, from which spread outward on each side two oppositely disposed flanges. From these flanges extend wings, which are preferably straight and must incline downward and outward, and are of such lengths as to bring their lower ends in or about the same horizontal plane as the base or contact face of the rail proper. In each of the flanges are boltholes, drilled vertically through the same, to enable the third-rail conductor to be mounted to the rail-hanger. This construction of third rail provides a water-shed over the rail proper, and may be made integral therewith, the downwardly inclined extending wings also protecting the conductor laterally.

40,000-Volt Transmission.—An interesting plant has recently been laid down in Northern Italy by Messrs. Brown, Boveri, and Co., of Baden. The works are situated near Gromo, amongst the Alps, and energy is transmitted some 20 miles to Nombro at 40,000 volts. The reason for this very high voltage was that the engineers wished to get the loss of energy in the line down to 4 or 5 per cent., and to use wires not more than 6·5mm. in diameter. The central station is equipped with three groups of turbo-generators of 750 kw. capacity The alternators are three-phase and work at a frequency of 50. The transformers are connected directly to the alternators without the intervention of any kind of interrupter, and the generator and transformers are connected in parallel on the high-tension side. The transformers are oil-cooled, and the oil is kept cold by means of water circulating through cooling pipes placed in the oil. In each of the three

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main conductors there are placed three single poles, oil break switches, which act automatically for excess current, and can be operated by hand. As these interrupters are arranged to act simultaneously, there are six breaks in the circuits at the same time when the switches are open. The automatic switches are opened by mechanical means to ensure simultaneous working. The insulators used on the overhead line are of special make, and have been tried up to 80,000 volts in dry air. When the moisture in the air reaches 60 per cent., there is a discharge to earth at 39,000 volts, and when water falls on the insulator there is a slight discharge at 54,000 volts. The insulators are carried on poles 26ft. high, and the wires are spaced 33in. apart. On sharp curves the poles are placed close together, but the mean distance is about 44 yards. The working results from this installation will be of great importance to the profession as a whole. The experience gained at these high voltages under the climatic conditions of Northern Italy will be of special value.

British Mineral Production in 1903.—A report on mines and quarries issued by the Home Office gives the amount and value of the home production of minerals during 1903. The total value of the minerals raised amounted to £101,808,404, a decrease of £5,296,480 as compared with 1902. This decrease, however, is to be accounted for by the fall in the average price of coal from 8s. 2·84d. per ton in 1902 to 7s. 7·93d. in 1903, the output of that mineral being the highest hitherto recorded—viz., 230,334,469 tons, an excess of more than three million tons over that mined in the preceding 12 months. The quantity of coal exported, exclusive of coke and patent fuel, and of coal shipped for the use of steamers engaged in foreign trade, was 44,950,057 tons, an increase of nearly two million tons on the exports for 1902. Germany, France, and Italy each received over six million tons, Sweden over three million tons, and Russia, Spain, Denmark, and Egypt each over two million tons. Adding the 2,055,444 tons exported in the form of coke and patent fuel and the 16,799,848 tons shipped for the use of British and foreign steamers engaged in foreign trade, the total quantity of coal which left the country was 63,805,349 tons. The amount of coal remaining for home consumption was 166,529,120 tons, or 3·930 tons per head of the population; 18,302,240 tons were used in the blast furnaces for the manufacture of pig iron, as against 17,649,137 tons in the previous year. The output of iron ore, 13,715,645 tons, shows a further increase of 289,641 tons, but the value (£3,229,937) is less by £58,164 than in 1902. The ore yielded 4,500,972 tons of iron, or about one-half of the total quantity of pig iron made in the country; 6,314,162 tons of iron ore were imported during the year, 78 per cent. of which came from Spain. Copper, gold, lead, silver, and zinc all show an increase on the figures of 1902 both in the amount and value of the metal obtained, and in the case of tin, although the amount obtained is less, the value is greater. Of the non-metallic elements an increase from 150,000 to nearly a million cubic feet in the output of natural gas at the Heathfield workings is recorded.

Municipalities and the Telephone.—The Postmaster-General received on Monday a deputation of representatives of corporations owning telephones, with reference to the proposed acquisition of the National Telephone Company's system by the Government. Delegates attended from Glasgow, Guernsey, Hull, Brighton, and Swansea. The municipality of Portsmouth were not represented, but telegraphed to say they were in accord with the views of the deputation. The Lord Provost of Glasgow explained that the authorities who had already organised and were working municipal telephones were in a state of considerable anxiety and doubt as to the future, which tended in some measure to restrict their efforts. They were of opinion that, if bought at all, the whole of the National Telephone Company's system ought to be purchased by the Government, and perhaps a solution of the problem would be the granting of a lease for a stated period of years to the great municipalities who had a service working in concert with that of the Government. Alderman Carden (Brighton), in answer to the Postmaster-General, stated that he thought it would be impossible to make it compulsory on municipal authorities throughout the kingdom to take over the telephone system. The Postmaster-General remarked that the effect of that would be that only the profitable undertakings would be worked by the municipal authority, and the unprofitable districts would be left to be worked by the Government, a policy which he was afraid he could not support. He expressed his gratification that the deputation were agreed that, if the National Telephone Company's business were purchased, it should not be done piecemeal, but as a whole. Similarly, any arrangement that might be made, or might be considered advisable, for the transfer to municipal authorities of the powers acquired must be equally in its entirety and not in part, and every municipality would then have to take it over and work its local exchange whether it liked it or not, leaving in the hands of the Government simply and solely the trunk lines. He did not know what Parliament would decide, but personally he should never himself support any view different from that, and he could not see that the transfer of any portion of this business to municipalities would conduce to cheapness or to efficiency. The deputation afterwards consulted with the Postmaster-General in private.

Electricity Vindicated.—The Electrical Contractors' Association is evidently animated by a laudable ambition to remove the firebrand stigma inflicted upon electricity by the indiscriminating reporter. From the official organ of that body we learn that a disastrous conflagration occurred a few days ago at St. Chrysostom's Church, Manchester. An electric lighting installation had been completed in the church a few days before, and, as it happened, the light was switched on for the first time on the day of the catastrophe. The flames spread with great rapidity, and within a few minutes of the discovery of the outbreak all hope of saving the edifice was abandoned. Beyond the bare fact that the electric light had been in use on the day, there was not a vestige of evidence to connect the conflagration with the new installation; but, following the usual practice, many of the papers in the neighbourhood immediately attributed the disaster, more or less candidly, to the electric lighting. The Manchester section of the Electrical Contractors' Association determined that these statements should not go unchallenged. After instituting preliminary enquiries, the association conducted an investigation into the matter in conjunction with the Corporation electrical department. Prior to the current being switched on when the light was used for the first time, a careful test had been made of the wiring, which proved to be completely insulated. Although the fire had left no trace of its cause, enquiry of the rector, verger, and assistants elicited the fact that at 6.45 p.m. one of the double-pole switches was turned off altogether by the contractor's foreman, and through the second double-pole switch a supply to two fittings in the choir only remained. These lights were turned off by the verger in the presence of the cleaners a little after 7 o'clock, some hours before

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the fire. Thus all circuit wiring from the switchboard onwards was absolutely cut off from the supply, and the mains from the point of supply to the place where they rise through floor to the switchboard are still intact, showing that no fault occurred there. It transpired that a large fire was left in the vestry for the purpose of burning all the rubbish which had accumulated during the alterations, and a gas-ring was in use at the back of the organ for hot-water purposes. The evidence does not prove these to be the cause of the outbreak, but it shows pretty conclusively that the electric light was not responsible for the disaster. The Manchester contractors have rendered a valuable service to the electrical industry, and a few of these investigations will be of great aid in counteracting the unjust aspersions which are so often cast upon electricity.

Municipal Indebtedness.—At the meeting of the Institute of Bankers the other day the president, Mr. J. Spencer Phillips, selected for the subject of his address the question of municipal indebtedness, which has of late come in for frequent discussion in the Press and elsewhere. As is generally known, the sum of this indebtedness approximates £400,000,000, and suggestions have been made that our municipalities are instituting a race with the National Debt. There is, however, still a big margin between the two, and in considering the rapid strides which municipal indebtedness has incontrovertibly made of late years it should be remembered that this has been essentially the period of municipal development. Heavy outlays have been incurred which are not likely to be repeated during the next decade. We do not propose to deal here with the ethical aspect of a comparison between the National Debt, which may be termed a reflection of the battlefield, and municipal liabilities, for which the country has had a substantial return in economic progress; but in considering the criticisms of municipal trading, it is but fair that some discrimination should be shown between its different branches. As to whether music halls, aquaria, and banks should be the subject of such enterprise there may be considerable difference of opinion, but few will deny that a public service such as the tramways comes within its legitimate sphere, and in this department there have been many successes, some of them notable ones. From its past year's revenue Liverpool contributed towards the relief of the rates no less than £25,166 from tramways alone, and altogether local taxation was reduced to the extent of 11½d. in the £ as the result of municipal enterprise. Glasgow and Leeds are other examples which readily occur to the mind. Nor is this the measure of the benefit derived by the public, the other great advantages including improved services and reduced fares, though in the latter respect there is a tendency to adopt the prudent advice recently given by the president of the Municipal Tramways Association. Another point which has to be remembered in considering the growth of municipal expenditure is that local authorities have had imposed upon them certain functions of, financially speaking, an unproductive character, such as education, which exhibits an annual tendency towards expansion. In regard to the Metropolis, Mr. Phillips severely deprecated the extravagant example which it set to the provinces. This is rather a reversal of the usual practice of holding the English capital up as a model of economic stagnation. However, the statements made by Lord Welby the other day should be reassuring to the alarmists, for, notwithstanding the numerous enterprises upon which the London Council Council has embarked, the total of its loans is still considerably less than two years' rateable value. Were municipal indebtedness to continue increasing at the rate it has done during the past decade, it would doubtless be necessary to place some curb upon it, whether by legislation, public opinion, or the common-sense of our local councillors. Perhaps a combination of the last two would effect the object, as public opinion, which so far has not made its voice felt very distinctly in this connection, would probably assert itself if the rates bill became too onerous.

The Temperature of the Arc.—Messrs. C. W. Waidner and G. K. Burgess contribute an article on this subject to the *Physical Review* of New York. After discussing the various phases of the question, the authors give a table, reproduced herewith, of the estimates of arc temperature reviewed by them. From this table it will be seen that the photometric methods based on the extrapolation of Wien's equation show that the "black body temperature of the arc" (pure graphite) is at least 3,750deg. absolute, so that its true temperature must be higher than this; it is not possible to state how much, in the absence of more definite knowledge concerning the departure of carbon from black body radiation. In the light of the best evidence that is at present available it would seem that the true temperature of the hottest part of the positive carbon is between 3,900deg. and 4,000deg. absolute.

Observer.	Absolute temperature of the arc.	Method.
Le Chatelier.	4,370	Photometric: Intensity of red light.
Violle.	3,870	Calorimetric: Specific heat of carbon.
Wilson and Gray.	3,600	Total radiation of copper oxide, empirical relation for.
Wanner.	3,700-3,900.	(Varying with carbons used.) Photometric, in terms of Wien's law.
Very.	Between 3,600 and 4,000.	Wave-length of maximum energy Wien's displacement law: $\lambda m\ T = C$.
Lummer and Pringsheim.	Between 3,750 and 4,200	Wave-length of maximum energy Wien's displacement law: $\lambda\ T = C$.
Féry.	3,760	Total radiation: Stefan-Boltzmann law.
	4,150	Photometric: Wien's law.
Waidner and Burgess.	3,690	Holborn-Kurlbaum pyrometer, Wien's law.
	3,680	Wanner pyrometer, Wien's law.
	3,720	Le Chatelier pyrometer, Wien's law.

As an explanation of the high values found by Le Chatelier and Féry, using photometric methods, the authors allude to the want of monochromatism of the glass used, this circumstance applying specially to the red glasses that are sometimes employed with the Le Chatelier optical pyrometer. Further, the authors point out that the "centre of light" transmission of this glass is higher than that usually assumed from Le Chatelier's early determinations, probably made with a different kind of glass. The authors state that if they are justified in assuming these explanations to be satisfactory, a comparison of the results contained in the table will show, when allowance is made for the experimental difficulties and uncertainties that may arise from varying conditions of the arc (such as current strength, length of arc, quality of carbons, etc.), that the results obtained, dependent as they are on the extreme extrapolation of different laws, are in quite satisfactory agreement, and diminish somewhat the doubt which is always present when we must venture beyond the domain of experiment. The value obtained by Féry for the "black body temperature" of the arc by making use of the Stefan-Boltzmann law for the total radiation of a black body is in most satisfactory agreement with the results obtained by Wanner, dependent on the extrapolation of the Wien-Planck relation, and is nearly identical with the author's own photometric determinations, based on the same relation.

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LEEDS, WAKEFIELD, AND WEST RIDING TRAMWAYS.

An extensive system of electric tramways, owned by the Wakefield and District Light Railways Company, has been recently inaugurated. Although there is a considerable mileage at the moment in operation, the scheme is only partially completed, and when the remaining sections and links are finished the system will embrace wide districts round Leeds and Wakefield, including Horbury, Ossett, Normanton, Castleford, Pontefract, Lofthouse, and Rothwell. Eventually it will involve the operation of some 75 miles of single track, linking together, by a frequent service, some of the most populous districts in the West Riding of Yorkshire. The ramifications of the tramways are clearly shown in the accompanying map (Fig. 1), from which it will be seen that the most important trunk line runs from Wakefield to Thwaite Gate, and there joins the Leeds Corporation tramways system. Bearing in mind the recent and important discussions on the subject of joint running powers, it is interesting to note that it has been possible for the company to arrive at an arrangement with the Leeds Corporation under which cars can be run to the centre of Leeds. Such an understanding must result in the greatest convenience, and should materially add to the efficiency of the District Company's system and prove to be a useful feeder to the Corporation tramways.

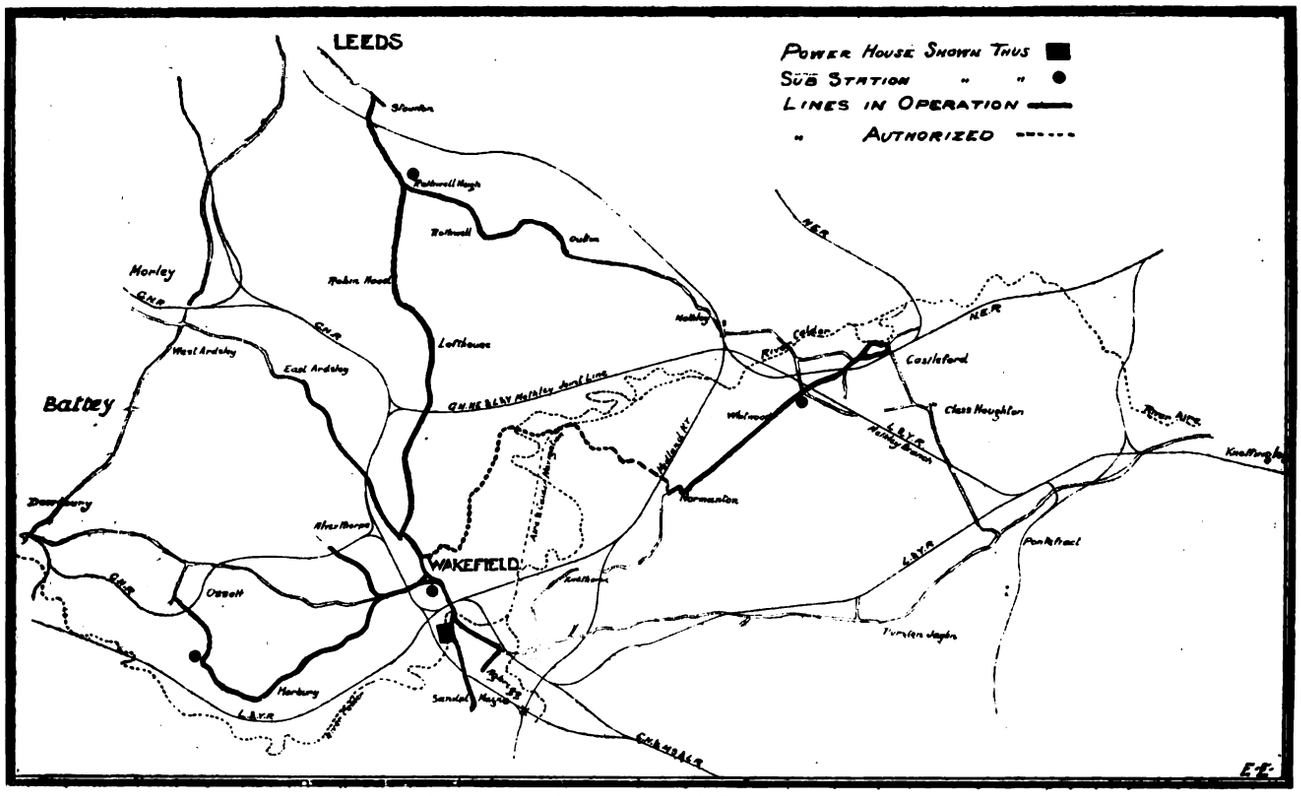

FIG. 1.—Map of Leeds, Wakefield, and West Riding Tramways.

Taking Wakefield market place as the centre, the system branches out into four directions—to Sandal Magna (two miles), to Agbriff (two miles), to Ossett *vid* Horbury (nearly five miles), and to Thwaite Gate (about seven miles). There is, in addition, a most important branch line from the Leeds end of the line through Rothwell and Oulton. A considerable portion of track has been constructed between Normanton and Castleford, a distance of about 3½ miles, and eventually

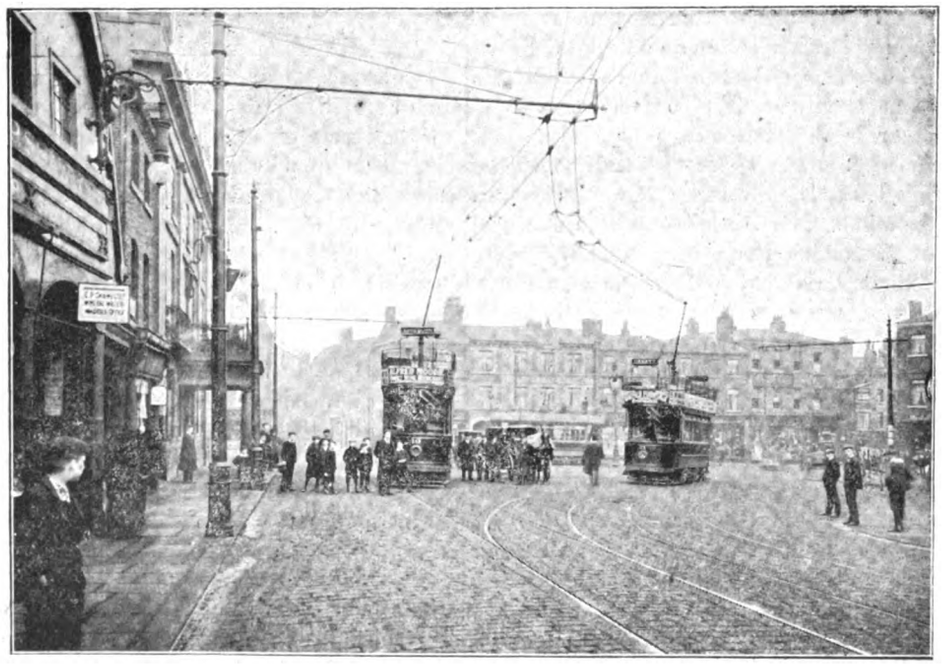

FIG. 2.—Side-Pole Construction, Bull Ring, Wakefield.

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this would be linked up to the main system. Other lines are in course of construction, the total mileage constructed up to date being roughly 32½ miles of single track. The contract for the whole of the work was given to the firm of Dick, Kerr, and Co., Limited, the consulting engineer for the scheme being Mr. B. D. V. Cooper.

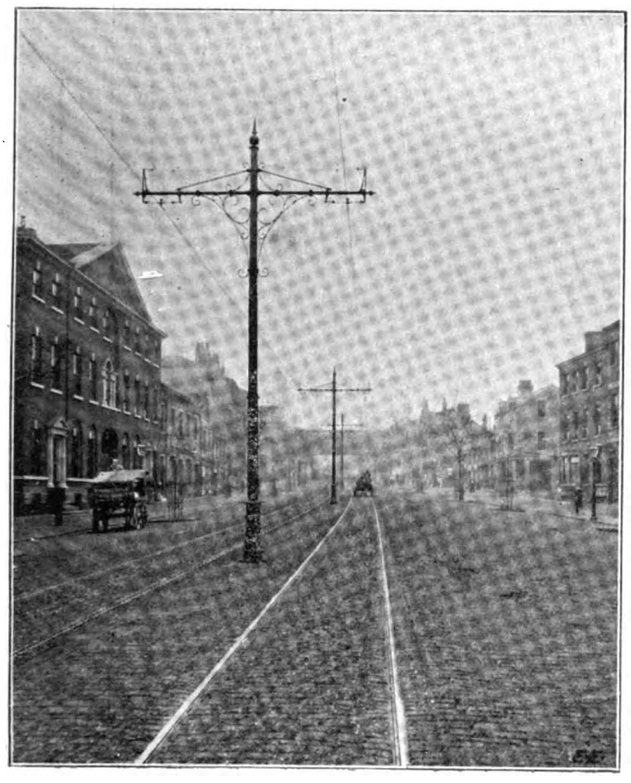

FIG. 3.—Centre-Pole Construction, Westgate, Wakefield.

Such a system obviously calls for high-tension transmission, as it would be, of course, impossible to work all the routes embraced in the extended scheme from one central station. The generating station is situate at Belle Isle, Wakefield, where alternating current is generated at high pressure for transmission to sub-stations, where it is transformed to direct current of 500 volts. One sub-station is in use in Wakefield about one mile from the power station, where three 200 kw. rotary converters have been erected, and another in Rothwell with two 200-kw. rotaries. Later on there will be a third at Castleford, which is about 10 miles from the power station, and a fourth at Ossett.

The total length of tramways at present in operation is approximately 25 miles of single track, laid to a gauge of 4ft. 8½in. The usual method of construction has been employed. On about nine miles of single track the roadway has been excavated to a uniform depth of 12½in. below the upper surface of the rails, to receive an 8in bed of concrete to carry the paving for a width of 8ft. for single track and 17ft. for double track. The roadway between the rails and for an average space of 18in. on either side,

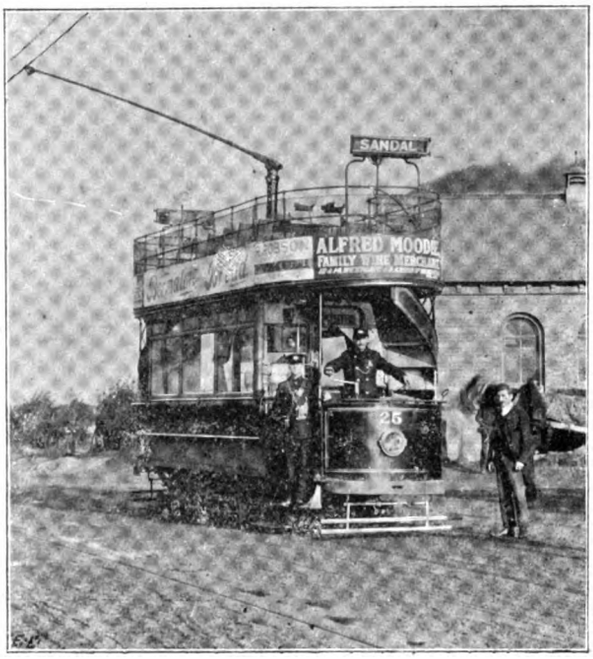

FIG. 5.—Motorcar, Leeds, Wakefield, and West Riding Tramways.

both for single and double track, is paved with granite setts 5in. deep and 4in. wide. In the remaining portion, some 16 miles, the roadway between the rails is filled in with screened macadam. The rails are of the girder type, weighing 94lb. per yard, and are laid in 45ft. lengths, with a proportion of shorter lengths to allow for closures. The rails are generally in accordance with standard tramway practice, 6½in. deep, with a groove of 1⅛in.; they are used as a return conductor, the joints being of the plain type, secured with six-holed fishplates, 24in. in length, and are double bonded with 4/0 Neptune copper pin bonds.

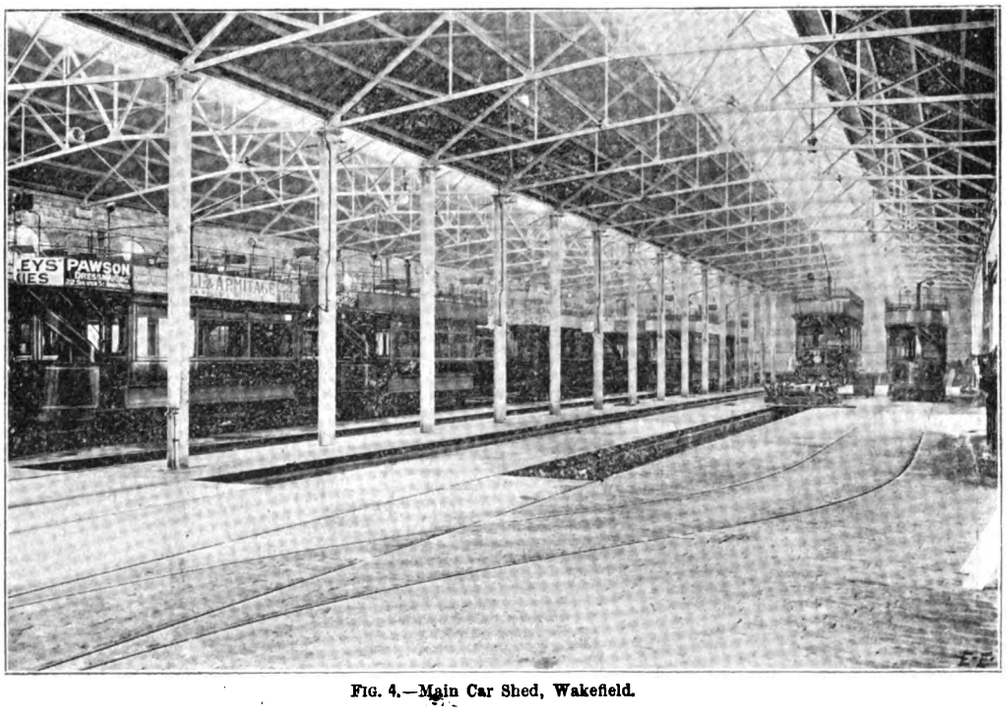

FIG. 4.—Main Car Shed, Wakefield.

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The construction of the overhead lines is for the most part carried out on the side-pole system (Fig. 2), with bracket arms and flexible suspensions. Centre poles (Fig. 3) are employed only to a small extent. The poles, which have an over-all length of 31ft., and are made up in three sections

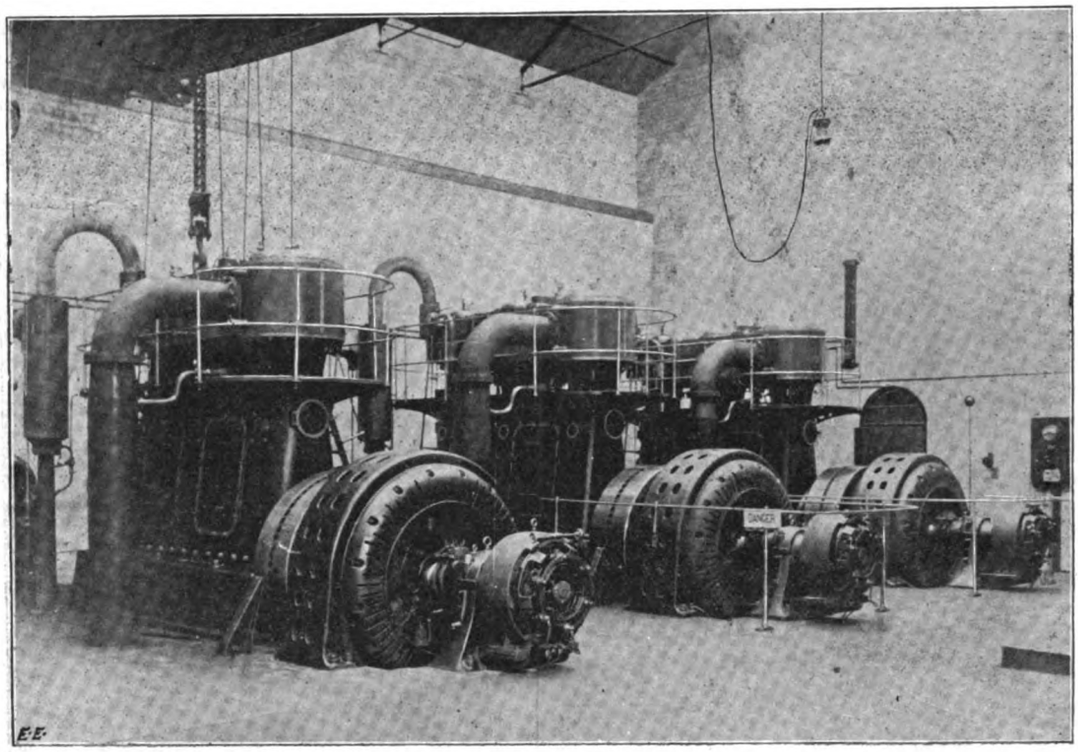

FIG. 6.—Generating Plant, Leeds, Wakefield, and West Riding Tramways Power Station.

of lap-welded mild steel, are erected about 40 yards apart on the straight, and closer on curves, in holes 6ft. deep, surrounded by from 6in. to 9in. of concrete. In towns and residential districts the brackets are fitted with wrought-iron scrollwork of a neat design. The trolley wires are of hard-drawn copper wire, 2/0 S.W.G., having a diameter of ·348in., weighing 1,935lb. per mile, and with a breaking strain equal to 24 tons per square inch. At certain points over the low-tension feeders, feeder switch pillars of the Dick-Kerr standard pattern are erected. Each pillar contains a white marble panel, on which are mounted two 400-ampere quick-break switches, these being connected through vulcanised indiarubber cables direct on to the trolley wire. At all other points the mains are looped into the pole section bases described below. At every half-mile along the route small cast-iron boxes are fitted to the poles, each containing four 150-ampere "no arc" switch fuses. These boxes serve the purpose of dividing the trolley wire into half-mile sections and cross connecting for the parallel running. The cable taken from these connecting boxes up the poles has the same section of copper as the trolley wire, and is insulated with vulcanised rubber.

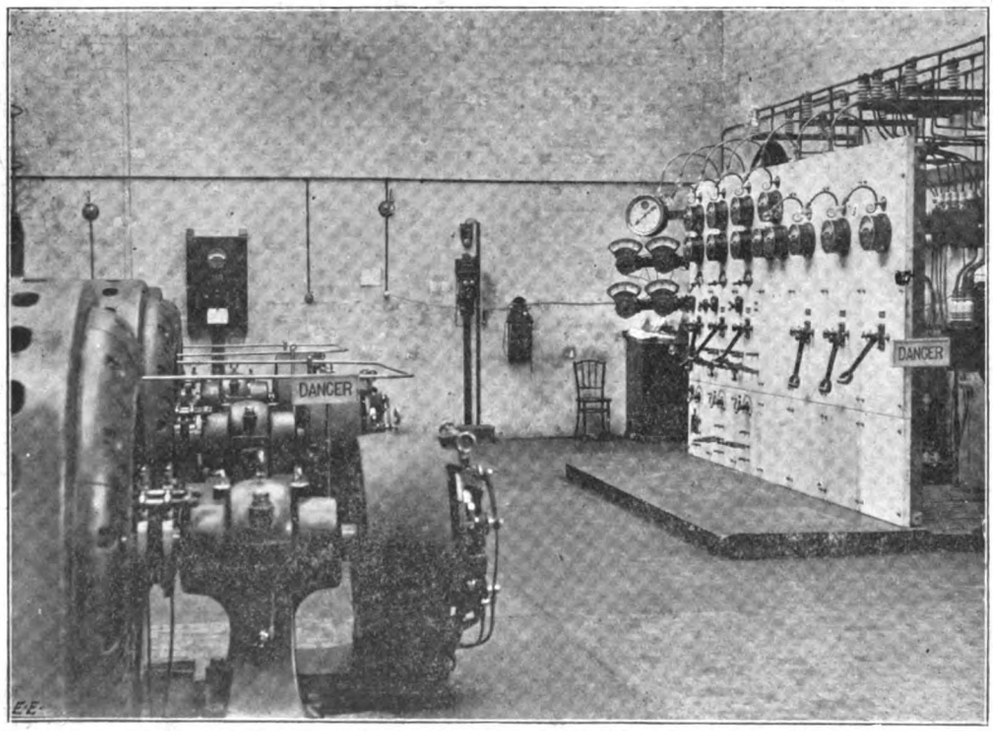

FIG. 7.—Main Switchboard, Leeds, Wakefield, and West Riding Tramways Power Station.

Three car-sheds have been constructed. The principal depôt (Fig. 4), situated at Wakefield, has six tracks, and is capable of accommodating 35 cars. The other two sheds have been built at Rothwell and Castleford respectively. The rolling-stock eventually will consist of 55 electric motorcars of the double-deck, single-truck, reversed stair-

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case type (Fig. 5), with a seating capacity of 22 inside and 34 outside. The car bodies were built for Dick, Kerr, and Co. by the Electric Railway and Carriage Works, Limited, of Preston. The floor frames are made entirely of oak by 1½in. fixed longitudinally. To prevent sagging, each side frame of the car is trussed by a ⅝in. tension rod attached to the bottom sills. The side and end frames are of pitch pine and ash. The side frames each contain three

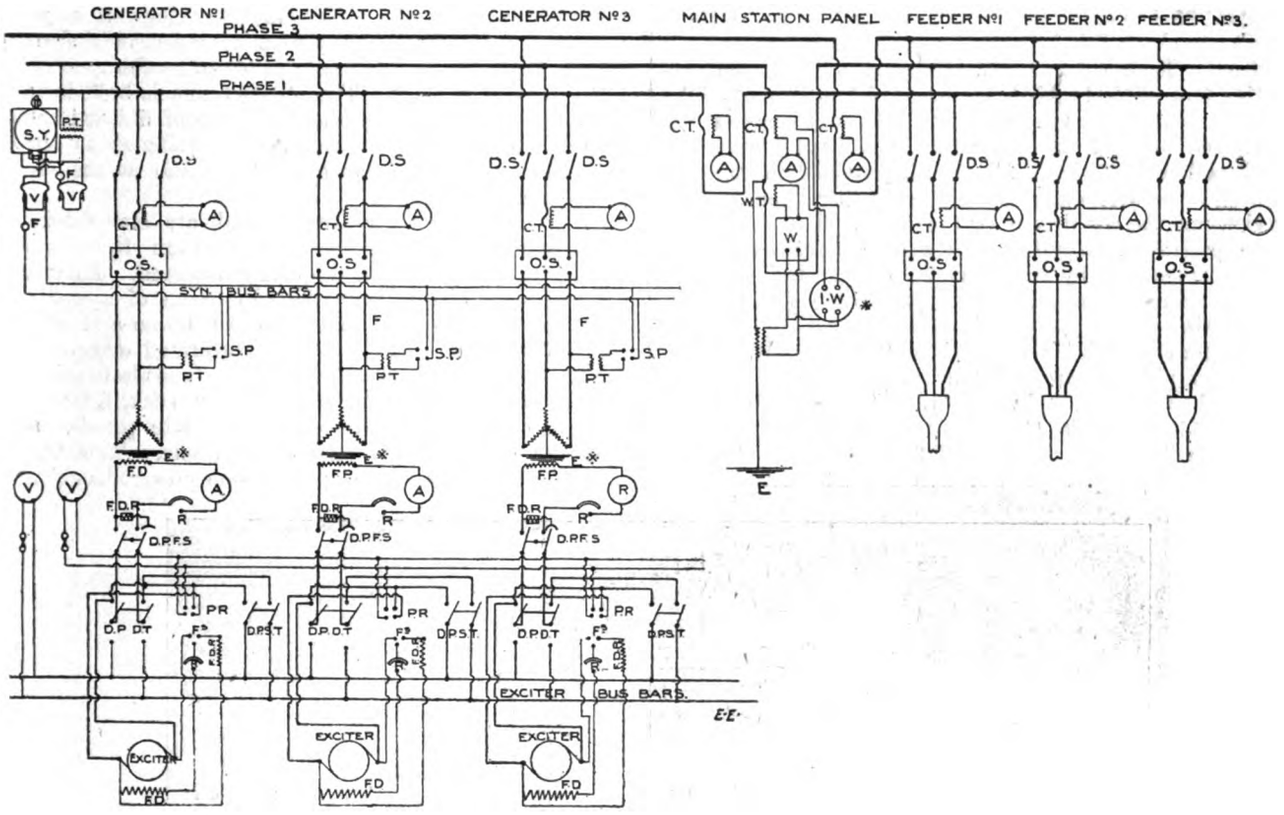

Fig. 8.—Diagram of Connections to Main Switchboard, Leeds, Wakefield, and West Riding Tramways Power Station.

and pitch pine. They are designed to combine the greatest strength and stiffness and minimum weight. Special care has been taken in designing the cars to ensure the interchangeability of all the most important parts entering into their construction. Openings are arranged in the flooring large windows, with narrow pivoted ones above for ventilation. The roof frame is made of ash, the horizontal members being all in one piece without splices. The cars are fitted with lifeguards of the trigger pattern. Each car is wired for 15 incandescent lamps, which are run in series of five

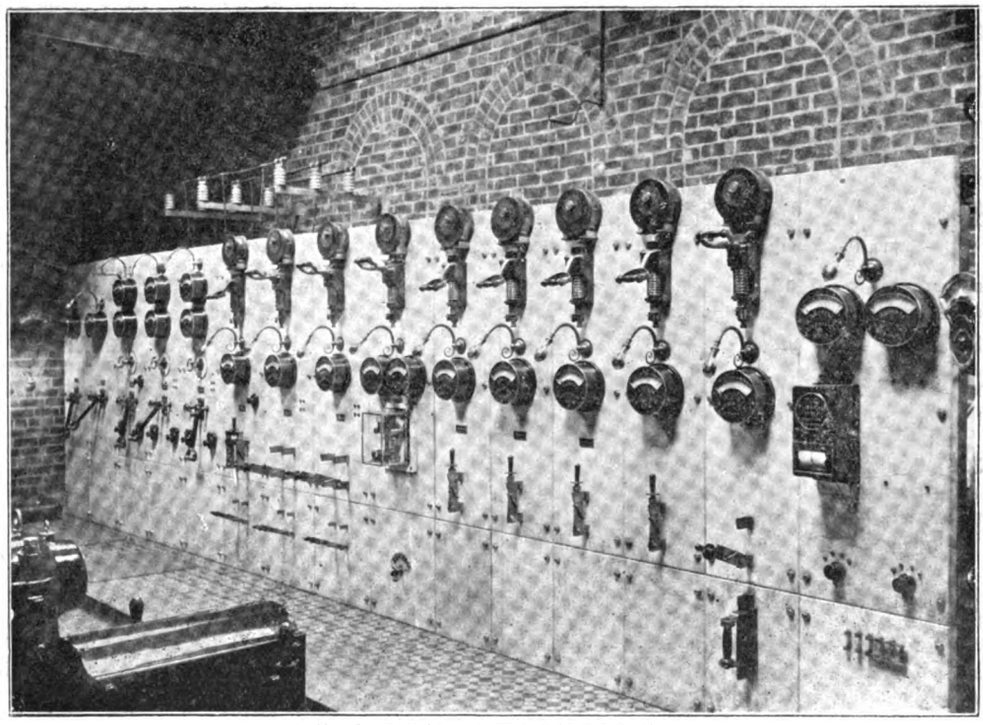

Fig. 9.—Switchboard. Wakefield Sub-Station.

over the motors to afford convenient access to the armature brushes, and to all bearings requiring frequent inspection and oiling. The platforms are carried on four steel angles, the bearers being extended without interfering with the clearance of the trucks. The main floor is laid with ⅞in. tongued and grooved boards 4in. wide with strips of deal 2in. off the main circuit, the wires being run inside the walls of the car behind the ventilators, thus being efficiently protected and put completely out of sight and reach. Two 16-c.p. lamps are fitted as head lights with reflectors. The cars are mounted on Brill trucks of the 21-E type, suitably built to support the car bodies and to receive the motors

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and gearing. The axles are 3¾in. in diameter, and are made of Siemens-Martin steel capable of standing a tensile strain of 60,000lb. The wheels are of chilled iron and are 30in. in diameter. Each car is fitted with a complete Dick-Kerr standard equipment, consisting of two of Dick-Kerr's standard 25-A traction motors. The controllers are of Dick-Kerr's standard D.B I. form, C type, with metallic shield blow-out. Each consists of a strong cast-iron frame supporting two vertical cylinders, upon which are mounted the contact segments. One of these cylinders controls the power and speed of the car, and the other is for reversing the direction of motion. Means are provided in the controller for allowing either motor being entirely cut out of service, and the car driven by the other. The controllers are especially arranged with resistances for emergency braking, operated by the driving handle, which may be utilised either when the car is proceeding forwards or backwards.

The power station is situated at Belle Isle, Wakefield. The steam plant consists of four Lancashire boilers, with the usual accessories, including "Lord" furnaces, hand-fed mechanical stokers, a Green's fuel economiser, a water-storage tank with a capacity of 20,000 gallons of water, and two feed pumps capable of delivering 24,000lb. of water per hour against a pressure of 150lb. The feed water is drawn from the River Calder and town supply, the water for condensing purposes being wholly taken from the River Calder.

In the engine-room (Fig. 6) there are at present installed three "Howden" high-speed triple-expansion condensing engines, working at a steam pressure of 150lb. These engines run at 375 revolutions per minute, and are coupled to high-tension alternators of Messrs. Dick-Kerr's standard type, which generate three-phase current at 6,300 volts, 25 cycles, each set being provided with a direct-driven exciter. The alternators are "star" connected, have an output of 400 kw. continuously, and are designed to give an overload of 25 per cent. for one hour with a moderate rise of temperature. All three machines are designed to run in parallel with each other, means being provided for raising their voltage up to 6,600 to compensate for loss in the mains when running at a constant speed. The rotor spider is made of high quality cast iron, and is of a very strong design, the hub being provided with a flange for bolting to the engine flywheel.

The pole-pieces are made of laminated steel, and are held together between two cast-steel end plates of strong construction. The upper part is of a T-shape construction for holding the field coils in position, while the lower part of the pole-pieces is dovetailed for fixing on the rim of the rotor, and held in position by means of keys. The removal of the field coils is effected by sliding the pole-pieces from the dovetailed groove parallel to the shaft without disturbing any other part of the machine. The design and shape of the pole-pieces gives a distribution of lines of force in the air-gap to produce an approximately sinusoidal-shaped wave of E.M.F. The exciter is mounted on the extension of the alternator shaft. The stator frame is built in two halves, securely bolted together by means of finished bolts. The frame is made of cast iron, and is designed to allow complete ventilation of the laminations and at the same time to secure rigidity of the frame.

The coils are former-wound, and are embedded in rectangular slots, being held in position by wooden wedges, and are easily and quickly replaced. They are protected outside the laminations by means of a cast-iron shield, cast in sections, bolted to the frame and easily removable. This shield is of a perforated design, and does not in any way interfere with the ventilation. The main switchboard (Fig. 7) was built by Dick, Kerr, and Co., and consists of seven enamelled slate panels, each supported independently on an iron frame. The board consists of three generator panels, one power panel, and three high-tension feeder panels. Fig. 8 is a diagram of the connections to this board.

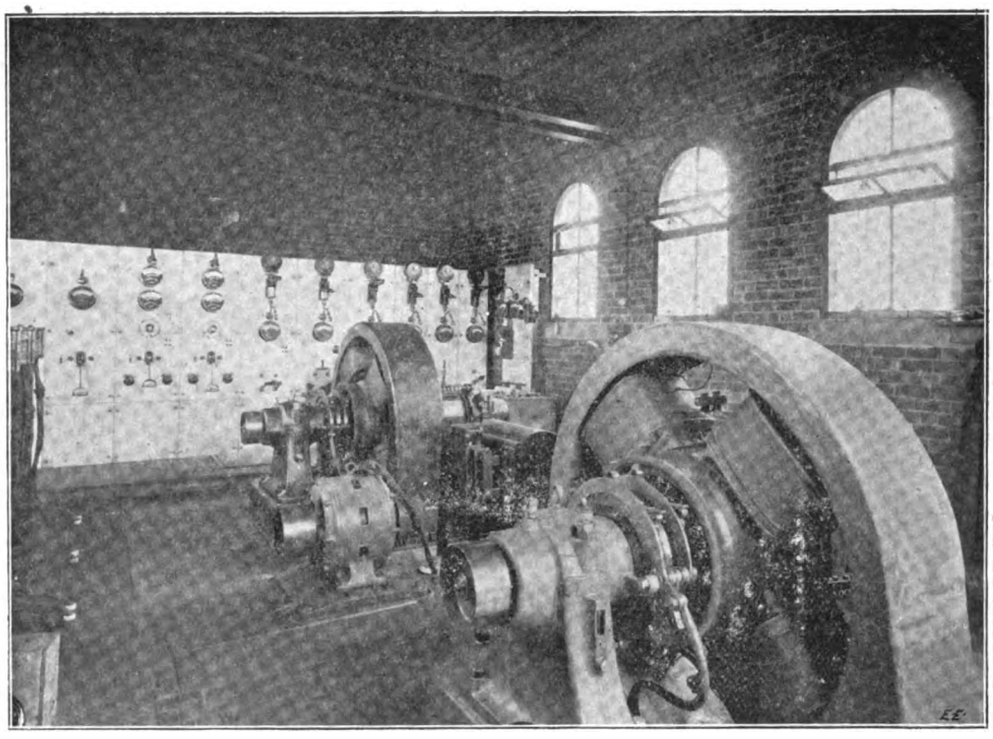

FIG. 10.—Rotary Converters, Rothwell Sub-Station, Leeds, Wakefield, and West Riding Tramways.

The sub-stations are fed from the main station by duplicate three-core, high-tension, lead-covered cables. At the Wakefield sub-station there are three standard Dick-Kerr 200-kw. compound-wound rotary converters, running at 750 revolutions per minute, and generating direct current at 500/550 volts. Each rotary has its complement of single-phase, oil-cooled, step-down transformers. The rotaries are capable of dealing with an overload of 25 per cent. for one hour. The switchboard in this sub-station is shown in Fig. 9. The Rothwell sub-station (Fig. 10) is similar to the one at Wakefield, except that its equipment comprises only two rotaries, with the necessary transformers and switchgear.

We are indebted to Messrs. Dick, Kerr, and Co. for the above description.

ELECTROLYTIC BLEACHING.

BY DR. ALFRED GRADENWITZ.

The use of chloride of lime in the bleaching industry, according to the practice of upwards of a century, is attended by many drawbacks. Apart from the instability

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of this substance with regard to both air and light, and the extremely inconvenient preparation of the corresponding bleaching liquids, there will always remain on the fibres of the tissue a deposit of calcium carbonate, encrusting the latter, preventing a thorough bleaching, and, accordingly, resulting in the goods becoming yellow afterwards. As regards, on the other hand, such bleaching liquids as are obtained by electrolysis, experience has shown for a long time their use to be much more satisfactory than that of chloride of lime; special mention should be made in this connection of the apparatus designed by Mr. Haas and Dr. Oettel, which was one of the first allowing of the electric principle being employed on a commercial scale. We now learn that the inventors have just improved their apparatus considerably, and, therefore, wish to describe their bleaching device both in its original and new forms

The system of bipolar electrodes was chosen from the very beginning in the Haas and Oettel apparatus, this system affording the special advantage of reducing to only two the number of contacts to be superintended. The electrodes are made up of a carbonaceous matter, the terminal electrode being formed of two vertical plates, whereas the intermediate electrodes are transverse plates about 1cm. in thickness, which are inserted into the vertical slots of the apparatus. The sets of intermediate

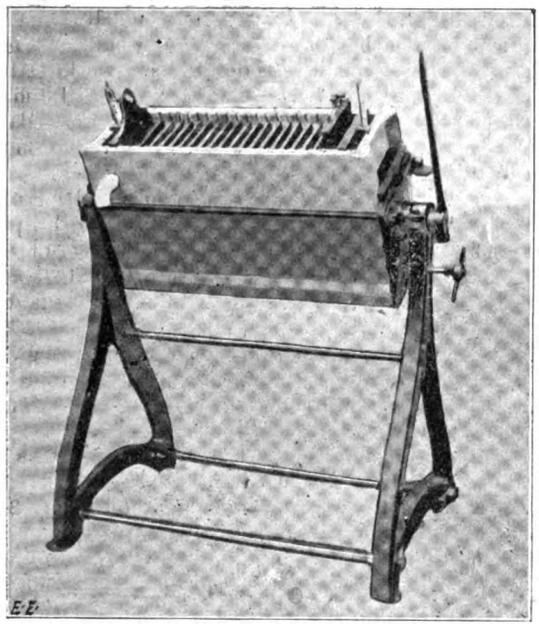

FIG. 1.

electrodes, so far from filling up the whole height of the apparatus, are each placed on an insulating bar, being prolonged by a similar bar beyond the level of the liquid. This arrangement is intended for forming at the bottom of each chamber a compartment where impurities may accumulate for a time without endangering the electrolyser, and, on the other hand, for maintaining the electrode entirely below the level of the liquid, so that any chlorine bubbles, even those evolved on the upper portion of the electrode, are absorbed by the liquid, thus avoiding any disagreeable smell of chlorine in the operation. The sodium chloride solution used as electrolyte enters the first chamber in a concentration of 6·4deg. Baumé, traversing all the chambers in a vertical serpentine path and entering the same alternately beneath and above a partition wall. From the last chamber it is discharged as bleaching liquid into a reservoir, where any smaller impurities due to the salt are deposited. Both at the entrance and issue there are thermometers allowing of the percentage of bleaching liquid being ascertained. On traversing the apparatus, the liquid, in fact, in addition to being chemically altered, becomes heated, experiment having shown a given increase in temperature to correspond with a given percentage in hypochlorite, taken by the salt solution on its passage, the difference of both thermometer readings thus affording a means of regulating and adjusting the speed of the liquid.

The apparatus, as shown in Fig. 1, is free to move in an iron frame, so as to allow of its being readily cleaned by turning the apparatus upwards at 90deg. Should any electrodes be damaged, only the electrode wall concerned will have to be taken off the apparatus, which, after inserting the new electrodes, will be ready for use again. On account, however, of the considerable life of the specially prepared electrodes, this is of no frequent occurrence, involving no disturbance in the service or any additional expense worth speaking of. The apparatus is designed for various current intensities and voltages, mostly for 65, 110, 120, 220, and 240 volts, as they are frequently connected to existing lighting systems. Now, whereas some 15 years ago, with the first type of apparatus, rather diluted liquids

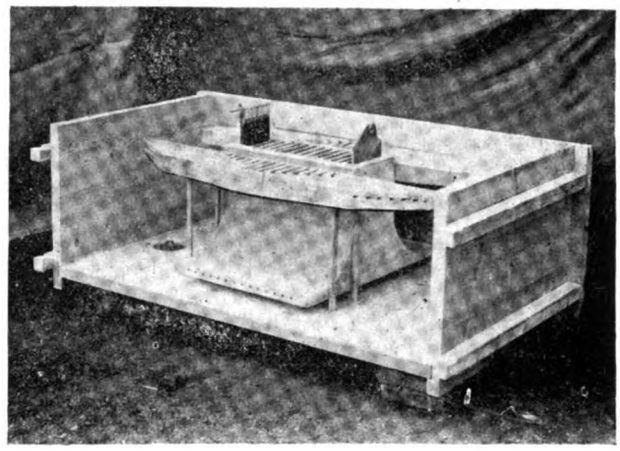

FIG. 2.

were required, it has of late years become necessary to increase the percentage in chlorine up to 5, 8, and even 10 grammes, in order to bleach goods that are less easily handled than cotton. It proving not convenient to make the liquid traverse the tank at a slower rate, on account of the inactive chlorate which is then formed, owing to the greater heating effect, means had to be provided for preventing any increase in temperature beyond a certain useful limit.

This result is obtained in the new type of electrolyser just brought out by Messrs. Haas and Dr. Oettel, Aue

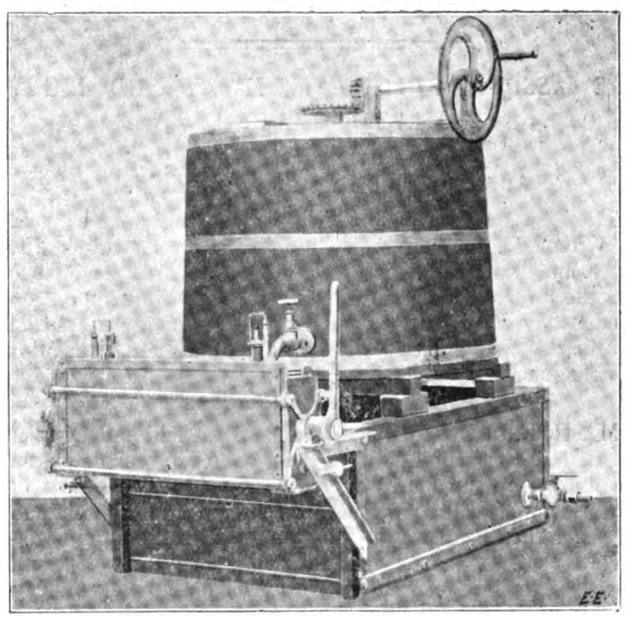

FIG. 3.

(Saxony). In order to convey to the apparatus a continuous supply of cooled liquid without the aid of any external mechanical force, the hydrogen evolved by electrolysis is used to convey the permanently cooled liquid through the electrolyser quite automatically without any regulation, superintendence, or additional outlay being necessary. This new electrolyser for concentrated liquid is shown in Fig. 2, the underlying principle being as follows: The

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electrolyser proper has the shape of a case with a similar arrangement of the electrodes to the original apparatus but for its being entirely fitted into the bleaching liquid reservoir. The various compartments, being locked from each other, are fitted at the bottom with an opening through which the contents of each compartment communicate with the charge of the external reservoir. In the neighbourhood of the upper edge each chamber is in addition provided with an overflow tube penetrating also into the liquid reservoir. The latter is filled with salt solution until this reaches the overflow both inside and outside of the electrolyser. Now, if the current be completed, the liquid in the chambers will rise, forming a violent foam, while overflowing regularly through the tube and sucking fresh amounts of liquid through the opening in the bottom. The reservoir and chambers form a system of communicating vessels, a solid column of liquid being formed in the former, while the latter contains a mixture of liquid and hydrogen bubbles. As this mixture obviously is lighter, a higher column would be needed to obtain the equilibrium in the chambers but for the overflow. As long as there is an evolution of hydrogen, there will therefore never be a hydrostatic equilibrium, the liquid being drawn most rapidly through the chambers of the electrolyser. The fine bubbles of hydrogen carried along will allow of the lively movement and intermixing occurring in the liquid of the reservoir being readily noted over great distances, the more so as this intermixing is aided by the great distance between the inlet and outlet of the liquid. There are actually but very small differences in the percentage in chlorine throughout the operation in the different parts of the reservoir, this evidencing the high efficiency of the apparatus. The reservoir contains, in addition, a cooling coil, maintaining the temperature of the liquid below 24deg. C. As the cooling water remains perfectly clean and available for any use, the additional cost of this cooling device is confined to the first cost of the lead coil.

These electrolysers may readily be adapted to any requirements as regards both the consumption of salt and energy. In countries where salt is expensive, a most perfect utilisation of the salt is secured by the construction of the apparatus, whereas in the case of the salt being cheap the consumption of energy is reduced. In both cases the output of the apparatus may be so regulated as to obtain chlorine at an economical price.

THE ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS.

Autumn Meeting at Wakefield.

The autumn meeting of the above association was held in Wakefield on Wednesday and Thursday last week. It was a most successful gathering, both as regards attendance and the interest of the proceedings. The members met on Wednesday afternoon at the town hall, and were assured of a hearty welcome to Wakefield by the Mayor, Councillor E. Stonehouse.

Presidential Address.

Mr. H. ENGLAND, manager of the Wakefield and District Light Railways, who is president for the year, then delivered his address, in the course of which he said: The object of the association was to promote discussion and interchange ideas for the advantage of those engaged in the administration of tramways and light railways. As an association, they were not concerned with questions of policy. They did not discuss whether a corporation or a company was best fitted to control a tramway undertaking, but confined themselves to the discussion of practical everyday questions affecting the working of their undertakings. They had as members of the association managers and engineers engaged in operating tramways worked by companies, as well as managers and engineers in charge of corporation tramways. He would like to see all men engaged in tramway work brought together under the auspices of one representative association. The multiplication of associations having similar aims was to be deprecated. Many of the corporation tramway officials had, at one time or another, acted in a similar capacity for a company, and a number of company managers and engineers had been attached to corporations. Transfers were constantly taking place. The sole object of their existence as an association was to bring together men who had similar daily work to do, and who, by comparing notes and discussing freely the problems which they encountered, fitted not only themselves but their fellows for performing the work before them. It mattered not whether the work was done for a corporation or a company. The difficulties in working a tramways system were identical in both cases.

Prominent among the several important matters which would have to be dealt with in the near future was the carriage of goods on their tramways. This was not a new proposal, and it seemed surprising that more had not been done in the matter. If it were true that not more than two or three tramways were now carrying goods, there must be some reason for the reluctance of managers to cater for the traffic. Difficulties were made to be overcome, but it seemed to him there were some very real difficulties in connection with this question. In large cities passenger traffic was so heavy and continuous that goods traffic would have to be dealt with between 12 midnight and 6 o'clock in the morning, and as that would mean keeping the overhead line "alive" from Sunday morning to Saturday night, the time for repairs would be almost nil. Again, it must not be forgotten that it would not pay a system to run power plant outside ordinary working hours unless a decent load could be obtained. The real difficulty in arranging for goods traffic was siding accommodation. Unless they provided sidings they must interfere with their passenger traffic.

He was glad to find so many corporations and companies were beginning to see it was the convenience of the public that must first be considered, and to that end were making arrangements for through running. The difficulties anticipated were theoretical, and disappeared as soon as practical work commenced. His company had made an agreement with the Leeds Corporation, by which they were granted the privilege of running to the centre of Leeds from their terminus at Thwaite Gate, and the Leeds Corporation had equal facilities over the company's system.

It was a matter for regret that tramways were constructed of various gauges. Often in the same district the gauge of various tramways ranged from 3ft. 6in. to 4ft. 8½in., which made through running either for passengers or goods out of the question. There were very few places in this country where the standard gauge could not be adopted, and the Board of Trade would be doing a real service to the industry were they to insist on the 4ft. 8½in. gauge being used for all new work. Five years ago there was a golden opportunity to secure uniformity, but, unfortunately, the chance had not been seized, and the consequence was they saw towns like Bradford and Leeds, Bradford and Halifax, ready and willing, he believed, to exchange traffic, but unable to do so by reason of each system being constructed to a different gauge.

They were indebted to the Municipal Association for the splendid work done in reducing chaos to order in connection with tramway accounts. He was not one of those who attached much importance to comparisons, either of working costs or capital charges, but it was very convenient to know exactly where to look in an account for any item in which they were interested. They all knew that by increasing the mileage of their cars they could materially reduce the costs per car mile. Whether 1,000 or 10,000 miles were run, their general expenses were almost the same. They could increase their mileage to such an extent that although they succeeded in getting the lowest working costs in the country, their system would be run at a loss. He would recommend them to pay less attention to their mileage costs, but keep their attention on the percentage of expenses to receipts.

There were many subjects which lent themselves to discussion, and he would suggest a paper on roof-covered cars as likely to prove instructive and welcome to the members of their association. In his opinion, defects would manifest themselves where cars of the ordinary type had been fitted

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with roof covers. The car framing required strengthening, not so much to carry the extra weight, but to withstand the strains set up by wind pressure. Stronger truck springs should be employed, and cantilever extension brackets fitted to overcome the oscillation likely to be set up by the top hamper. "Truck Design" would make a splendid paper, and he hoped one of their members would go thoroughly into the subject and give them the benefit of his investigation.

There was also room for great improvements in regard to telephones, and they should discuss the matter and attempt to find the best way of building a telephone line, the most suitable type of box, and the most reliable instrument.

Average Speed and Speed Allowances.

The next item on the programme was a paper by Mr. A. R. FEARNLEY, manager of the Sheffield tramways, entitled as above. In dealing with this important question, the author remarked that in order to obtain information he had sent out queries to all the British tramways, 81 of whom had replied. According to these replies, 14 miles an hour now appeared to be frequently granted, 10 tramways having stated that this was their maximum allowance. These towns were: Barrow-in-Furness, Birkenhead, Cardiff, Glasgow, Hull, Lanarkshire, Liverpool, Manchester, Walsall, and Newcastle-on-Tyne. Twelve miles an hour appeared to be the average maximum speed allowed, 37 tramways having obtained this allowance, amongst these being his own department—viz., Sheffield—also Salford, Blackburn, and the London County Council, in addition to many other important undertakings. There were 25 tramways allowed only 10 miles an hour as a maximum. He was at a loss to understand this in regard to such places as Chester, Blackpool, Doncaster, Farnworth, Southport (both company and municipal), and South Staffordshire, being quite certain there were many places on the lines named which might with perfect safety be allowed a much higher maximum than 10 miles an hour on certain portions of their route, and it probably only required application and a little pressure to obtain this increase. Eight miles an hour was the maximum on six tramways. There might be some particular reason for this low figure, which held in regard to the following towns—viz., Chatham, Dover, Oldham (Ashton and Hyde), Wigan, Wrexham, and Middleton.

Average Speeds.—Leaving out of the question light railway undertakings, he found some 14 tramways stated that they were obtaining an average speed of from 8 to 8¼ miles an hour. These were: Blackpool, Chester, Darwen, Doncaster, Gateshead, Gravesend, Grimsby, Lowestoft, Newport, Oldham (Ashton and Hyde), Poole, Warrington, Worcester, and another large undertaking. It was interesting to note that in this list there was not included a single tramway which had been granted the maximum allowance of 14 miles an hour, and, further, that only half of those named—*i.e.*, seven—had even 12 miles an hour allowed as a maximum, so that on many of these roads, where 8 to 8¼ miles was being obtained as an average speed, the maximum allowance was 10 miles an hour. Four towns returned 7¾ to 8 miles an hour as their average; 10 towns 7½ to 7¾ miles, among which were such busy tramways as Liverpool and Birmingham; 10 returned 7 to 7¼ miles, among which were Manchester and Glasgow; three returned 6¾ to 7 miles, included in the three being Newcastle and Hull; 12 returned 6½ to 6¾ miles, included in which were Huddersfield and Halifax (both towns with very steep gradients), and also Wolverhampton with a system of traction peculiar to itself; 10 returned 6¼ to 6½ miles; 10 returned 6 to 6¼ miles; three returned 5¾ to 6 miles (including Sheffield); two returned 5½ to 5¾ miles—viz., Norwich and Chatham; and two returned 5¼ to 5½ miles—viz, Ipswich and Wigan. Taking an average of the average speeds of the 81 tramways who had sent returns, he found this to be 7·24 miles an hour. There was no doubt that the average was considerably lowered in many towns by the great amount of time cars were allowed to stand idle at the termini. Whilst this standing over time had certain advantages, it would be found to pay very much better, he thought, to keep the cars moving and allowing them only just sufficient time at a terminus to reverse the trolley, motormen and conductor to change ends, etc., and then to be practically due away. The returns showed that very considerable advance had been made during the past three years regarding the question of speed allowed. Up to 1901 the majority of tramways were only allowed a speed of eight miles an hour. It was a very nice point at the present time to decide whether the speed on Continental tramways was in excess of the speed on British tramways, and if the roads which were described as "purely suburban" were left out of the question, the English tramways were at least equal to the Continental tramways, the average of the Continental tramways being returned at 7 2 miles an hour. The American return published in 1903 stated that their average speed on urban routes which pass through the centre of the city from one extremity to the opposite extremity was 8·13 miles an hour, and as many of our own routes complied with this condition, it would be seen that we were gradually approaching the American idea with electric traction.

Suggested Increase in Maximum Speed.—Was there any good reason why the same maximum speed which had been granted to motorcars should not also be granted to the tramways for those portions of their routes where it might be run with safety? The conditions which might be required were: an urban route; track to be kept in first-class condition, and to be either double track or long lengths of single track without crossings, etc.; cars to be fitted with power brakes to be used as service brakes, and gradients not to exceed 1 in 20. These conditions, he believed, were to be met with on many electric tramway systems at the present time, especially so on routes owned or worked by such companies as the British Electric Traction Company, and others with which members of the association were either connected or familiar. In America tramcars were now making through runs of over 90 miles, and attaining a maximum speed of 30 miles per hour. Unless higher speeds were allowed or maintained in this country, he failed to see how many of the existing and suggested suburban tramways and light railways were to be worked successfully. It was useless to expect that tramways working between towns 12 or 14 miles apart would attract much through traffic, if to complete such a short journey it took, say, 80 minutes. But if higher speeds were to be allowed and taken advantage of, some very decided change in his opinion would have to be made in our methods of constructing tramway tracks. To attempt to run at the speeds reported as being allowed and attained on American tramways, on tracks laid as at present in this country, on what might be termed the "solid system," would, he was convinced, soon lead to serious trouble, and he had wondered whether the advocates of goods traffic on tramways had considered the matter from this point of view. This question was one which should receive the attention of the promoters and officials of all tramways and light railways constructed for the purpose of linking up small towns, and which, consequently, ran through a good deal of sparsely populated country. It was, of course, a question which more closely interested those concerned with the management of tramway companies than the officials of municipal departments; but many of the latter were somewhat closely concerned in the question, and it would be of considerable assistance to have authority for the speeds which were now frequently attained, and which were certainly demanded by their customers.

DISCUSSION.

In the course of the discussion which followed, it was pointed out that the size of town had a great influence on the average speed obtained. No uniformity could be expected with regard to the maximum speeds allowed, since conditions varied, and what might be safely permitted in one place would be quite out of the question in another. The local authorities concerned, and not the Board of Trade, were to blame for many unnecessary restrictions as to speed. In order to maintain an average speed of eight miles an hour, it would be necessary to fix the maximum at 16 miles on any given system of tramways. That was to say, the average speed represented approximately half the maximum actually obtained. There was no doubt that the Board of Trade maximum allowances were still very much

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below what could safely be permitted. With proper brake power a higher maximum than at present sanctioned would be quite safe in the majority of cases. And wherever increased speed had been obtained, the public had appreciated the change. Speed was the greatest factor in regard to the maintenance of track. With higher speeds tracks would certainly have to be laid differently. This question of track maintenance was a point which must be kept in view.

Tramway Car Wheels and Rails.

Then followed a paper by Mr. A. N. BANISTER, of Norwich, dealing with the cost and maintenance of tramway car wheels and rails, which questions, the author pointed out, were two of the most important in tramway management. The life of the wheels and also of the rails was very largely dependent on the condition in which the permanent way was maintained. The topographical conditions of the system were also important factors, and very frequently wheels which gave good results on one system would prove quite unsuitable for another. In order to arrive at a correct decision as to which was the best class of wheel to use on any particular system, it was essential that all the factors involved should have most careful consideration. Until comparatively recently the only possible wheel was of the chilled cast-iron type. During the last few years, however, they had been run very close, and in many cases surpassed by steel-tyred wheels, either with cast-steel or forged-iron centres. This result was due to the price at which steel-tyred wheels could now be produced, being about 25 per cent. less than it was five or six years ago, while the wearing qualities had been greatly improved.

With cast-iron wheels probably the most frequent cause of trouble was the chipping of flanges. This, on many systems, was unavoidable, for with the narrow-grooved rail required by the Board of Trade the flange of the wheel was of necessity so thin that the metal was chilled completely through the casting, and was consequently too brittle to long withstand the continued shocks received in passing over points and crossings. Flat spots constituted another trouble frequently experienced with chilled wheels, but could be almost entirely eliminated by careful training and discipline of the motormen. With steel tyres the flanges did not chip, flats were almost unknown, and the cars ran smoother and quieter, with, it was claimed by the makers, less wear on the rails. This latter point was, however, by no means established. On the other hand, trouble was often experienced through the flanges of steel tyres wearing completely off, in which case the cost of re-turning must be added to the price. There was also a reduction in life owing to the amount turned off to produce new flanges. Another disadvantage of steel wheels was their varying size through their lifetime, and consequent variation in the height of the car body from the rails, which introduced complications in the slipper brakes and life-guards, both of which had to be so arranged as to be adjustable to suit the varying height of the car. This variation amounted from 1¾in. to 2in. through the wear of the tyres.

The author then referred to the records of two experimental sets of steel-tyred wheels. These had cast-steel centres, and were bought on a basis of 1s. 8d. per 1,000 miles run in July, 1902. To this figure, the author continued, must be added the cost of

	s.	d.		£	s.	d.
Boring out and pressing on	11	0½				
Cutting off tyres when worn out	1	6	Per set of four.			
Taking out of car and replacing	11	2½		£1	3	9
Less scrap value, 3s. per set of four				0	3	0
Total per set				£1	0	9

The mileage obtained was 47,000. Hence cost per 1,000 miles per wheel for above work = 1s. 4d., making the total cost per wheel per 1,000 miles 21·4d. Cast-iron wheels at that date cost 30s., and ran 14,000. Allowing for value of scrap, this gave 24d. per 1,000 miles per wheel. Adding the cost of boring out, etc., 4d., this gave a total cost per 1,000 miles of 28d., as against 21·4d., showing a saving by the steel wheels per 1,000 miles of 6·6d. There remained the cast-steel centres, and allowing 10 per cent. per annum for depreciation, these were worth 32s. per wheel.

Proceeding to the question of the maintenance of wheels, the author said great care should be taken to have them pressed on to their axles to the same gauge. The practice in Norwich gave $\frac{1}{16}$in. clearance to each wheel. They should be pressed on at a steady pressure up to from 30 to 35 tons. The pressure should increase steadily from zero to the total amount—that is, each inch of travel should require an equal increase of pressure. If the pressure was unequal it indicated a bad fit, and there was danger of the wheel coming loose on the axle in service. They should also be carefully watched to prevent variation in size between the two wheels on one axle. At Norwich the wheels were calipered once a fortnight, and if the variation in diameter amounted to $\frac{1}{16}$in., the wheels were ground to size. At the same time the depth of the flanges was noted, and, if necessary, they were ground to the original depth. Flats were ground out immediately they were reported, the practice in Norwich being to punish any motorman who made two flats in six months for which he could give no satisfactory explanation; also if he neglected to report a flat as soon as it was made. By this means they had reduced their trouble from two or three flats a week to about one a month or less. To ensure wheels having equal wear, cars should be occasionally turned. The setting of the wheel brakes and the action of the brake gear should be carefully attended to. They had recently altered the pattern of their brake blocks in Norwich, so as to do away with the lip on the flange side, whereby the weight and consequent cost of the brake blocks was considerably reduced, and any danger of wear on the flange of the wheels removed, without, so far as he could see, any disadvantage. The average mileage of chilled wheels obtained on the Norwich tramways from the date of opening (July 30, 1900) had increased from 14,000 to 19,000. This improved result he attributed entirely to extra care and attention to the wheels and rails.

Continuing, the author pointed out, in connection with the maintenance and care of track, that one of the most frequent causes of broken flanges and excessive wear of rails was incorrect gauging of the track. Too much care, he said, could not be taken to ensure accuracy in this respect. There appeared to be a great difference in the practice of engineers in gauging the rails on curves. This was somewhat surprising, inasmuch as it was quite a simple matter to ascertain with great exactitude the correct gauge for any given curve. The same alteration of gauge was not, however, applicable to curves of all radii, but must be worked out for each different radius and gauge. With the aid of diagrams the author then described one method of ascertaining the amount of this gauge alteration. Referring to corrugating, he remarked that where this occurred steps should be at once taken to grind the head of the rail so as to prevent worse trouble. The method employed in Norwich was to fix a slipper formed of carborundum blocks to the slipper brake gear, and run the car up and down over the rail to be ground, a spring being inserted in the brake rod to give the necessary pressure.

DISCUSSION.

The discussion which ensued centred chiefly round the respective merits of steel-tyred and chilled wheels. Generally speaking, the evidence was all in favour of the former type. One speaker had obtained an average mileage of 56,297 with steel-tyred wheels for 20 cars so fitted. The cost worked out at ·0293d. per car mile, that of chilled wheels being about six times greater. Another obtained a mileage of approximately 5,000 for $\frac{1}{8}$in. wear of the steel tyres. With regard to the corrugation of rails, although it was agreed that this was a very serious matter, no satisfactory explanation was forthcoming as to its cause. The phenomenon might be associated in some degree, it was suggested, with high speeds, but no data were offered to prove or disprove this theory.

Radial trucks were incidentally mentioned and favourably commented on by several speakers.

Dinner.

After the first day's business the members and guests of the association were entertained by the directors of the Wakefield and District Light Railway Company at dinner.

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Mr. Leon, chairman of the company, presided, and those present had a most enjoyable time.

Is Our Present System of Ticket Check the Best.

The first business on the second day of the meeting was the reading of a paper, entitled as above, by Mr. F. Coutts, Ayr, who explained that his intention was simply to introduce this important subject, and throw out a few suggestions, with a view to drawing out in discussion the various methods that might present themselves to the members. He thought everyone who had given the matter any thought would at once agree that to attempt to catch the dishonest conductor with a uniformed inspector was useless. The author went on to describe a few of the tricks resorted to by dishonest conductors. These tricks, and a dozen others well known to all tramway managers, could, he thought, be far more easily detected by someone travelling in plain clothes, paying his fare in the ordinary way, and whose connection with the tramway department was unknown to the men. But the question was: Who could be got for this kind of work, and when got, how long would they travel without being spotted by the men? In the case of large systems there was not so much difficulty as with small ones.

There were always to be found a number of suitable men, or, better still, women, who, for an annual payment of £10 or so, would be willing to give their assistance. In this way five to seven could be had for the wages of one inspector at present employed. A choice might be made of those whose employment compelled them to travel frequently. They would never have to enter the tramway office, but could do everything by correspondence. Insurance agents, collectors, sanitary inspectors, etc., would do well for the purpose.

An alternative system, and perhaps a better one, was the formation by all the municipal and company undertakings of a detective staff of specially trained men and women, whose duty it would be to travel here and there over the different systems, never remaining long in one town; and for a fixed annual sum, according to the size of the undertaking, each company or corporation would have one or more of the detective staff sent for a few days several times a year. The employés of such a department would be very valuable in hunting up special cases for managers who suspected irregularities. They could also keep an eye on motormen and conductors as to their general conduct, spot the careless motorman who helps to run up the big current bills, report on the careful one, take note of the impertinent conductor, and be able to give a favourable account of the cheerful, obliging, and civil conductor. He advocated the new system not with the idea that tramway men needed more supervision than other men, but with a view of saving the expense of a large staff of inspectors, and in order to get better reports than now seemed possible. At the same time the service of uniformed inspectors could not be entirely dispensed with, as they, too, had their uses.

Discussion.

A somewhat lengthy discussion followed, in the course of which it was agreed that the passengers rather than the conductors wanted watching—generally speaking, there was very little dishonesty practised among the latter. One speaker gave it as his opinion that checking by experts was very useful to managers. Uniformed inspectors were, however, too conspicuous for the work, and people picked up here and there would be no use whatever. Another speaker had absolutely no faith in private detectives, and suggested the systematic comparison of the men's average earnings as a possible way out of the difficulty. It was also suggested that pilfering among passengers in regard to excess fares could be best checked through the agency of police detectives by arrangement with the authorities.

Automatic Regenerative Control.

A reprint of an article dealing with the above subject was next taken. As this had been published some time ago it was not read. Mr. Raworth, jun., however, supplemented it by introducing his father's contribution to the discussion on Mr. John J. Hall's paper, dealt with in our issue for last week.

Several questions were afterwards put to Mr. Raworth, who, in reply, said that although with the system the motors were always in series, there was only half the usual pressure between the commutator bars, and this was better for them. With regard to sparking at the brushes, the motors used now had a fixed line of commutation, and, consequently, no sparking occurred so long as the field current did not fall below a certain limit. That a car equipped for regenerative control could not be reversed was claimed as an advantage. Shunt motors, as compared with series machines, were 8 per cent. heavier and larger for the same horse-power. A man of ordinary intelligence could drive shunt motors after a few hours' instruction. It was true that the system did not at present endow the cars with hill-climbing capacity equal to that obtained with series-parallel control, but series-parallel regenerative control was coming, and with that it was hoped to attain a speed of 10 miles an hour on up grades. The starting current was less than for series-parallel control.

Next Place of Meeting.

It was decided to hold the next meeting of the association at Bristol in April next year provided suitable arrangements can be made.

Visits.

The afternoon was occupied with visits. The first of these was to the Corporation electricity works, remarkable principally for the variety of alternators comprised in the equipment. A call was also made at the works of Messrs. E. Green and Son, of economiser fame, where splendid evidence was seen of this firm's world-wide reputation.

Next and last in order came the inspection of the Wakefield and District Light Railway Company's undertaking, a detailed description of which will be found elsewhere in this issue. A sub-station was visited, and tracks then made for the power station and car-sheds adjoining. The company have put up buildings of a very substantial character, but devoid of all architectural embellishment. An old chimney shaft has been utilised in the scheme, the flue from the boilers being brought round one end of the station to it. The engine-room walls, contrary to what is the usual practice now, are not fancifully tiled, nor is there provided an elaborate and expensive roof. At the same time the equipment is of the best that money could buy.

Mr. T. T. Davies, the resident engineer, can be trusted to get the best out of the plant. Results obtained after only three months' working augur well for the future. The cost of generation, including salaries, has been as low as ·39d. per unit delivered on the line, we understood, while Mr. Davies hopes to ultimately reduce this figure to ¼d. Certainly there is much to favour the attainment of this end. Coal delivered on the site is cheap—4s. 8d. per ton for pea nuts being the price at present ruling—while the station has an abundant supply of water available for condensing purposes. Jet condensers are used, without, it is interesting to note, air-pumps, and no doubt considerable economy is effected in this way.

After the inspection the formal opening of the works took place. It was explained that this ceremony could not be arranged for the time when the service of cars was inaugurated some three months ago.

OVERHEAD v. CONDUIT.

The following verbatim extract from the agenda of the London County Council is interesting reading. One could quote proverbs by the score, but the fact remains that the London County Council now desire to introduce themselves the trolley system, which they have so strongly opposed in the past. It is only justice that the metropolitan borough councils should now oppose this step, and that the London County Council should feel what its chief weapon against private enterprise—*i.e.*, arbitrary municipal opposition—is like.

4. In the London County Tramways (Electrical Power) Act, 1900, a provision (Section 23) was inserted which gave to each borough council absolute power of vetoing the

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use of any overhead system of electrical traction in its own district.

We think that even the strongest advocates of the conduit system will agree that this is not a position in which the tramways authority should be placed. It is one thing to allow the local authorities every opportunity of criticising or opposing the proposals of the central authority; it is quite a different thing to give them an absolute veto which ties the hands of the tramways authority in the management of its business. Serious practical difficulties have arisen, as was to be expected. One effect of the position is that, even when the Council is able to agree with one borough council as to what should be done in its district, the Council is unable to proceed owing to the objection of another borough council. One borough council thus penalises another. We feel sure the Council will agree that it is desirable that it should secure freedom of action. The very important question as to the localities in which and the extent to which overhead traction should be employed, is a matter for subsequent decision by the Council. It is necessary to explain why we bring up this question at the present moment.

The Council on July 7 and 14, 1903, considered certain proposals which we submitted to it for the reconstruction, for electrical traction, of the Council's (northern) tramways. The scheme in question provided for the adoption on the lines of both the underground conduit and the overhead system of traction, and was the result of the most careful consideration by us of all the circumstances bearing upon the matter. The question of the system to be adopted depends to a great extent upon engineering conditions, and also upon the width of the thoroughfares traversed by the tramways, as the conduit system can only be satisfactorily used for double lines of tramways. Our proposals were based largely upon these considerations, and also had in view, as far as possible, the general policy of the Council of using an underground system in the central districts of London, reserving overhead traction for the more outlying districts. The Council adopted that portion of the scheme which related to the use of conduit traction, but before dealing with the proposals for overhead traction instructed us to ascertain the views thereon of the local authorities affected.

We accordingly at once placed ourselves in communication with the borough councils upon the subject, and on July 14 and Oct. 27, 1904, conferences were held between representatives of the borough councils and ourselves with reference to the steps to be taken in the matter. We placed all the facts bearing upon the question fully before the local authorities. Although certain of the borough councils have expressed their desire to assist the Council in the matter, the majority are not prepared to consent to the use of overhead traction. A copy of the notes of proceedings at the two conferences that were held has been sent to each member of the Council, from which may be gathered the attitude generally of the borough councils upon the subject. In these circumstances we have most anxiously considered what course we should recommend the Council to adopt. As the result of an exhaustive review of all the facts, we have decided to recommend that powers should be sought in the session of 1905 to secure the removal of the veto of the road authorities upon the use of overhead traction.

The final conference with the local authorities on the subject, which has emphasised the necessity for dealing with the matter on the lines we propose, has been held so recently that it was not possible for us, as we should have liked to have done, to have communicated to them our decision before submitting a report to the Council.

In addition to the Council's (northern) tramways, there are other tramway systems, either acquired or hereafter to be acquired, upon which, owing to engineering difficulties or the narrowness of the thoroughfares affected, it may be necessary to use overhead traction if the work of electrification is to be carried out expeditiously. Moreover, we think it right to point out that, as the result of the present state of affairs, a large number of thickly populated districts in which tramway development is urgently required will be seriously prejudiced owing to other authorities being unwilling to agree to the use of overhead traction in their boroughs

We quite recognise that there are many points—for instance, the system of paving and the method of carrying out the work—in regard to which the local authorities are necessarily closely interested, and the Electric Power Act gives them full rights in these respects. As already stated, however, we feel very strongly that the Council, as the tramways authority for London, should, in order that it may deal with the question of locomotion comprehensively both as regards traffic requirements and engineering and financial considerations, have a predominant voice as to the systems of traction to be used. We would point out, in this connection, that the consent of the Board of Trade is required by the Act to whatever system may be adopted, and the road authorities are entitled to be heard by the Board before such consent is given. Outside this very important reservation, we consider that the Council should be free to act if it is properly and satisfactorily to carry out its duties as the tramways authority, and to study from every point of view the interests of the public using the tramways. In dealing with the question of traction, it is to be borne in mind that the Council's policy is circumscribed by a variety of considerations which do not naturally weigh so strongly with the local authorities, who have principally in mind the local conditions obtaining in particular districts. The construction of new lines, the development of sparsely-populated districts, the framing of satisfactory and uniform conditions of labour, the linking-up of distinct systems of tramways inside and outside the county, are among the questions which are closely affected by the Council's freedom in regard to the systems of traction to be used, and we think that this freedom may properly be asked for without endangering the interests of the several road authorities concerned.

It should further be pointed out that in regard to these matters, and also as regards engineering considerations, the conditions which obtained in the case of the southern lines, which have been reconstructed for underground conduit traction, differed in important respects from the lines upon which, we think, it may be desirable to introduce overhead traction.

It is important that the matter should be dealt with without delay, particularly in view of the fact that the Council's generating station at Greenwich will be ready, it is hoped, early in 1906, and from this station power will be available for working a large portion of the tramways both north and south of the Thames. In the circumstances, we have decided to recommend that powers should be sought in the next session of Parliament. The solicitor has advised, in accordance with Standing Order No. 365, that the Council has power to promote legislation with this object. As required by Standing Order No. 363, we have informed the Parliamentary Committee of our proposal to submit a report to the Council in this sense.

The urgency of the matter clearly brings the case within the class contemplated by Standing Order No. 364; the terms of Standing Order No. 363, however, make a suspension of that order necessary:

(*a*) That the operation of Standing Order No. 363 relating to the time for the submission to the Council of schemes involving application to Parliament be suspended, in order that the following recommendation may be considered:

(*b*) That parliamentary powers be sought in the session of 1905 to relieve the Council of the obligation laid upon it by Section 23 of the London County Tramways (Electrical Power) Act, 1900, of obtaining the consent of the several road authorities concerned to the use of an overhead system of electrical traction.

TRADE NOTICES AND NOVELTIES.

Differential Hot-Wire Voltmeter.

Messrs. Johnson and Phillips call our attention to their differential hot-wire voltmeter, which is illustrated herewith. This instrument is equally useful on continuous as well as alternating current circuits of any periodicity. It is fitted with two independent movements, one above the other in one case, and

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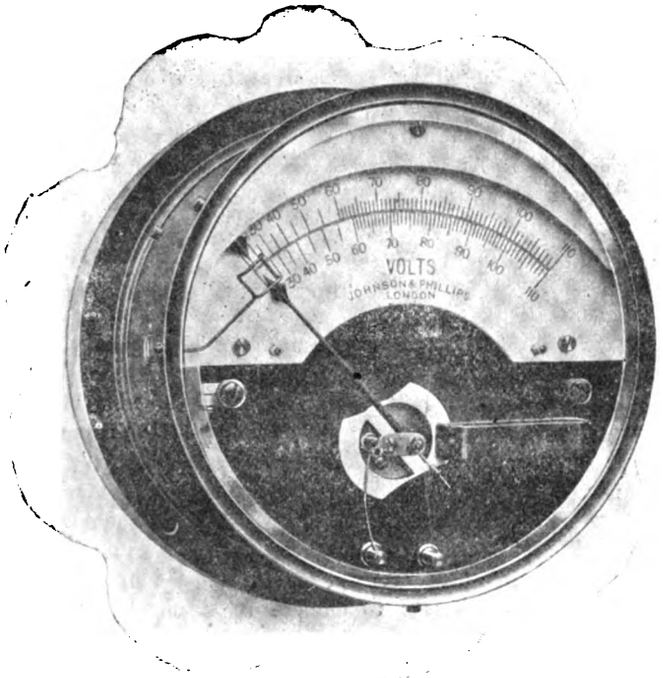
with two scales on one dial. It is a great advantage to have the pointers opposite each other and so close together, while it is often a benefit that the instrument only occupies the same space as a single voltmeter. These instruments have been supplied to many central stations, and are chiefly used for paralleling alternators. The fact that the two readings can be seen at a glance on the same dial is a great advantage for such

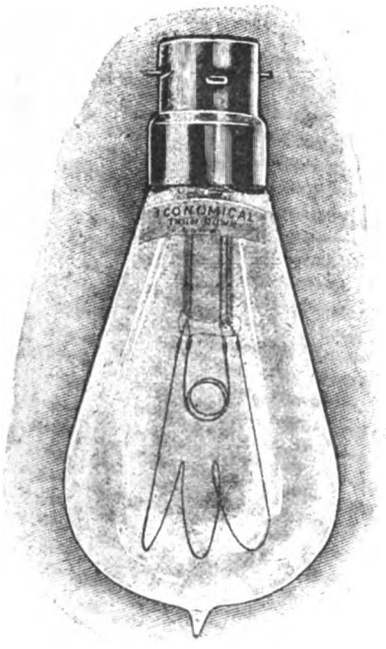


Differential Hot-Wire Voltmeter.

paralleling work, and it renders the observation of a difference between the voltage of the two machines very easy.

The Economical Turn-Down Lamp.

We illustrate herewith a type of lamp introduced into this country from America by Messrs. Geipel and Lange, Vulcan Works, St. Thomas-street, S.E. This lamp has two filaments—one the ordinary, the other a 1-c.p. filament. A switch is contained in the lamp cap for switching one or the other filament



Turn-Down Lamp.

into circuit. This can be actuated either by means of a pull-string or otherwise. The lamp is recommended for use in places where lights may be turned down with advantage, as in the case of gas-burners.

For the Drawing Office.

The accompanying illustration shows a very useful form of flexible curve made by Mr. W. J. Brooks, 33, Fitzroy-street, W. It consists of a flexible strip of celluloid or steel, provided with tabs at intervals along its whole length. Up to the 8in. size the curve can be held down in position by placing the fingers of one hand on the tabs, while the pen is used with

Brook's "Pattern A" Flexible Curve.

the other. In the larger sizes the tabs are secured by weights or drawing pins.

FORTHCOMING EVENTS.

FRIDAY, NOV. 11.

Electro-Harmonic Society.—At 8 p.m., concert (ladies' night).

Tramways and Light Railways Association.—Visit to London County Council's power station at Greenwich, etc.

Physical Society.—At 7.45 p.m., council meeting. At 8 p.m., "Investigation of the Variations of Magnetic Hysteresis with Frequency," by Prof. T. R. Lyle; "The Determination of the Mean Spherical Candle-Power of Incandescent and Arc Lamps," by Mr. G. B. Dyke; exhibition of physical apparatus by Mr. Robert Paul.

SATURDAY, NOV. 12.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to Messrs. Mather and Platt's works.

Permanent-Way Institution.—At 3 p.m., council meeting at Nottingham.

Electrical Engineers' Corps.—Smoking concert.

MONDAY, NOV. 14.

Institution of Mechanical Engineers (Graduates' Association).—"New Electrical Swingbridge over Flood-Course of the River Weaver, Northwich," by Mr. T. P. B. Cliff.

TUESDAY, NOV. 15.

Institution of Civil Engineers.—At 8 p.m., further discussion on Mr. A. E. Carey's paper, "Coast Erosion," and Mr. E. R. Matthews's paper, "Erosion on the Holderness Coast of Yorkshire." Mr. J. F. C. Snell will read a paper on "Distribution of Electrical Energy."

WEDNESDAY, NOV. 16.

Society of Engineers.—Conversazione.

Society of Arts.—At 8 p.m., inaugural address by Sir Wm. Abney.

Chemical Society.—At 5.30 p.m., ordinary meeting.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., opening address by Mr. J. Swinburne (past-president).

Royal Meteorological Society.—At 7.30 p.m., "Meteorological Observing in the Antarctic," by Lieutenant Charles Royds, R.N. (first lieutenant National Antarctic vessel, "Discovery"); "Decrease of Fog in London During Recent Years," by Mr. F. J. Brodie; and "A Hurricane in Fiji, Jan. 21-22, 1904," by Mr. R. L. Holmes.

THURSDAY, NOV. 17.

Institution of Electrical Engineers (Students' Section).—At 2.30 p.m., visit to the Great Eastern Railway Locomotive, Carriage, and Wagon Works, Stratford, E.

FRIDAY, NOV. 18.

Institution of Mechanical Engineers.—At 8 p.m., general meeting.

Junior Institution of Engineers.—At 8 p.m., Mr. W. H. Lindley will deliver his presidential address on "Municipal Engineering on the Continent."

December 1.—Annual dinner of the Institution of Electrical Engineers at the Hotel Cecil.

APPOINTMENTS VACANT.

Assistant Engineer, Croydon electricity works. Commencing salary, £2 per week. Applications by Nov. 12.

Assistant Electrical Engineer, Oldham Corporation. Salary, £275. Applications by Nov. 14.

Assistant Electrical Engineer, Kingston-upon-Hull electric tramways. Salary, £120 per annum. Applications by Nov. 14. See advertisement.

Station Superintendent, Chester Corporation, £130 per annum. Applications by Nov. 14.

Electrical Engineer, Battersea Borough Council, £400 per annum. Applications by Nov. 15.

Mains Superintendent, Poplar electricity works. Salary, £120 per annum. Applications by Nov. 18. See advertisement.

Mains Assistant, Blackburn electricity works. Commencing salary, £130 per annum. Applications by Nov. 18. See advertisement.

Junior Assistant for a firm of consulting engineers. See advertisement.

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THE
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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TRAMWAY MATTERS—NATURAL AREAS.

The authorities at the London County Council are changing their minds, a process so far satisfactory in that we may hope to wake up some fine morning to hear of further changes. We are not going to dilate upon conduit or overhead systems to be used in tramway work, or to consider where the one or the other may be employed to advantage. The London County Council is growing in wisdom, and begins to see that what it has done is not what it should have done, and so is desirous of greater freedom, which in this case will probably bring less responsibility. At the present time each borough council has absolute power of vetoing the use of any overhead system of electrical traction in its own district. To us such a power is logical, is, in fact, the only course that could honestly be pursued. The citizens of a district elect their representatives for that district, who presumably carry out the wishes of their constituents, and say what the tune is to be that the piper has to pay for. If some other authority having other aims—it may be antagonistic to the district—is to come in, work its own sweet will without "by your leave," then local control becomes a myth, and trespasses upon the nonsensical. To a certain extent we are glad the matter has arrived at this stage, because for many years we have been advocating reform. The ancient haphazard divisions are not suited to modern requirements. Overlapping in all directions takes place, and conterminous authorities controlling various parts of the same natural area give rise to endless squabbles, from which no class except the legal benefits. Whether for intercommunication, lighting, water supply or distribution, sanitation, etc., the whole land can be more or less divided into natural areas, and these natural areas should determine the controlling authority, not the old, outworn, artificial areas, which have had their day, done their work, and ought now to rest in an archæological museum. We have mentioned the powers of the various boroughs, but the fun comes in when it is recognised that the County Council has powers to construct tramways in most of these boroughs, and by its own action in the past has debarred itself from that construction its responsible officials deem most advisable. Surely it has been hoist with its own petard. No matter what the decision of conduit *versus* overhead, it is absolutely certain that no work can be properly undertaken which has to be carried out so as to comply with the often conflicting views of various independent authorities. All works carried out under such a system are of the nature of compromise all round, so that in hardly a single direction is a detail carried out according to the real views of the expert adviser. The County Council now seeks powers "to relieve the Council of the obligation laid upon it by Section 23 of the London County Tramways (Electrical Power) Act, 1900, of obtaining the consent of the several road authorities to the use of an overhead system of electrical traction." We fail to perceive how the Legislature can relieve the Council, unless it nullifies municipal control altogether. In municipal work wisdom does not come unless you wait, and then experience often modifies to the direct contrary the views hurriedly come to by irresponsible and inexpert members of councils. The present action of the London County Council will bring the whole question forcibly to the front, and people will see that piecemeal action is of little use. All over the kingdom local squabbles or local jealousies are causing trouble. Birmingham, Manchester, Liverpool, Newcastle, and Plymouth have had trouble, because conterminous authorities have objected to the carrying out of schemes as proposed which were designed to serve natural

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areas. The trouble concerning tramways is the more curious since the London County Council has been the most strenuous opponent to ordinary commercial company work, and has obtained powers of an exceedingly onerous character, which place the Council in a position to render company work within the borders of its control almost impossible. We do not imagine there can be two opinions about the substitution of natural in lieu of artificial areas in such work as intercommunication, water supply, lighting, etc., but why the London County Council should be favoured more than Manchester, Liverpool, or any other great centre, we fail to see, and trust, if the Legislature touches the subject at all, it will deal with the matter comprehensively. With regard to the particular case that has given rise to these remarks, the London County Council has shown itself liable to make a blunder in one respect; may it not be making a still greater blunder in much, if not the whole, of its tramway policy.

WHY?

In our last week's issue we gave a list of tenders for some telephone work which had been received by the Guardians at Richmond. The tender accepted was nearly 10 per cent. higher than the lowest tender received. Our readers will be surprised to hear that—if our information be correct—this accepted tender is for foreign-made instruments, and the lowest tender is for English-made instruments, which are quite capable of doing the same work. The question therefore arises as to why the Board of Guardians at Richmond and their architect have taken the higher tender? There are several answers which can be given, but the most charitable seems to be that the Guardians are afraid that if they encourage English industry and local labour they will lose office, because the need for a workhouse equipped with telephones may cease. At a time when the London County Council and some of the large provincial corporations have begun to realise that it is false economy to send work out of the country in order to save a few pounds in prime cost, it is curious to find the Richmond Guardians taking a diametrically opposite view and paying more for the foreign article. Again we would ask both the Guardians and the architect, Why?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE RICHMOND (SURREY) GUARDIANS AND GERMAN TELEPHONES.

SIR,—I observe from the Richmond papers of Saturday last that at the meeting of the Richmond Board of Guardians Colonel Henchy, who was in the chair, protested that the Board had adopted German telephones for the installation at the workhouse, notwithstanding that they might have had British manufactured instruments for £10 less money. This appears to open up a matter of special interest to ratepayers, whose money to the extent of £120 is being spent on the installation, and of general interest to the community at large as an example of the way in which public money is leaving the country.

I have made enquiries of the firm who sent in the lowest quotation for British telephones, an alternative one of £110. 16s. 5d., as against £122. 3s. 7d. for the German instruments specified by the Guardians. The proprietor of the business in question is a ratepayer in the borough, and, I am informed, signed his tenders as such. His alternative estimate clearly pointed out that the instruments were of the same British manufacture as some of those which are at present installed at the workhouse, although some there are German, but all are to be embodied with the new ones in one big system to work in connection with one another.

I questioned him on the subject of local labour, which I understood from the Guardians is to be our strong point in the future, and I thought I had him here—but no. It appears that by a strange coincidence he had made a provisional arrangement for by far the greatest portion of the work to be done by the very firm of Richmond builders whose estimate for the building of the new Board-room and offices, although not the lowest, was subsequently accepted for this very reason. Now, Sir, may I ask why the Guardians, in view of the distress and want of work among our own artisan classes, should go out of their way to support those of other countries, and why we should be asked to pay more money for this installation than if the order had been confined to these shores?—Yours, etc.,

Nov. 9, 1904. PUZZLED.

BIRTHDAY HONOURS.

The list of honours conferred by his Majesty the King in commemoration of his birthday includes two names which are well known in the profession of electrical engineers. By the conference of a knighthood upon Dr. J. Wilson Swan, F.R.S., his Majesty has given pleasure to all electrical engineers. Electrical Engineers in 1900 conferred upon this distinguished pioneer the honorary membership of the Institution, but the kingly act which makes him Sir Joseph Wilson Swan is a wider recognition of his services to the nation. It is in connection with the invention of the incandescent electric lamp that the new knight is always associated, and we need hardly repeat here the story of this invention. Although after an expensive legal fight Mr. Edison's name became associated with Sir Joseph W. Swan's invention, we have always looked upon the work carried out at Newcastle as giving the essential discoveries which rendered incandescent lamps commercially possible. The discovery of the means of producing a squirted carbon filament of uniform density and section was the great step which rendered electric lighting possible for interior work. Quite apart, however, from this invention, Sir Joseph Swan's researches in other directions, and especially in photography, have been so successful as to warrant the honour now conferred upon him. Again, his last presidential address showed an insight into the practical details of electroplating and copper depositing, which could only be acquired after arduous and lengthy experiments. The selection of his name in the new list of knights will be everywhere appreciated, and we can only add our congratulations to the recipient of the honour.

The other name referred to above is that of the Hon. Charles A. Parsons, D.Sc., F.R.S, who has been made a Commander of the Most Honourable Order of the Bath. By this the King has recognised the importance of the steam-turbine, which owes its commercial possibilities entirely to the Hon. Parsons. We remember when in the early eighties the Parsons turbine was first being introduced in the Newcastle district by the then firm of Messrs. Clark, Chapman, and Parsons. After considerable success in shiplighting work, the turbines, direct coupled to dynamos, were extensively used for the lighting of the Newcastle Exhibition in 1887. They supplied the light to all the main buildings in the exhibition by means of the large Sunbeam incandescent lamps which the same firm were then manufacturing. The exhibition brought these high-speed turbines to the notice of the engineering world, and their history since then has been one of continued success. When the above-mentioned firm dissolved partnership the Hon. C. A. Parsons, C.B., started the firm which now bears his name, and designed an improved form of turbine which is now so largely used. The enormous contracts which are now being carried out with steam-turbines as the prime movers are evidence of the foresight and engineering skill of this inventor in recognising and overcoming the inherent difficulties of this great problem. The extension of the steam-turbine from its orignal purpose of driving dynamos to the direct propulsion of steamships is one which will be

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followed with the keenest interest. Its success is assured, and was no doubt in the mind of the King when he selected his birthday list of new Commanders of the Bath. Here again we would add our congratulations to those which will be sent from all parts of the world to the Hon. Parsons, C.B.

RADCLIFFE ELECTRICITY WORKS.

One of the latest schemes which the Urban District Council of Radcliffe have had in hand and have brought to a successful completion is that of the electricity undertaking for the supply of electric energy for tramways and lighting in the district. Some time ago the Council wisely decided that a good electric lighting system would be essential, the population of the district being about 25,000, and a loan of £21,500 was obtained to be expended on the scheme. In 1902 specifications were prepared for the various sections of the scheme by Messrs Lacey, Sillar, and Leigh, the consulting engineers to the Council, and work was commenced about the end of the same year. The whole of the works have been successfully carried out by the various contractors under the direct supervision of the consulting engineers, whilst Mr. Henry, the resident engineer, has also given valuable assistance.

The Council are to supply current for about seven miles of tramway track, they having installed a traction switchboard at the station and having laid the permanent way and the necessary cables, etc. The tramways will be operated by the Bury Corporation, they providing the overhead equipment and the rolling-stock. The work in connection with the permanent way and the overhead equipment is at present in progress, and it is expected that the complete system of tramways will be in operation shortly. The works are conveniently situated in Lomax-street on the banks of the Irwell, the water for condensing purposes being obtained from the river. The plans of the buildings were supplied by Mr. Rothwell, the Council's surveyor, the work being carried out by Messrs. Sandyford and Thornley.

The buildings comprise boiler and engine room, accumulator room, testroom, offices, etc., adequate provision being made for extensions. The engine-room has a basement for the convenience of pipes and cables, the condenser pump, motor-generator, and balancer also being situated here. The steam-generating plant consists of two Lancashire boilers supplied by Edward Heaton and Sons. Each boiler is 30ft. long measured between the end plates, and 7ft. 6in. in diameter measured inside the inner rings of the plates. The grate area is 36 square feet, and the working pressure 160lb. per square inch. They are provided with the necessary safety high-steam and low-water valves and two accessible check feed valves. Two superheaters, supplied by the same firm, of Simpson and McPhail type, are erected at the back end of the boilers in the path of the boiler flues. Each superheater is fitted with a 2in. by-pass pipe and valve, and with a safety valve, thermometer, pockets, etc. The economiser, supplied by the same firm, of the Green type, is fixed in the main flue. It consists of 192 tubes, each tube being $4\frac{9}{16}$in. in diameter and 9ft. long, divided into two sections in rows of eight tubes wide, and fitted with deflectors at the back. The boiler feed pumps, supplied by Messrs. Mather and Platt, consist of one electrically-driven pump and one steam-driven pump, each being capable of delivering 1,800 gallons of water per hour against a steam pressure of 160lb. per square inch, the feed water being taken from a hot-well situated in the pump-house. The electrically-driven pump is three-throw single-acting, the stroke being variable. The steam-pump is of the simple direct-acting vertical type. The condenser, which is situated in the engine-room basement, and supplied by the same firm, is of jet type, with three-throw pumps electrically driven. The jet nozzles are of renewable type, and the condenser is of sufficient size to deal with 15,000lb. of steam per hour, and giving a vacuum of 26in. with cooling water at a temperature of 65deg. F. The cooling water is lifted approximately a height of 15ft. from the River Irwell, and the discharge is taken into the hot-well before mentioned, which overflows into the river. The various steam, exhaust, feed, and water pipe accessories were put in by John Wolstenholme and Son, an oil-filter being fixed in circuit with the main exhaust pipe and condenser.

The generating sets consist of two 120-kw. steam dynamos supplied by Messrs. Mather and Platt, with engines by Messrs. Browett-Lindley. The engines are of two-crank enclosed vertical compound type at a speed of about 500 revolutions per minute with a steam pressure of 140lb. per square inch, with a steam-chest, and working condensing with a vacuum of 24in. Each dynamo has a capacity of 120 kw., the current output being 250 amperes at 480 volts, the voltage being variable between 480 and 440 by means of a shunt resistance when running as a shunt machine. When running as a compound machine each dynamo has a constant potential of 550 volts maintained at any load between 70 and 220 amperes. The outputs given above of the steam sets are when working normally, but each set is capable of an overload of 25 per cent. for short periods. The dynamos are four-pole machines with bar-wound armatures. The balancer, supplied by Messrs. Crompton and Co., consists of two four-pole machines coupled together on one bed-plate, running at a speed of 800 revolutions per minute. The motor-generator, supplied by the same firm, consists of two 16-kw. dynamos and one motor, all mounted on one bed-plate, this set being used for battery-charging purposes when steam dynamos are running on traction. Both the lighting and traction switchboards were supplied by Messrs. Statter and Co. These boards consist of enamelled slate, upon which the various necessary instruments are mounted. The measuring instruments are of Crompton type, and the circuit breakers of B.T.H. type. The accumulators, supplied by the British Accumulator Company, consist of two sets of 123 cells and six spare cells, making in all 252. The battery is capable of giving a discharge of 40 amperes over a period of 10 hours and 180 amperes for a period of one hour, the voltage of each cell being not less than 1·8 at the end of discharge. The travelling crane, supplied by Messrs. J. Spencer and Co., is capable of lifting 10 tons. The station wiring for lighting and motors was carried out by Messrs. D. Firth and Sons, two switchboards being fixed in the engine-room, one for the control of the lighting and one for the control of the motors.

The lighting and traction cables, pilots, conduits, etc., were supplied and laid by the Callender's Cable and Construction Company, the work being supervised on their behalf by Mr. Mollard. For the lighting system the feeders terminate in two lighting pillars, from whence several distributors are taken. The distributors are lead-covered fibrous cable, laid in Howard troughing. The feeder cables and pilots for the tramways are in all cases lead-covered fibrous cables drawn into stoneware conduits. The rail bonds supplied by the Forest City Electric Company are of the protected type.

The supply of electricity for lighting and power purposes was commenced about the end of August, and already there are a good number of consumers connected or are about to be connected. The works were formally opened on Oct. 5 by Mr. J. H. Lund, chairman of the Electricity Committee, in the presence of a large assembly, when Mr. F. A. Cortez Leigh, on behalf of the consulting engineers, presented him with a gold key.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY ALEXANDER SIEMENS, PRESIDENT.

In taking the chair for the coming year, I am placed at a disadvantage compared with my predecessors, in so far as I cannot begin my address by thanking you for having elected me, but have to explain how it has come about that I occupy this honoured position. The late lamented death of our secretary induced the Council to consider how a continuous policy in the management of the affairs of the Institution could be best ensured; and as a result certain

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alterations in the by-laws have been suggested by the Council, and have been sanctioned by you in due course. The revision was, however, not formally completed in time to propose a president-elect at our last annual general meeting, and the expedient was adopted of proposing Mr. Robert K. Gray for a second term of office, to which he agreed, on condition that he might resign in favour of a president-elect as soon as the alteration of the constitution had been duly carried out. As our new secretary had been only a short time in office, the Council decided to elect a past-president as the successor of Mr. Gray, and did me the honour to select me, when Mr. Gray formally intimated that he did not wish to serve a second time as president. During the recess Mr. Gray, with a numerous party, went to the United States, as you all know, and during his absence it has been my sad duty to represent you at the funeral of our hon. member and past-president, Major-General Webber, who has the further claim on the regard of the Institution, that he was the last surviving founder.

Members of Council know better than the other members of the Institution how indefatigable General Webber was in promoting the interests of the Institution in every possible way, not only by attending meetings of Council and of committee, but by suggesting improvements wherever he thought imperfections existed. He notably took an active part in all the negotiations connected with the acquisition of a site for an Institution building, about which the Council reported at the last meeting. In him we have lost a true friend of the Institution, and his memory will be held in honour as long as the early days of our Institution are remembered.

It would, perhaps, appear natural to take this opportunity of comparing the status of the Institution, or, rather, of the Society of Telegraph Engineers, at its inception with the position now occupied, but this has been done so recently in presidential addresses that my words would be only a superfluous addition to the remarks more ably expressed by my predecessors. On the other hand, the causes which influence the growth of industries, and thereby the rise of institutions connected with them, will bear further discussion, as they are of the most varied character, and are an apt illustration of the interdependence of all factors of modern civilisation. Considering the features of this civilisation generally, it will be acknowledged, after a short reflection, that its true foundation is the lowering of the cost of production—in other words, the progress of civilisation is in proportion to the cheapening of articles of consumption. Although this may sound purely materialistic, the process of lowering the cost of production, which implies the employment of all the knowledge we can acquire, and of all the training the best schools can give us, results in greater ease of acquiring the necessaries for keeping alive, and therefore it gives us more time to cultivate other aspects of our existence. This general principle has manifested itself as much in the electrical industry as elsewhere, and further progress appears to be dependent on further lowering of the cost of its products. When we come to enquire into the means for carrying out this principle we soon recognise that the solution of the problem depends upon a variety of circumstances which all influence the result, although they may be investigated and discussed separately.

For "internal working," if I may say so, every industry depends upon three principal factors: (1) the capital which provides the works and the raw material; (2) the workman who converts the raw material into the finished product; (3) the management. It is quite idle to try to establish the relative importance of these three factors, for each one is indispensable, and likewise the prosperity of each one is inseparable from the prosperity of the others; so that no industrial establishment can flourish where these three factors do not co-operate heartily and harmoniously. As a first condition for further progress we should, in fact, recognise the identity of interest between the capitalist, the workmen, and the management, as any measure which is intended to unduly favour any one of these three factors would inevitably increase the cost of the product beyond what it ought to be and thereby restrict its sale, thus damaging all three. When we examine in detail in what way each of the three factors can contribute to the lowering of the cost of production, we find ample confirmation of the intricacy of the problem.

Taking capital first, its share in the value of the finished article is proportionate to (*a*) the cost of the depreciation and maintenance of the works and of their outfit; (*b*) the cost of the raw materials; (*c*) the profit, representing interest on the total capital invested in the undertaking. In order to minimise the first item the works ought to be carefully planned and equipped, so as to be careful of turning out the maximum quantity of produce, and their machinery should be selected and laid out in such a way that its wear and tear is only due to its legitimate working, and that the handling of all materials is reduced to a minimum.

The second item, the cost of raw materials, is too intimately connected with fiscal questions for treatment in this address; but incidentally it should be noticed that practically there is no such thing as "raw material"—at least, the Royal Commission on Trade declared itself unable to define what is "raw material." It is true that each industry works up what it designates as "raw material," but this in turn is the finished product of some other industry; even the products of nature, whether minerals, plants, or animals, form the basis of great industries, and are more correctly called finished articles than raw materials. In any case for the natural progress of industries, the cost of the materials which they work up should be kept as low as possible, and every increase of it is a hindrance to their proper development.

There is, apparently, not much difficulty in diminishing the third item—the profit on the capital invested—but it stands to reason that the interest earned by the capital could not fall below a certain amount without the industry in question losing the support of capitalists and collapsing. The rate of interest may therefore be considered a fixed quantity, and in order to diminish the amount payable under this head, it is important to avoid burdening an undertaking with more capital than is required for setting it up as a going concern and for providing a reasonable amount of working capital. A particularly dangerous way of increasing capital expenditure is buying patents, as the best inventions may be superseded at any time either by better ones or by a change in trade requirements, for in such cases the capital invested in the patent would be quite unproductive, while the interest would still have to be paid. It is much more equitable to remunerate an inventor by a royalty, so that his reward may be in proportion to the success of his invention, and to charge the amount that may have to be expended in developing the invention to revenue account.

When considering the influence of the second factor—the workman—on the value of the product, it becomes clear very soon that the amount of work turned out in a given time has a twofold influence on the result, as the time occupied in producing an article not only regulates the amount of the wages, but also the proportion of the dead charges to be debited to the article. It is, therefore, quite certain that in order to contribute his share to the lowering of the cost of production of an article the workman has to turn out a greater number of these articles in a given time, and the problem is how to attain this object without endangering the interest of any one of the three principal factors. This sounds almost as if slave labour would prove an economic plan in the carrying on of industries: it can, however, hardly be contended that the interest of the workman is considered under such conditions, and for this reason alone it should be condemned, even if there were no other objections to it.

There are, however, legitimate ways in which the amount of wages to be charged against an article can be diminished. Most important among them is the substitution of machine work for hand labour, and where this is done, unskilled labour should be utilised for running the machines under the supervision of a few skilled artisans. Here, again, the interests of the workman appear to suffer, and whenever he is confronted with a new labour-saving machine he airs his old grievance that machines will deprive the workingman of his living, just in the same way as he opposed the use of all machinery a hundred years ago. The

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lesson taught by experience has evidently not made an impression; but nobody can deny that, instead of making skilled labour superfluous, the introduction of machinery has resulted in more skilled workmen being employed, and at better wages than before, and similar developments are likely to follow when the workman is further relieved from hard toil by his best friend the labour-saving machine. Another feature of machine work is the greater accuracy that can be attained, so that, while the cost of production is lowered, the quality of the product is improved, and at the same time the interchangeability of parts is secured, which in itself contributes to the lowering of cost. It is not easy to convince workmen that "increase of output" is of advantage to them; if we are to accept statements published in the newspapers, they rather believe in the direct opposite, "restriction of output," although their official organs repudiate the idea.

This desire to do as little work as possible is, in a way, ingrained in us all, but in the workman it is in addition reminiscent of the mediæval guilds, those ideal trade unions which have been abolished everywhere as incompatible with modern industries. In their time they have filled a useful purpose, but the conditions which made them appropriate have entirely passed away, and any attempt to revive them or their principles is doomed to failure. According to their constitution nobody was allowed to exercise a trade, or even to sell its products, who had not been brought up to it in accordance with strict regulations, first serving an apprenticeship, then becoming a journeyman, and finally advancing to be a member of the guild if he could produce a satisfactory masterpiece. The number of apprentices taken on was prescribed and the number of masters in each community was limited, so that every craftsman was tolerably certain of constant employment.

No wonder that such a condition of things has a great attraction for the modern workman, especially when he happens to be out of work, and that he thinks he can improve the position of his class by restricting output and by insisting on a minimum rate of wages, after the manner of the old guilds. His reasoning, apparently, is that modern conditions of living require a number of things to be done every day; consequently, the less work each individual does the more individuals have to be employed, and if a minimum rate of wages is enforced, the question of the unemployed is satisfactorily solved.

In the Middle Ages, when each community was to a great extent self-contained, and the intercourse even between neighbouring towns was hampered by bad roads and insecure travelling, it was possible to adopt this solution of the problem, especially as the style of living was very much the same for the great majority of people, while their requirements did not include much beyond their bodily wants. During this time the workmen, when they had become full members of the guild, were practically chained to the soil, and in return for this immobility their number in a community was limited. They had to do all their travelling, if they were that way inclined, while they were journeymen, and most of them used that time for picking up information useful for their trade, even in foreign countries. As the facilities for travel increased, and with it the intercourse between distant countries, the prices of products fell which formerly had been obtainable only by the very rich, and gradually the great majority of people have become accustomed to surround their daily life with luxuries, meaning thereby everything that is not absolutely required to keep body and soul together. This alteration in the way of living has been further accentuated and extended by the substitution of machine work for manual labour; in fact, this change of the mode of production is still going on to the great advantage of the consumer. In other words, everybody is sharing in the benefit of the cost of production being lowered.

On the position of workmen the further circumstance has exercised an important influence that, by the facilities of intercourse and by the employment of machinery, huge factories are enabled to undersell works on a small scale, so that for successful competition in modern industries capital has become a necessary adjunct. It is, therefore, no longer possible to insist on masters being selected only from the class of workmen, nor is the work which is absolutely necessary for the daily existence of mankind sufficient to keep all workmen in constant employment, so that the old remedy of the guilds can no longer be applied. Restricting the output has, in fact, nowadays exactly the opposite effect to what it is intended for. When the price of an article is raised owing to this supposed remedy, a number of consumers begin to do without it, and the demand for it diminishes, so that less people can be employed on its production. Instead, therefore, of securing employment for more men, it will endanger the continuance of work for those who restrict output under the mistaken impression that they are benefiting their fellow-workers. How far this restriction of output is carried sometimes can be illustrated by the action of the workmen in shipyards and boiler shops, who either refuse to work pneumatic riveting machines or insist on doing no more work with the machines than could be done by hand, exacting the same prices per rivet as for hand labour. It escapes their attention that they handicap their employers in competition with others who are free to utilise such labour-saving devices to their full extent, and that unsuccessful tendering means no work at all.

On the other hand, a good example of the beneficial effect of lowering the cost of production is furnished by the trade in incandescent lamps. At first, when they were made by a few highly-skilled workmen and sold at 25s. each, there were very few consumers able to indulge in the luxury of electric light, and the number of hands employed was correspondingly small. That condition of things has been absolutely changed since the price has been lowered to its present level; thousands of skilled workers are employed in the production of lamps, in addition to the tens of thousands of unskilled people who attend the machinery used in the manufacture and perform the manifold functions connected with this trade. Such a result could not have been attained without the use of labour-saving machinery of the most varied description, and it seems incredible that, in spite of this and similar demonstration of the beneficial influence of increased output at lower cost, the workman should remain blindly hostile to this principle and cling to his exploded remedy of restriction of output. This attitude is illustrated by a remark which a leading workman made when the importance was impressed on him of diminishing the amount of wages chargeable to each individual article, because in this way the article became cheaper, more customers could be found to purchase it, and consequently more workmen would be required to produce it. His observation was that he fully understood the argument, and that it meant, in his opinion, when carried out to its full extent, that everybody would find employment if no wages were paid at all. It is rather sad to think that such a man, who has been elected by his fellow-workers to a high office in his trade union, should not be able to discriminate between the rate of wages paid to a workman and the proportion of such wages chargeable to each article produced by that workman.

Workmen have also a rooted objection to seeing machines worked by unskilled men, which is apparently based on the mistaken notion that such unskilled men are replacing skilled workers. They, however, overlook the fact that labour-saving machines are only introduced where the same articles produced by hand labour would be too expensive for sale; consequently, no skilled workmen could be employed instead of labour-saving machinery. Another fetish of the working-man is his desire that all workers should be treated alike, and no preference given, absolutely ignoring that the capable and industrious are more deserving than the lazy and careless workers. How disastrously this tendency sometimes operates I can tell from a personal experience when I started the first continuous working tank glass furnace in Leeds, about 25 years ago. Up to that time all glass for bottle-making was melted in pots, and the glass-blowers were never certain when their services would be required, as it was almost impossible to melt the batch in a given time. Again, their work was frequently interrupted if the furnace man was unable to control the heat properly, so that the melted glass was either too hot or too cold. In any case, the working out of the last portion was very troublesome,

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as the pipes had to be dipped far into the furnace to reach the bottom of the pots. All these drawbacks are overcome in the tank furnace, where the melted glass is always ready for the blower; its temperature is under perfect control, and its level is always the most convenient for the workers.

As it happened, the secretary of the trade union worked at the furnace and expressed repeatedly his great satisfaction at this complete solution of all their difficulties. His union consented to the prices of bottles being lowered, but in spite of that the men succeeded in earning higher wages than before, owing to the greatly increased facilities of working. Encouraged by the success, the firm desired to establish three shifts of workers in order to utilise to the full the continuous working of their plant, but the trade union would not give their consent, alleging that the firm were making enough profit working two shifts. The firm then resolved to build some more furnaces of the same kind, but, to everybody's astonishment, the trade union threatened to withdraw all their members if another furnace were built. I asked the secretary for an explanation, and reminded him that he had nothing but praise for the improved system of glass-melting. In reply he said that he had nothing to take back, but that it was precisely the very great advantage that men enjoyed who worked at these furnaces which induced his council to prohibit their further building, as it was not likely that all the Yorkshire employers would follow suit, and they did not wish to have some of their men working under better conditions than others. To this decision the trade union adhered for nearly 20 years, and the consequence has been that hardly any glass bottles are now made in England.

I was reminded of this story when I saw in the newspapers, a short time ago, the bitter complaint of the glass-workers that foreign bottles were dumped in this country to the detriment of the native workmen. If these men had understood 25 years ago the principle that to lower the cost of production is to facilitate and increase the sale of an article, and thereby to benefit the whole community, themselves included, they would not have opposed the introduction of the tank furnaces, and they might also have remembered that competition would have forced all employers very soon to adopt this improved method of glass-melting, so that all the members would have worked under the same favourable conditions. Such a glaring case of short-sightedness does, perhaps, not occur very often, but this particular one has done irreparable injury to the manufacture of glass bottles in Yorkshire. Similar mistakes on the part of the trade unions can only be prevented by enlightening the workmen as to the necessity of lowering the cost of production, so that he uses his best endeavours to increase the output by adopting the latest methods and the best labour-saving machinery, and by convincing him that restricting the output means restricting employment.

(To be continued.)

YORK ELECTRICITY ACCOUNTS.

The following are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., taken from the accounts of the York Corporation electricity department for the year ended March 31, 1904.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	2,662	14	6
Repairs, etc., of buildings and plant	383	15	11
Distribution of electricity	294	17	9
Attending and repairs to public lamps	448	6	1
Rents, rates, and taxes	348	7	3
Management expenses	772	13	2
Special charges—insurance	52	0	8
	4,962	15	4
Balance transferred to net revenue account	4,149	15	10
	£9,112	11	2

Cr. Income.	£	s.	d.
By sale of current	8,685	0	11
Rentals of motors and radiators	243	4	5
Miscellaneous	148	14	4
Stores on hand	35	11	6
	£9,112	11	2

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	92,926	0	0
Sundry creditors	965	19	0
Owing to bank—capital account	6,593	11	1
Owing to bank—revenue account	2,254	13	1
Sinking fund accumulations	3,570	16	3
	£106,310	19	5

Cr. Assets	£	s.	d.
Capital account—amount expended for works	99,519	11	1
Sundry debtors for current supplied	3,013	13	10
Stores on hand	206	3	10
Sinking fund accumulations	3,570	16	3
Deficit balance on reserve fund account	0	14	5
	£106,310	19	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		924,263
Quantity sold { Public lighting 122,885 / Private consumers 643,657 }		766,542
Quantity used on works		44,485
Total quantity accounted for		811,027
Quantity unaccounted for		113,236
Number of lamps connected		53,454
Number of consumers connected		470
Maximum load demanded (kilowatts)		651

LEYTON ELECTRICITY ACCOUNTS.

From the accounts of the Leyton electricity department for the year ended March 31, 1904, the total expenditure on capital account to that date is stated to be £141,050. We give below abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	4,822	12	9
Distribution of electricity	243	8	6
Attending and repairs to public lamps	1,018	0	1
Rents, rates, and taxes	397	11	8
Management expenses, salaries, etc.	1,377	15	1
Law and parliamentary charges	19	10	0
Special charges, insurances, etc.	207	17	7
Total expenditure	8,086	15	8
Amount carried to net revenue account	9,508	1	10
	£17,594	17	6

Cr. Income.	£	s.	d.
By sale of current per meter	12,725	2	3
Public lighting	4,230	19	1
Rental of meters and other apparatus	397	14	0
Profit on repairs and work done	178	13	8
Rents receivable	10	10	6
Hire of instrument	51	18	0
	£17,594	17	6

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	135,478	0	0
Sundry creditors	2,965	1	11
Amount due to treasurer (less cash in hand)	15,604	18	4
Self insurance fund	371	0	0
Consumers' deposits	496	11	4
Sale of gas plant (less amount carried to net revenue account)	801	0	6
	£155,716	12	1

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	141,050	0	4
Stores on hand	210	16	9
Sundry creditors for current (less bad debts)	6,024	0	6
Net revenue account	8,431	14	6
	£155,716	12	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U		1,433,251
Quantity sold { Public lamps 390,142 / Private consumers by meter 804,802 }		1,194,944
Quantity used on works		72,719
Total quantity accounted for		1,267,663
Quantity not accounted for		165,588
Total maximum supply demanded (kilowatts)		854

Number of public lamps: 72 arcs, 658 incandescents.

Fire-Resisting Floors.—We have received an illustrated catalogue from Messrs. Hodkin and Jones, Limited, Havelock Bridge Works, Queen's-road, Sheffield, and 63, Finsbury-pavement, E.C., describing the corrugated-bar system of fire-resisting floors. The principal claims are strength, simplicity, and cheapness.

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DUBLIN LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Presidential Address.

BY MARK RUDDLE.

As it is not usual for your chairman's address to be followed by a discussion, the omission of this feature entails upon him a great responsibility in the selection of the subject matter upon which he should address you. Unfortunately, in the present instance, owing to ill-health and pressure of work, I have been unable to prepare an address which, in itself, would prove sufficiently interesting to entitle me to take advantage of this custom. I hope, therefore, that in the remarks which follow you will find ample material for your criticism, as in view of the rapid increase in our membership I propose to deal briefly with the method of training necessary for entrance into the profession we represent.

The right of electrical engineering to be termed a profession has sometimes been questioned by men who considered that manufacturers were too freely admitted into the ranks of the Institution, and that it had thereby been reduced to the rank of a mere trade union, but I think it is now admitted that we hold a clear title to rank as a profession, since our development has been mainly due to the efforts of a long line of experimenters and philosophers. Science, as Huxley says, is organised common-sense, and the groundwork of our claim to be a profession is the necessity for the exercise of all our past experience in the treatment of each problem as it arises—that is to say, for the application of those general principles unconsciously derived from all one has seen, or read, or thought about. The laboratory experiment of to-day is utilised in practical engineering to-morrow, and there is no other branch of engineering which so lends itself to exact mathematical treatment and demonstration. We have reason to be proud of the progress our profession—the youngest of the engineering sciences and arts—has made during the 25 years of its existence upon any appreciable scale. A century ago electricity seemed but a scientific toy; it is now thought by many to constitute the reality of which matter is but the sensible expression. The latest evolution of scientific research places the atomic theory in the background of ancient history, and the atom is now regarded as only the relatively vast theatre in which minute monads perform their orderly evolutions, the monads themselves being considered to be units of electricity operating by their interaction with the ether in which they are bathed. If this theory be true, it is small wonder that electrical science has of late years made such giant strides at a rate unparalleled in the history of the world.

It is unnecessary for me to weary you by detailing the multifarious applications of electricity in everyday work; new uses, and improvements of existing ones, so crowd upon our notice that it becomes practically impossible for an engineer in full work to keep himself abreast of the times in this respect in all branches of experiment and work. Every day is making more manifest the absolute necessity for specialisation in our profession, for, owing to the highly scientific and complex nature of the problems which have to be solved before arriving at a satisfactory method of meeting the demands of new applications and conditions, no one man can hope to have a thorough up-to-date knowledge of the whole cycle of professional work. This leads up to a most important point—viz., the training of electrical engineers with regard to their successful entrance into and practice of the profession.

A municipal engineer is often looked upon as an encyclopædia of information as well as a universal provider of employment, and parents frequently consult me as to the easiest way in which their sons can become trained electrical engineers, with, needless to say, a correspondingly satisfactory salary, and in the majority of instances leave me with a feeling in their minds that I am unduly magnifying the amount of study and training necessary before the first step can be taken upon the ladder of remunerative practical work. One frequently hears the remark made, "Oh! So-and-so is a 'born engineer.'" To a certain extent this is, of course, true, but in the ordinary meaning of the term, as implying that the person in question had no difficulty in acquiring his engineering knowledge, I venture to think that these "born engineers" exist only in imagination. Take, for example, a chick, which, upon coming out of its shell, is able to balance itself correctly, walk about, pick up food, and so on, thus showing it possesses the power of directing its movements to a definite end. How did it learn this very complex co-ordination of muscle, eye, and beak? It has not been individually taught; its personal experience is nil, but it has the benefit of ancestral experience, and in its inherited organisation are registered all the powers which it displays at birth. Man also carries with him the physical texture of his ancestry as well as the inherited intellect bound up with it, but this extends no further in the making of an engineer than giving the possession of a quick comprehension, a retentive memory, and a power of grasping problems. All else in modern engineering has to be acquired by a more or less tedious process of strenuous education. It is, of course, a well-known fact, but one of supreme importance, that actions, whose performance at first requires even painful effort and deliberation, may by habit be rendered automatic. Witness the slow learning of its letters by a child and the subsequent facility of reading in a man, when each group of letters which forms a word is instantly, and without effort, fused to a single perception. Instance the billiard player, whose muscles of hand and eye, when he reaches the perfection of his art, are unconsciously co-ordinated. Instance the musician, who, by practice, is enabled to fuse a multitude of arrangements, auditory, tactual, and muscular, into a process of automatic manipulation. I think, however, that the experts I have instanced would be the first to disclaim that their knowledge was born with them and to testify to the many years of mental and physical training necessary to attain to such facility of action. At least, such training is necessary to the vast majority of men. By myriad blows, to quote an old philosopher, the image and superscription of the external world are indelibly impressed upon our minds, the amount varying with the individual receptivity, due to ancestral inheritance and environment, and the immediate object in all systems of technical instruction is to so organise the course of study that the ultimate result shall be attained with the least possible waste of time and effort.

I shall not attempt to place before you to-night any cut-and-dried scheme or syllabus embracing the whole art of training an electrical engineer, for that at present seems to be a matter with regard to which the most diverse opinions are held by the leading experts in technical education. All of you will, no doubt, have in your minds the very exhaustive paper presented by Dr. Walmsley to the meeting of the Institution in London on Feb. 11 of this year, and the prolonged discussion which ensued thereon, and it is a serious matter to find that even now no one settled plan seems to meet with general approbation. This is greatly to be regretted, for upon the system of technical education to be pursued in the near future rests largely the position which will continue to be held by the Empire in the commercial markets of the world. Notwithstanding our backwardness in this matter in comparison with many parts of the Continent, we have hitherto managed to hold our own, being largely assisted by the natural resources of the country, but competition is becoming more keenly felt every year, and we cannot afford to drift along in the same old careless way.

The task of keeping the training of students for the profession of electrical engineering abreast of current practice seems almost hopeless in the face of the present rapidly increasing rate of development, and this leads to the important question whether it is advisable for the various colleges and technical schools to confine themselves to the teaching of the scientific principles which underlie engineering in general and the electrical branch in particular, or whether they should supplement that course by practical information upon the construction and operation of the various types of machines themselves, which would, of necessity, require that the equipment should be kept up to date by the newest and most efficient types of actual plant. The latter plan has actually been tried in practice, and the following figures from Dr. Walmsley's paper will show the scale of the experiment: In America the capital expenditure upon buildings and equipment for technical education amounts to no less than £75,000,000, of which £10,590,000 is devoted to engineering purposes. The annual income for 1901 is given as £9,623,200, of which the engineering sections received £1,527,000. The number of students in that year reached a total of 98,000, of which the engineering section formed 14 per cent. It might, therefore, be fairly thought that for this enormous outlay a good working system would have been evolved. Judging, however, from the paper itself and the lengthy discussion which followed, this has not been the case, and complaints have been made that the workshop and laboratory equipment has been on such a lavish scale that the students have been rather overloaded with a large and confused assortment of facts, and that the training in general principles has thereby necessarily suffered. In these countries we have not had the privilege of suffering from over-lavish equipment of our training institutes; on the contrary, for want of the necessary funds it has been cut down to the lowest point, but the general effect seems to be the same, and the trained students do not appear to be thoroughly equipped for entrance to the profession.

One predominant fact appears certain—namely, that one course of general training is necessary for those men who have the ability and funds for qualification into the higher branches of the profession, and that an entirely different training is required for those who, under ordinary circumstances, will have to commence their career with the routine work of the many applications of electrical engineering. By the higher branches I mean men who intend to devote themselves more particularly to original research and to the

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theoretical development of the scientific side of the profession, but this section is outside the scope of my present remarks. I feel more concern for what I may be excused for terming the rank and file of the profession, each one of whom, nevertheless, carries a marshal's baton in his knapsack, if he has been properly trained and qualified to seize the opportunity when it occurs.

The question seems to hinge largely upon the syllabus of the primary and secondary education received up to the age of 16. This should have comprised, in addition to the ordinary subjects of general education, a good grounding in algebra, euclid, elementary physics, and, if possible, either French or German, or both. If in the secondary school there is even a small workshop, a very valuable amount of knowledge could be imported in the elementary principles of simple tools and machines. Whatever the course of training to be pursued after this age, full advantage cannot be taken of it if the secondary education has not been directed with a definite idea of the engineering object in the future, for inadequate preparation means that much valuable time must be lost in preparatory work after leaving school. After this period two general courses of training are open to the student, each having strong advocates and, consequently, neither giving universal satisfaction. First, he may enter a suitable engineering works and spend two to three years in learning as much as possible of machine work, turning, fitting etc., together with some experience of drawing office work. After this, having gained an insight of practical everyday work, he may then enter an engineering college for thorough training in the theoretical side of his work. On the other hand, he may, on leaving school, at once take up theoretical work in a well-equipped technical college, and after, say, a three years' course, he may enter an engineering works with an eye to one particular branch of professional work or to gain all-round experience. The latter course has much to recommend it, as there is then no break in the educational course such as must occur if the student goes into a workshop straight from school, and after leaving the latter, has to resume the habit of learning and of routine study, which is not always an easy task. It is also not advisable in all cases for youths to be subjected at such an early age to the influences of ordinary workshop life, which they are not always able to withstand and find difficult to shake off on entering the training college; while if he first enters the latter, his character will be sufficiently formed when the time comes for leaving.

There is, however, a middle course which is often recommended for those students who are unable for various reasons to spare sufficient time to take full advantage of the general training I have mentioned—that is, to enter a works for practical training and to work up the theoretical side in evening classes. Except where no other course is possible, I do not recommend this plan. It is hard for a youth of 16 or 17 to keep ordinary shop hours at mainly physical work and to give up the majority of his evenings to private study or attending technical classes, and I am not sure that it is unattended with danger to his proper physical and mental development. A growing youth must have time for recreation and rest, and success is dearly bought at the expense of a debilitated constitution. Still, there are cases in which there is no option but to pursue this plan; but men so trained cannot expect to compete on equal terms with those who have had a more liberal course of study, except in cases of unusual ability and aptitude.

Much, however, depends upon the student himself. If he has an innate love of the science and art of electrical engineering, and of learning for the sake of finding out hidden things; if he has the earnest desire to attain to as near the front rank as his capabilities will permit, and has the physical and mental constitution to stand the strain of burning the candle at both ends, so to speak, he will, with average good fortune, attain his end more surely than many others who start under more, apparently, favourable auspices, for, having the self-stimulus of an insatiable knowledge-hunger, he is in closer sympathy with his teachers, and does not wait to be spurred on in his work. And this is the true spirit which should animate those seeking to enter our profession. Its devotees must give more than lip-service—answering of examination questions and obtaining passes and certificates—for, as you know, these alone are no test of a man's fitness, and, in fact, are often the cause of much wasted time by giving a premium to those who best develop a parrot-like facility of answering set questions rather than probing the depth of the information they have assimilated. In saying this, I must not be taken as considering these examinations entirely useless, for they undoubtedly do serve a useful purpose in separating the earnest student from the merely brilliant one. The failures in formal examinations often provide the most reliable raw material to be worked up afterwards, as only those who have grit in them continue to persevere as usual in spite of their failure to pass, and this determination to persevere stands to them in their after career, for it must never be forgotten by those who would be successful that they must be students all their lives. There is no such thing as finality in the knowledge of electrical engineering—a week now is more pregnant with discovery than 100 years was formerly, and those who desire to keep in the front ranks must keep pace with the times in their special spheres of work.

A serious danger is now developing owing to the great inrush of young men into anything electrical in name; many of them seem satisfied to acquire just enough technical knowledge to secure a post. Once secured they settle down and perform their routine duties more or less thoroughly, and gradually drift out of keeping their training up to date. Football, cricket, cycling, and often matrimony, or the preliminary stages of it, claim their leisure hours entirely, and even when on duty occupy such idle moments as occur between the intervals of actual work in the perusal of sporting or sensational literature rather than in anything bearing on their professional work. Time goes on, and opportunities occur for promotion or for entering fresh fields of work, and they find they stand no chance against competitors of more modern training from not having kept their knowledge up to date. It is not enough to have sufficient knowledge for present needs; one must look ahead, and be prepared for developments.

I have hitherto dealt principally with the technical side of a student's training, but before a student can expect to secure a position of any importance he has yet to acquire the commercial or business side of his education. No technical training institute can teach a student how to handle workmen, or how to turn out finished plant from a workshop at commercially remunerative prices, nor would it be reasonable to expect it to do so, for such knowledge can only be gained in the hard school of practical experience, and learnt little by little as opportunity offers. And yet such is the ultimate object of all profession training in the majority of cases, for the most perfectly and scientifically designed scheme is quite valueless unless it can be made a commercially financial success. Students should, therefore, take every opportunity of seeing works in practical progress; they feel utterly at sea with regard to much that goes on, but to an observant mind there are many object lessons to be learnt and hints obtained which will be of much service in after life. I have often been struck with the apathy displayed by the majority of students when given the opportunity of visiting works in process of erection, or in actual everyday running; they ask no questions, and apparently look upon the whole thing as a bore, or an opportunity of escaping a regular class lesson at best, instead of regarding it as a unique chance of seeing practical engineering works and life into which they may hope one day to enter. It is most depressing to those who have to show them round and desire to make the visit interesting and instructive to those who may be their colleagues or successors at some future time to find that so little interest is taken in what is going on, and they feel quite relieved and grateful when one of their visitors asks the most trivial question upon any point. Ask questions about everything is my advice to students; never mind whether they may appear foolish or trivial, give evidence in some way that you appreciate your opportunity, and you will gain many valuable hints for your future work, and render the task of your instructors a little easier.

I may here express a word of sympathy for the teachers and instructors in technical institutions, for theirs is, indeed, a difficult task. Too often they are unjustly blamed for being unable to meet the demand for trained men to fill the ranks of workers in technical industries, but they do not always deserve that reproach. Some there are, no doubt, who become teachers because the position gives them the means to live, but I know of many earnest capable men who are animated by a keen desire to fit their pupils in the best possible way to meet the battle of life, and yet are handicapped by themselves not having a practical knowledge of technical work and the requirements of employers in the various industries. They are, therefore, unable to so shape their course of training that it prove suitable, and being themselves cognisant only of a college course they naturally follow on the same lines. This is not altogether their fault; it reflects mainly upon the leaders of industry and large employers, who for the most part take but little interest in the training of the raw material from which their employés are drawn, and who have not realised that it is to their own interest, as well as that of the country at large, that they should co-operate with the teaching bodies, and assist them by both advice and funds in being properly provided with the most suitable staff and general teaching equipment.

I think I have detained you long enough upon this subject for to-night, and I would now say a few words upon the work of our local centre. The standard of papers read before you has been well maintained during the past session, and, in fact, one or two have seemed almost too high class for a large number of the members, though not for the credit of our centre. I judge of this by the very limited amount of discussion which ensued thereon, and, with all due deference

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to my hearers, I cannot but feel it somewhat of a reproach that so few members can be got to join in the discussions, even upon subjects with which most of you are familiar in your everyday business. This should not be. It is not quite fair to expect the same men to speak upon every occasion, and it does not tend to elicit the most profitable discussion upon the particular subject. This, I venture to say, is a great loss to all of us, and takes away largely from the main object of our meetings, which should be the advancement of our mutual knowledge, and, therefore, the interests of the profession at large. I would, therefore, appeal to our hitherto silent brethren to help us in the future ; it is not necessary to make a long speech, a few words of practical experience straight to the point are worth infinitely more than a long dissertation couched in ornate phraseology but adding little or nothing to our information. Everyone should endeavour to contribute his mite to the discussion ; it may not be easy at first to unpractised speakers, but it will improve with practice, and it is most valuable training for students. A more general discussion would enable us to invite shorter papers from members, and this in turn would remove much of the present difficulty in getting members to contribute papers. In most instances a paper taking 15 to 20 minutes to read would furnish ample material for 1½ hours' discussion, and would not be such a tax upon the contributor as a more elaborate paper lasting an hour or more.

Our honorary secretary informs me that there is such a scarcity of papers in view that he may have to fall back upon a visit to the Corporation electricity works to fill up a gap in the meetings. I need hardly say that the Lighting Committee will be ready to facilitate such a visit, as the chairman has always taken a keen interest in the work of our centre, but I hope is will not be necessary to take up one of our few regular meetings in this way, as, if the members desire, it can be arranged instead for some Saturday afternoon, when the generating station could be inspected under more favourable conditions.

In conclusion, gentlemen, I have to thank you for your attendance here to-night, and to express the hope that at the close of the present session our proceedings will show that we have made substantial progress in advancing the interests of the profession to which we have the honour to belong and of the Institution which officially represents it.

ST. PANCRAS.

The late mayor of St. Pancras, Mr. T. H. W. Idris, in his address to the Council on his retirement from office, gave a most interesting review of the work of the past year. His retrospective notes as to the early attempts at gas lighting in the district are quite historical. Speaking on the electricity undertaking he said :

Before dealing more fully with important matters connected with the electricity undertaking, I think we are justified in congratulating ourselves on the splendid progress we have made. The handsome profit of over £20,000 for the past year, after repaying all costs of production and distribution of the current, repaying a considerable portion of borrowed capital, interest on loans, and all other charges, is a result which other authorities would have liked to emulate. Considering that we are the pioneers of municipal electricity in London, that we have had to gain experience and overcome many difficulties, and that our charges for current are amongst the lowest in the Metropolis, we may say to-day without egotism that we have achieved a remarkable success. During the past year we have, perhaps, had rather more than our share of trouble in connection with this undertaking. Several owners and occupiers of property abutting on our King's-road central power station entered an action against the Council alleging nuisance, noise, and annoyance from vibration, etc., from the refuse destructor and the electricity works. Unfortunately, the late vestry, when they acquired the land for the station, had to obtain it by agreement, inasmuch as they had no power to promote a Bill at the charge of the rates for compulsory purchase giving a statutory right to use the land for generating electricity thereon.

As is generally the case in these circumstances, the local authority got the worst of it, and an injunction was granted which would have become permanent unless all vibration had been stopped, which was almost an impossibility. The result is that we are purchasing the interests of the persons concerned, at what are no doubt in many cases exorbitant prices. We had practically no option in the matter. As a result of this action you thought it was very necessary that some steps should be taken with a view to preventing similar arbitrary and unjust proceedings being taken in future, and at least putting electric lighting undertakings in no worse position than other undertakers who have statutory obligations imposed on them. A conference was, therefore, called of all local authorities and companies owning electricity undertakings in the country, with the object of petitioning the Board of Trade to promote legislation on behalf of electricity undertakers for obtaining compulsory powers of purchase of land for their purposes, and for the amendment of the Electric Lighting Acts, with a view to repealing the nuisance clause and preventing actions being brought against the undertakers in all cases where the works are carried on without negligence. I was elected to the chair of the conference, which was well attended by representatives from all parts of the kingdom, and the subject was very fully discussed, and the conference appointed a committee to formulate propositions for action. This committee subsequently approached the President of the Board of Trade, and asked him to receive a deputation in support of the resolutions (one of which referred to the Supply of Electricity Bill) passed at the conference. A reply was, however, received from the President, suggesting that as the Supply of Electricity Bill then before Parliament had been referred to a Select Committee of the House of Lords, the best course for those interested would be to submit their views to that committee.

I may remark in passing that, with regard to this Bill, you had already presented a petition for the elimination of Clause 6 (1), inasmuch, as if it had been passed as drafted, it would have been possible for a company to enter into competition with the Council in the borough. As the matter was of urgent importance, and the Bill was to be in committee in a short time, I took the responsibility of having petitions prepared, both on behalf of the Council and of the conference, praying for an addition to Clause 1 of the Bill, which would have the effect of placing electricity undertakers, who had acquired their land by agreement, and not under statutory power, in a position to successfully defend actions in respect of vibration, etc., so long as the works were carried on without negligence, and also in regard to the Council's petition for the elimination of Clause 6 (1), and praying that we might appear by counsel and witnesses in support of the petitions. My action in the matter was approved by you, and the conference also signified its approval. The prompt action on our part had the effect of obtaining very valuable amendments to the Bill. The interview we had with the assistant secretary to the Board of Trade resulted in the Board agreeing to amendments which the Select Committee agreed to insert, and made the Bill very satisfactory to all electricity undertakers.

Briefly, the Bill as amended will give undertakers power to apply to the Board of Trade for a provisional order to acquire or use land already in their possession for generating, converting, or transferring electricity. A clause was also inserted providing that what is known as the nuisance clause should not be incorporated with a provisional order, so that if works included in an order are carried on without negligence, no person would be entitled to claim compensation for nuisance, and there would be no power to grant an injunction to close the works. Other clauses were included in the Bill which I need not specifically refer to, but which would be of benefit to electricity undertakers.

All electricity undertakers are indebted to Mr. Morse (solicitor to the British Traction Company), Mr. Gripper (managing director of Edmundson's Electricity Corporation), Alderman W. H. Matthews, Councillor G. Hickling (chairman of our Electricity Committee), Councillor J. Bussey (chairman of the Electric Lighting Committee of the Poplar Borough Council), Mr. R. M. Prescott (town clerk of Fulham), and Councillor S. Slatter (of the Barnes Urban District Council), to whom the supervision of the opposition of the conference was referred, for the zealous attention they devoted to the work, which meant attendance at frequent consultations and in the committee room of the House of Lords during the time the Bill was under consideration ; and our best thanks should be tendered to them for the valuable services they have rendered. The Bill, as amended by the Select Committee, was passed by the House of Lords, but owing to the prorogation of Parliament its further progress was stopped. I do not think there is much doubt that it will be reintroduced into Parliament next session, probably by the Board of Trade in its amended form, and we all hope will then become law. We may, I think, congratulate ourselves on the measure of success of our labours in this direction, which I feel sure will eventually bear a fruitful result.

Before leaving this matter, I desire to express the obligation we are under to Mr. Richards (the deputy town clerk), who acted as honorary secretary of the conference, to Mr. Baynes (our chief electrical engineer), to Mr. Blair (our borough engineer), and to Mr. Pycraft (the chief clerk of the electricity and public lighting department), for the unremitting and painstaking services rendered by them in connection with the opposition of the Council and the conference to the Bill in order to obtain the amendments referred to, these services being in addition to their regular duties, and necessitating working not only during the day but long after the office hours.

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COMPANIES' MEETINGS AND REPORTS

CAPE ELECTRIC TRAMWAYS.

The report of the Cape Electric Tramways Company for the year ended June 30 last states that the profit and loss account shows, after providing for debenture interest and redemption of debentures, a net balance to credit of £57,080. From this sum the directors have paid to the shareholders 10 per cent. upon their capital, represented by two interim dividends of 5 per cent. each, paid on Jan. 28 and on Aug. 17 respectively. The reserve fund has also been credited with the sum of £8,000, making a total appropriation of £56,000, and thus leaving a balance of profit of £792 to be carried forward. The passenger and revenue returns for the Cape Town system for the 12 months under review both show a slight increase over the previous year, and the expenditure account a small decrease over the same period. An increase of passengers and revenue has also been experienced in Port Elizabeth; but the expenditure account of that system has had to bear several very heavy charges during the past 12 months, due principally to the necessity for constructive repairs to the permanent way, to a serious increase in the coal account, and to other special items, amounting in all to about £6,000. At the commencement of the year 1904 the Board appointed an independent general manager for the Port Elizabeth system—Mr. J. A. Barkley—and the directors are glad to be able to now state that the improved condition of this system and the decreasing expenditure have fully justified them in this measure and in the selection of the present manager to the post in question. At Cape Town, during the year under review, the important extension of Hanover-street was opened to traffic. At Port Elizabeth the Board had sanctioned an extension on the Walmer-road to the municipal boundary, which is now being proceeded with, and on completion of the same an extension on the Cape-road, also in the direction of the municipal boundary, will be taken in hand. These two extensions are amply justified by the increase in the number of suburban residences in these districts. As regards the power-house at Port Elizabeth, the additional unit referred to in last year's report has since been completed, and is working in a satisfactory manner. The Camps Bay tramline, leased from the Cape Town Consolidated Tramways and Land Company, Limited, by this Company, has not hitherto proved the success that was anticipated, owing to industrial depression. The loss on the year's working, including the rent paid to the Consolidated Company, amounts to about £9,000.

ROSARIO ELECTRIC.

The ordinary general meeting of the Rosario Electric Company, Limited, was held on Monday at River Plate House, Mr. W. T. Western presiding.

The **Chairman** said that at the time of the last annual meeting the Company was transferring from its old system to a new system. The Company had now done what it had contemplated, and the results had been satisfactory. The new engines and cables had been taken over in August, 1903, so that the Company had up to the date to which the balance-sheet was made up had 10 months' use of them. Up to last Christmas the staff in Argentina had been practically occupied in transferring the Company's customers from the old system of cables to the new one, so that naturally the Company did not get much benefit from the new machinery during that period. After Christmas, however, business went ahead. After deducting the running expenses in Argentina, the profit for the first six months of 1903 amounted to £2,700, and for the six months to Dec. 31, 1903, they had risen to £2,800, while for the six months to June 30, 1904, they had advanced to £5,100. For the first two months of the Company's current financial year the figure was over £2,400. The number of customers had risen from 800 in December, 1903, to 936 in September last. Besides taking on new consumers for lighting, the Company had made a beginning in the power business.

The report was adopted.

A resolution was passed to increase the capital of the Company to £160,000 by the creation of 8,000 further 6 per cent. cumulative preference shares of £5 each, ranking *pari passu* with the existing preference shares.

In future dividends will be paid half-yearly.

The resolution was carried.

A separate meeting of preference shareholders was subsequently held, and the creation of the new preference shares was agreed to.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

For the half-year ended June 30 the directors report that the gross receipts have amounted to £300,057, against £265,099 for the corresponding half-year of 1903. The working expenses, including £25,712 for maintenance of cables, absorb £141,707, against £138,516 for the corresponding period of 1903, leaving a balance of £158,350, the net profit being £143,378. After adding £41,890 brought forward from the previous half-year, there is an available balance of £185,269. Two quarterly interim dividends of 1¼ per cent. each, amounting to £75,000, have been paid for the half-year, leaving a balance of £110,269 to be carried forward. During the half-year a further partial renewal of the Hong Kong-Foochow cable has been effected, and the cost, amounting to £6,273, charged against the general reserve fund. The s.s. "Restorer" has been sold to replace the Commercial Pacific Cable Company's s.s. "Scotia," and a small steamer (s.s. "Magnet") has been purchased for effecting repairs ro the many cables which the Company possesses in shallow waters of less than 400 fathoms. The subsidy arrangement in connection with the Tonquin cable expired in February last, and a new agreement has since been arranged, subject to parliamentary approval, by which the French Government will acquire the ownership of the cable.

WESTERN TELEGRAPH.

The sixty-second ordinary general meeting of this Company was held at River Plate House, Sir John Wolfe Barry, K.C.B., presiding.

In moving the adoption of the report and accounts (particulars of which appeared in our issue of the 28th ult.), the **Chairman** stated that since the conclusion of the period under review the general aspect of trade, which had been reflected in their receipts, was, on the whole, promising.

In reply to questions, the **Chairman** said that he thought wireless telegraphy would be a kind of "handmaid" to the cable system.

The report was adopted.

LEGAL INTELLIGENCE.

CHEPSTOW GAS COMPANY v. CHEPSTOW ELECTRIC LIGHT AND POWER COMPANY.

An appeal by the defendant company came before the King's Bench Division last week.

The local magistrates had convicted the electrical company for laying their mains in undue proximity to those of the gas company, and contrary to the provisions of the statute. It was proved that the electrical company did not give the gas company notice, as provided by Section 18 of the Electric Lighting Clauses Act, 1899, before commencing to sink trenches, but prior to the arbitration which preceded the proceedings before the magistrates, the gas company had given notice that they did not claim penalties under that section. The arbitrator assessed the amount of the damages to be paid to the gas company, but did not order the removal of the defendants' wires, this being outside his province. The Act provided for a penalty during every day of default after conviction, and the magistrates imposed a fine of £1 and costs, and a daily penalty of £1 during default. The defendants appealed against this to the High Court, contending that the summons issued against them only alleged an offence under the statute, and did not comprise daily penalties. Further, they contended that a conviction for a penalty and for future offences was bad upon the face of it.

Mr. Shiress Will, K.C., on behalf of the defendants, argued that before a daily penalty could be imposed there must already be a conviction. He contended, further, that the offence was not a continuing one, as the damage sustained by the gas company was purged by payment of compensation as directed by the arbitrator. In addition, he contended that the time-limit of six months invalidated the prosecution.

Mr. Macmorran, K.C., for the gas company, argued that the Act contemplated penalties in addition to the compensation if the offence was not discontinued. The arbitrator had awarded a small sum for compensation, evidently on the assumption that the grievance would be remedied. He contended that the offence was of necessity a continuing one.

The **Lord Chief Justice** stated the Act clearly provided for penalties in addition to compensation. In regard to the contention that the connection was bad because it imposed a daily penalty beyond the fine of £1, counsel for the plaintiff had admitted that penalties for future offences could not be added, especially as it was provided by the Act that the penalty for default did not operate until after conviction. Respecting the time-limit, he could not adopt the defendants' view that this should be reckoned from the date of the notice served by the gas company. The dispute was in progress for some months after this, and upon the conclusion of the arbitration the gas company had served a second notice.

Kennedy and Bruce, J.J., concurring, the appeal was dismissed, with costs.

SPEED OF TRAMCARS.

William Drawbridge and Arthur Miller, tramcar drivers in the service of the London County Council, were summoned by the police for driving their cars along Clapham-road at an excessive rate of speed. It was stated that a member of the police had by the aid of a stop-watch timed the defendants' cars over a distance of 220 yards. The time occupied was 38 seconds, representing between 11 and 12 miles an hour.

A difficulty arose owing to the absence of the police officer on a holiday.

Under these circumstances the summonses were withdrawn.

ELECTRIC LIGHT ACCOUNT.

The adjourned summons against William Hunter for non-payment of his account of £3. 1s. 11d. for the supply of electric energy by the Aston Corporation was again before the local magistrates on the 4th inst. A report of the case appeared in our last issue, the matter being then adjourned for the production of the meter which caused the dispute.

The **Town Clerk** (Mr. Joseph Ansell), representing the Corporation, explained that the difficulty had arisen from the fact that the figures registered by the meter ought to have been multiplied by four, the reason for which was described in our last issue. It was a regrettable fact that the department did not supply to the consumers that infor-

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mation. To meet that difficulty the department undertook to reduce the charges by 25 per cent. up to April 25. Mr. Ansell urged that defendant had not been charged for any electrical energy beyond that which he had consumed.

Defendant, in reply to the magistrates, said that he was told that he had consumed 32 units, and it was for this he understood he would have to pay. He did not accept the statement that it should be multiplied by four, but had no evidence to offer against that interpretation.

Mr. C. Wallis (one of the magistrates) said that the defendant had a right to know from day to day what he was consuming.

After a consultation, the magistrates made an order upon defendant to pay £1. 16s. 6d.

PERSONAL.

The Wigan County Borough Council have increased the salary of Mr. Slevin, electrical and tramways engineer, from £300 to £450 per annum.

The Pontypridd Council have appointed Mr. Teasdel, Cardiff, resident manager of the electric lighting and tramways undertaking at a salary of £300 per annum.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Melbourne.—The Federal Postmaster-General requires tenders for 6,000 yards of telegraph cable. Tenders by Nov. 15.

Porto Alegro (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Banza (Spain).—The Municipality requires tenders for the electric lighting for five years. Particulars from the Alcalde, Banza (Jaen).

Guirgia (Roumania)—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Hammersmith.—The Council invites tenders for the supply of (1) extra high-tension feeder mains and (2) draw boxes, frames, covers, etc. Tenders by Nov. 16. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply, delivery, and erection of one 15-ton and two 5-ton electric overhead travelling cranes. Tenders by Nov. 22. See advertisement.

Erith.—Tenders are invited for material and work in connection with the installation of electric light at the Education Committee's offices at Picardy, Belvedere. Tenders by Nov. 11. See advertisement.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Liege.—Tenders are required for the construction and working (concession) of three electric tramways. A deposit of £400 is required. Particulars from the Provincial Government, Liège. Tenders by Nov. 14.

Hammersmith.—The Guardians invite tenders for a complete wiring installation for the electric lighting of their new workhouse and infirmary at Wormwood Scrubbs. Tenders to the Clerk to the Guardians by Nov. 15.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Rotherham.—The Corporation invite tenders for wiring the new isolation hospital buildings in Badsley Moor-lane. Specification and forms of tender at the office of the Borough Electrical Engineer, Rawmarsh-road. Tenders to be sent to Mr. W. J. Board, town clerk, Town Hall, Rotherham, by Nov. 21.

Ballinasloe (Ireland).—The Committee of the District Lunatic Asylum invite tenders for wiring the temporary buildings for 35 incandescent lamps of 16 c.p. each, at a pressure of 200 volts, and the necessary overhead cables to connect same with engine-house, and all else necessary. Tenders by Nov. 14.

Glasgow.—The Governors of the Glasgow and West of Scotland Technical College invite tenders for a complete wiring installation and switchboards for the electric lighting of their new buildings. Specification may be obtained from Mr. H. F. Stockdale, secretary and director, 38, Bath-street, Glasgow, to whom tenders must be delivered by Nov. 26.

Brussels.—Tenders are invited for the construction of an electric generating station and other works in connection with the establishment of a goods station at Brussels. The estimated cost of the work is about £4,367. A deposit of about £280 is required to qualify any tender. Specifications (price 1s. 10d.) and farther particulars may be obtained from M. De Rudder, Administrateur des Voies et Travaux, 11, Rue de Louvain, Brussels.

Burslem (Staffs)—Tenders are invited for the supply and erection of the following electric lighting plant at the workhouse, Chell, for the Guardians of Wolstanton and Burslem Union: (Section A) water-tube boilers, with fittings; (B) feed-water heater, feed pumps, piping, etc.; (C) two 25-kw. steam dynamos and booster; (D) switchboard; (E) cables and wiring; (F) accumulators; (G) arc lamps. Tenders to Mr. J. A. Lowndes, clerk, by 12 noon on Nov. 15.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Tenders by March 31.

Dundee.—The Town Council invite tenders for the relaying of the present copper strip feeder main throughout the town with insulated cables. Specifications may be had on application to Mr. H. Richardson, A.M.I.E.E., city electrical and tramways engineer, Dudhope-crescent-road, Dundee, on payment of 40s., which will be returned only on receipt of a bona fide tender. Tenders to Mr. W. H. Blyth Martin, clerk to the Council, City Chambers, Dundee, not later than first post on Nov. 12.

Sydney.—Tenders will be received at the office of the Acting Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 28, for the supply and delivery at the Departmental Stores, Sydney, of telegraph, telephone, and electric light material. Specifications and general conditions may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth. Samples may also be seen at Sydney, Melbourne, Brisbane, and Adelaide.

Manchester.—The Electricity Committee invite tenders for the whole of the work required in connection with the wiring for arc and incandescent lighting of Stuart-street generating station. Specifications may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester, on payment of a fee of £2. 2s., which amount will be refunded on receipt of a bona fide tender. Tenders to be addressed to the Chairman of the Electricity Committee, and delivered at the Town Hall, Manchester, by 10 a.m. on Nov. 11.

Belfast.—The Town Council invite tenders for the following tramway works, equivalent to about 70 miles of single track: (1) permanent way, road-bed, paving, and bonding; (2) overhead electrical equipment; (3) underground feeders, telephone and test wires, spare conduits, etc.; (4) steam dynamos, switchboard, also three-phase plant, condensing plant, overhead traveller, station lighting, etc.; (5) boilers, superheaters, mechanical stokers, economisers, coal and ash conveying plant, steam exhaust and feed pipes, pumps, etc.; (6) double-deck electric tramcars. Tenders must reach the Town Clerk's Office by 18th inst., at noon.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegragh Office Yard, Thursday Island, of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Limerick.—The Electric Lighting Committee have accepted the tender of Harrison Lee and Sons for the erection of a tank at the power house at £220.

Dudley.—The Electric Lighting Committee have accepted the tender of E. Seckerson, Stourbridge-road, Dudley, for extension of offices and erection of workshops.

Ipswich.—The Corporation have accepted the tender of Chamberlain and Hookham, Limited, Solar Works, New Bartholomew-street, Birmingham, for the supply of continuous-current meters.

Salford.—The Electricity Committee have accepted the offer of the Salford Oil-Refining Company to supply 25 barrels of crank-chamber oil, similar to that previously supplied, at 1s. 2d. per gallon.

Northwood (Uxbridge) — The Hart Accumulator Company, Limited, have been awarded the contract for the supply of storage battery, consisting of 278 of their standard central-station type cells.

Abergavenny.—The following tenders have been accepted for lighting the asylum: engine and battery rooms, J. G. Thomas and Sons, Abergavenny, £1,140; lighting plant, etc., Woods, Slacke, and Co., £2,364; wiring and fitting, Scott and Mountain, £2,640.

BUSINESS NOTES.

TRACTION.

Royton.—The Board of Trade have approved the tramway, which has been opened to the public.

Stockton.—The Corporation are in communication with the tramway company in reference to "those noisy trams."

Wolverhampton.—Three petitions have been presented for the reopening of the abandoned route from Coleman-street to Newbridge.

Stockport.—The Local Government Board have formally sanctioned the purchase of the Hazel Grove tramway undertaking by the Corporation.

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West Hartlepool.—The Corporation have decided to take proceedings against the tramway company with respect to the latter's failure to keep the track in good condition.

Dudley.—The Tramway and Electric Lighting Committee recommend that the application to the Board of Trade for the appointment of a referee in connection with the dispute with the company be proceeded with.

Halifax.—The Corporation have decided to double the tramlines from the loop near St. Jude's Church to the junction of the main road on the north side of Savile-park and Skircoat Moor-road at an estimated cost of £2,041.

Blackburn.—The six months ending Sept. 30 are estimated to show a net profit, compared with a loss of £690. 16s. 9d. for the corresponding period of 1903. The traffic this year has received a tremendous impetus from the fine weather.

Kilmarnock.—Arrangements have been made to start the tram service on the 10th prox., when Lord Howard de Walden will perform the inaugural ceremony. The consulting engineers were Messrs. Kennedy and Jenkin, and the work has been carried out most expeditiously.

London County Council.—The Act obtained by the Council in 1896 authorising the construction of tramways over the new Vauxhall Bridge does not sanction the use of electric traction. The Highways Committee recommend that powers be applied for in the next session of Parliament.

Trafford Park Estates, Limited.—The annual report shows a net profit on estate railways and tramways amounting to £949. The Manchester and Salford Corporations have entered into an agreement to run their electric cars over the company's tramways for a period of about 20 years, paying the company the profits earned thereon.

Erith.—The work of laying the tramways is in full swing. Operations have been commenced at Northumberland Heath and Abbey Wood, and in a short time a start will be made at Northend. From these three points the workmen will make for the railway bridge near the Wheatley Hotel, which has been marked out as a centre.

Penge.—The Urban District Council have adopted the following resolution: "That the Tramway Committee at the ordinary November meeting of the Council, or earlier if expedient, do present a report on the position of the Penge arrangements with the British Electric Traction Company in order that a comparison be made between the Beckenham tramway scheme and that of Penge."

Cardiff-Penarth.—A meeting of the Penarth District Council was held on Monday, when a resolution was moved that the consent of the Council be given to the Penarth syndicate to lay a line between Cardiff and Penarth, subject to their agreeing to the conditions laid down by the Council. The matter had previously been before the Council, who refused consent. It was decided to consider the matter again at the next monthly meeting.

South Shields.—The Rural District Council have appointed a committee to consider the question of obtaining powers for constructing an electric tramway from the terminus of the Sunderland borough tramways in Sea-lane, Roker, to the terminus of the proposed Corporation tramways in Sunderland-road, South Shields, and to enter into communication with the Sunderland and South Shields Corporation on the subject. The two towns are seven miles apart.

Reading.—The returns for the four weeks ending Oct. 20 show that the cars ran 65,668 miles, and carried 591,253 passengers. The total receipts were £2,505. 5s. 11d. The tramways manager has received from the Board of Trade a copy of the revised regulations with regard to the use of electrical power on tramway lines for preventing fusion of or injurious electrolytic action on gas and water pipes, etc., and for minimising injurious interference with the apparatus of other undertakings.

Mitcham Light Railway.—A large meeting of inhabitants passed a resolution the other day regretting the action of the Board of Trade in granting the British Electric Traction Company a 12 months' extension of time for constructing the light railway, and calling upon the Parish Council and the Rural District Council to convene a conference of local authorities with a view to arranging public ownership and control of the light railway, in order that there might not be any further delay in the construction of the lines.

London Tube Schemes.—The President of the Board of Trade states that new "tube" schemes or large railway extensions for the Metropolis must still be considered as subject to the warning given in the House of Lords that no enterprises of the kind can be considered by Parliament until the London Traffic Commission has issued its report. The President intimates, however, that exception might be made in urgent cases, and it is, of course, open to promoters to make application to Parliament in the usual way.

Pontypridd.—The Local Government Board have sanctioned the borrowing of £6,000 for a period not exceeding 30 years for the purchase of the tramway undertaking from the British Electric Traction Company. The clerk has been instructed to communicate with the company with a view to completing the purchase before the end of this month, and to ask for immediate possession. Eighty-six applications have been received for the appointment of resident engineer. The salary determined upon is £300 per annum. The Electricity Committee have selected certain candidates to appear before the Council.

Rochdale.—The Tramways Committee considered on Monday the further proposals submitted by Heywood, who desire either that the working expenses should be fixed at 4½d. per car mile for three years, or that Heywood should work their own cars, and be allowed to run into Rochdale. This was not agreeable to the committee, who object to any cars but their own running on their lines, and they also consider that 5d. per car mile for working expenses should be satisfactory, seeing that they have, in conjunction with Bury, offered to have a revision at the end of a year's time, should such be found necessary. Both Rochdale and Bury are agreeable to an entirely independent person going through the working cost for 12 months, and to be bound by the amount he should decide for the following five years.

Newport.—Colonel Druitt having inspected the Stow-hill route on behalf of the Board of Trade, the line was opened to the public on Saturday, a 10 minutes' service being provided. In the afternoon one of the cars got beyond the control of the motorman, and dashed down the hill at a great speed. There was a clear course, and, as the car kept the rails, the damage was trifling, being restricted to a slight bending of the trolley pole. There was a drizzling rain, and the motorman's supply of sand appears to have given out, with the result that the wheels were unable to effectively grip the slippery rails, thus diminishing the action of the brakes. Later in the afternoon a trolley wire fell at the Westgate centre, temporarily dislocating the service. Mr. Du Verge, the borough deputy electrical engineer, proceeded with the repair of the damaged wire, after which traffic was resumed.

Heywood.—At a meeting of the Tramways Committee on Monday it was decided to buy 10 steam-engines and cars so as to provide a service of trams within the borough. At a previous meeting it was decided to promote a Bill in Parliament during the coming session to deal with various matters in connection with the town. It is proposed to acquire powers to run trams along Middleton-road to the borough boundary, and to the borough boundary at Bamford, so that the committee will have the power, if it should be thought advisable in the future, to extend the tramway system in the directions named. Another suggestion is to include power to run into Bury and Rochdale. It was then stated that, failing an agreement with Bury and Rochdale, Heywood would be prepared to run their own cars into the adjoining towns, and give them power to run into Heywood.

Leeds.—As a means of finding work for the unemployed, a suggestion has been made locally that the scheme for making a tramway along Clarendon-road should be resuscitated. The Belle Vue-road scheme, which was substituted for this, leaves the whole of the Little Woodhouse district unprovided with tramway accommodation, and to the lack of this convenience the proposer attributes in a large measure the number of empty houses in the neighbourhood. The original scheme would probably need remodelling, and it is proposed that an extension should be made to the Ridge by way of Reservoir-street, Raglan-road, and Delph-lane, thus supplying direct communication between the centre of the city and a large and growing population on the Ridge, besides giving immediate access to one of our most beautiful public pleasure grounds. Such a route would seem to promise a good return.

St. Pancras.—The late mayor of St. Pancras (Mr. T. H. W. Idris), in his address to the Borough Council on the work of the past year, referred to the electrification of the tramways within the borough. He spoke of the negotiations with the London County Council respecting the employment of the overhead system, and endorsed the conclusion of the St. Pancras Council in favour of the conduit principle. He reiterated the view of the Borough Council that the obstacles in the way of the complete adoption of the conduit system through the borough were not insuperable. He also expressed the hope that all differences of opinion between the County Council and the Borough Council would be speedily settled, so that the public might be provided with an up-to-date tramway system at the earliest date. We fear that this hope is not likely to be realised in view of the action the County Council are taking in the matter.

Bournemouth.—For the six months ending Sept. 30 the tramways show a total of £7,385 as the excess of income over expenditure. During this period the tramways carried the population 95 times over. The future success of the undertaking will, of course, depend in a large measure upon the result of the recent arbitration proceedings with the Poole Tramways Company. The details of the six months' working show that the receipts aggregated £32,384, the working expenses £16,276, and capital charges £8,722. The passengers numbered 5,773,895. The revenue per car mile works out at 13d., the working expenses show 6·53 l. (generating expenses representing 1·37d. of this), and the net profit gives 2·97d. per car mile. It has been decided to acquire certain property in Southcote-road, and application is to be made to the Board of Trade for sanction to the borrowing of the purchase-money.

Wednesbury.—A local journal states that, although a certai amount of secrecy is being observed with regard to the tramway position, there are indications that the difficulties which have resulted in so much inconvenience to the travelling public, and have caused a complete stoppage of the service between Wednesbury and Darlaston for some months past, are on a fair way to being satisfactorily settled, if they have not even already been overcome. The attitude of the tramway company is said to point to a speedy restoration of the traffic between these two centres, as well as the opening up of traffic once more on the Dudley branch. A later announcement in the same paper indicates that a scheme for the electrification of the whole system will be undertaken forthwith, the directors having decided to put the contracts in hand. It is understood that the section from the White Horse, Wednesbury, to the Bull Stake, Darlaston, will be electrified first.

Aberdeen.—A rather curious position has arisen in regard to the work of effecting a junction between the Corporation lines in Bridge-street and Union-street. The Corporation obtained the sanction of the Board of Trade, but the Great North of Scotland Railway Company obtained an interim injunction from the Court of Session interdicting the scheme, on the ground of the proximity of the tramway lines to the Palace Hotel, of which the railway company are the proprietors. What objection the company had to the Corporation carrying the tramway lines to the company's hotel does not appear, but the Corporation appear to have clinched the matter by making the junction before the interdict arrived. For this purpose they utilised the slack period between Saturday night and Monday morning. The railway

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company appear to be rather disconcerted by this promptitude, and criticise the "unseemly haste" of the Corporation. The matter will come before the Court of Session at Edinburgh in a few days for settlement.

Audenshaw.—At the meeting of the District Council, the Clerk reported with regard to the Audenshaw-road tramways, that it was necessary to apply to the Board of Trade for a further extension of time. He had prepared the requisite memorial, and all the notices for insertion of advertisements in the local newspapers. Since the tramways order was first granted in August, 1899, the time limit had been extended from time to time. The last extension granted would expire on Dec. 9, 1904. The Council had not commenced the construction of the tramways owing to the fact that the Great Central Railway Company proposed to reconstruct two bridges on their main line, and the work, in fact, was already commenced. The tramway would have to cross the main line by these bridges, and, in the opinion of the Council, it would not be expedient to commence the construction of the lines until such bridges had been reconstructed. Under these circumstances the Council asked for a further extension of time for a period of 12 months from Dec. 9, 1904. The Council resolved to seal the memorial.

Long-Lived Railway Motor.—Mr. James Anderson, manager of the Sandwich, Windsor, and Amherstbury Railway, Windsor, Ontario, some little time back reported a most remarkable life record of a Westinghouse 12-A railway motor under his charge. It has been in constant operation for a period of eight years, covering during that time a distance of approximately 450,000 miles, and beyond the replacement of brushes, remetalling of bearings, and turning-up of the commutator, has not cost a penny for repairs. The armature and field coils are intact, and the only signs of wear are on the commutator, which has been reduced ⅛in. by trueing up. The wearing depth of the segments is ⅜in., so that if the winding holds out, as there is every reason to expect it will, the motor should last another eight years and double its already remarkable mileage. We understand there are several other motors of the same type working on this line that hold very nearly the same record, and have been equally free from serious repairs. They are all operated in single equipment and under 18ft. cars, and as the load is practically level and without sharp curves, the conditions are somewhat favourable.

Yarmouth.—The Corporation have received a letter from the Board of Trade conveying approval of the service of a notice on the Yarmouth and Gorleston Tramways Company, Limited, requiring them to sell their undertaking. The Tramways Committee recommend that application be made to the Board of Trade for sanction to the form of construction of the tramways now worked by the Yarmouth and Gorleston Tramways Company, Limited, and the proposed additions, as authorised by the Great Yarmouth Corporation Act, 1904. The borough surveyor submitted specifications for tramway rails, fishplates, soleplates, tiebars, and bolts necessary for the proposed reconstruction of the tramways, and the committee recommend that these be approved. The following are the particulars of the receipts and passengers carried on the Corporation lines from the Sept. 30 to Oct. 27: 102,239 passengers were carried at 1d. fare, 479 at 2d. fare (these fares being discontinued after Oct. 6), 3,384 workpeople, and 697 scholars. The receipts amounted to £442. 3s. 3d. There is an increase on the aggregate return from April 1 to Oct. 27 of £549. 12s. 10d. compared with the previous year. The new Queen's-road line is showing a good return.

Brighton.—We have received the following particulars relating to the Corporation electric tramways for the year ending March 31 last from the tramways engineer, Mr. T. B. Holliday: single line, 1 mile 65·08 chains; double line, 8 miles 11·04 chains; total as single line, 18 miles 7·6 chains; maximum gradient, 1 in 10; sharpest curve, 40ft. radius; gauge, 3ft. 6in.; type of rail, 6in. girder; weight of rail, 101lb. per yard; rail laid on transverse steel sleepers and 6in. concrete bed; three boilers, Babcock and Wilcox, pressure 150lb.; three engines, Willans and Robinson, total horse-power 900; three dynamos, Bruce Peebles, total kilowatts 675; storage battery, 323 kw.; 50 double-deck, single-truck, 50-passenger cars; motors and controllers—30 Westinghouse, 10 Witting, Eborall, and Co., 10 Dick, Kerr, and Co.; contractors for permanent way, Macartney, McElroy, and Co., last extensions by Corporation's own staff; cables laid in Sykes's stoneware ducts; current return by rail; passengers carried, 10,999,046; car miles, 1,151,477; total receipts, £46,246. 3s. 10d.; total working expenses, £40,247. 4s. 2d.; gross profits, £6 016. 19s. 8d.; sinking fund and interest, £10,687. 7s. 5d.; deficit, £4,778. 16s. 4d; income per car mile, 9·6421.; expenditure, 8·412d.; average fare per passenger, 1d.; cost of power per unit, 1½d.; consumption of units per car mile, 1·54. The adverse balance is attributable to the low fares charged—viz., 2¼ miles for 1d. It has to be remembered also that 54 per cent. of the Brighton system is on a gradient averaging 1 in 17. The Corporation, we notice, have issued a complete diagram of the various routes, with full particulars of the services.

Llanelly.—At a meeting of the Urban District Council on Monday the report of the deputation that visited Cardiff on the electric light and traction question was given. This deputation met the engineer of the South Wales Power Company, Mr. Graham Harris, the manager of the Power Company, the managing director and solicitor of the British Insulated and Helsby Cables, Limited, and the secretary and managing director of the Llanelly Tramways Company. The interview was understood to be without prejudice. Mr. Harris informed the deputation that he was prepared to enter into an agreement with the Urban Council relative to taking over the liabilities and responsibilities of the Insulated and Helsby Cables, Limited, as to electric light and traction for Llanelly, but in a modified form. Further, the South Wales Power Company propose to apply to Parliament in the ensuing session for an extension of the powers of the Carmarthenshire Power Company to Llanelly in the event of Llanelly being willing that the parliamentary notice should contain such a proposal. He asked that a formal assurance should be given him that the Council were prepared, subject to a suitable agreement being entered into, to approve of the extension of the powers of the Carmarthenshire Company in the way referred to. A friendly discussion took place, and the deputation recommended that the clerk should be authorised to write to Mr. Graham Harris intimating that the Council will offer no objection to the inclusion of Llanelly within the area of supply of the Carmarthenshire Power Company, provided a suitable arrangement be come to between the parties. The chairman moved the adoption of the report, and another councillor, in seconding, referred to the pleasant nature of the interview. The proposition was adopted unanimously.

Paisley.—A meeting of the Tramways Committee was attended by Mr. Johnstone Smith, chairman of the Paisley Tramways Company, Limited. The provost having stated the various matters as to which the committee desired to meet with the representatives of the company, these being the question of children's fares, repair of George-street between Castle-street and Maxwellton-street, and completion of the undertaking so far as regards the extension to Greenock-road and Meiklerigge, Mr. Johnstone Smith stated, in regard to children's fares, his company were willing to substantially agree to the proposals of the Corporation. With reference to the repair of George-street, Mr. Smith stated that the company do not propose at present to proceed with the extensions to Meiklerigge and Greenock-road, but should the Corporation repair the portion of George-street referred to, he thought that the company would contribute a reasonable sum under this head if the construction of lines along that thoroughfare was decided upon. He also stated that, while there might be disappointment as to the company not proceeding at once with the extensions, it should be known that they have exceeded the original estimate as regards expenditure by having formed double lines where single lines only were contemplated. Furthermore, other extensions are in contemplation by the company. With regard to the congestion at certain parts of the route, Mr. Smith stated that if there is any proposal to remedy this by buying up and demolishing property in the neighbourhood, when this comes to be seriously contemplated and details are submitted, the company will be prepared to give every reasonable consideration to the matter. The official inspection of the Renfrew and Abbotsinch sections of the systems belonging to the Paisley and District Electric Tramways Company was made on Wednesday by Colonel von Donop on behalf of the Board of Trade. The inspection of these sections marks the completion of the extensive system of electric tramways inaugurated by Mr. W. M. Murphy on Nov. 2, 1903. The system connects Johnstone and Renfrew with Paisley, and from the Paisley Cross there are branches extending southwards to Charleston and Potterhill, and northwards to Abbotsinch on the Inchinnan road. Cars have been running over the whole system, with the exception of the Abbotsinch route, for some time. The inspection party included representatives of the Corporations of Paisley, Johnstone, and Renfrew. After carefully inspecting the equipment, Colonel von Donop expressed his approval. Subsequently the company entertained a large party, including several members of the Corporations, to lunch.

Wakefield.—The Wakefield and District Light Railway Company begun to run cars early in August, but no formal opening took place at the time, owing to the incompleteness of the system and other causes. This ceremony, however, was carried out on the 3rd inst., when members of all the councils over whose roads the lines pass were invited by the directors of the company to a general inspection of the system. The guests, some two or three hundred in number, assembled in the Market-place, Wakefield, where special cars were in readiness to convey them to Thwaite Gate, the terminus which connects with the Leeds Corporation tramways. The afternoon was somewhat chill and cloudy, but in spite of this the trip proved very enjoyable. On the return journey a halt was made at the Rothwell Haigh substation, which augments the power generated at the central station at Bell Isle, Wakefield. On arriving at the latter depôt, the party proceeded to inspect the car-sheds, the power-house, and the subsidiary arrangements for working the system. After light refreshments had been served, Mr. H. S. Leon (chairman of the board of directors), in welcoming the guests on behalf of the board, explained that the company had decided to take advantage of the visit to Wakefield of the Association of Tramway and Light Railway Officials to ask the members of the various local authorities to join them in an inspection of the system. The success of an undertaking of that kind, he proceeded, depended entirely on good management, and he imagined that they had as good a staff as it was possible to get. He took that occasion to acknowledge the excellent services rendered by the whole staff, from the chief officials to the conductors, under very difficult conditions. With regard to the local authorities represented by the guests, he hoped that the cordial relations which had existed in the past between those bodies and the company would be continued in the future. They recognised frankly that if they had been compelled to face the active opposition of those bodies, they would not have been able to open their lines at all. The advantages of a light railway of that kind had been perceived, and every assistance had been afforded the company in their work, and for this he desired to express the thanks of the directors. He could not say when the complete route would be finished, as in order to ensure financial success they would have to proceed cautiously, especially when it was considered that no less than £750,000 would be expended. The Mayor of Wakefield (Mr. E. Stonehouse) in proposing a vote of thanks to the directors for their hospitality, said that he hoped the system would prove successful and profitable. The Mayor of Ossett (Mr. F. L. Fothergill), in seconding the vote of thanks, remarked that the tramway was welcomed at Ossett, not only because it afforded better travelling facilities, but because it would extend building operations and thus increase the rateable value of land. He suggested that ½d. fares for short stages should be established. Mr. R. A. Smithson, chairman of the Leeds Corporation Tramways Com-

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mittee, said that, on behalf of the municipality of Leeds, he had pleasure in wishing success to the undertaking of the Wakefield Company. He said that frankly, as one connected with municipal management, because there was ample room for private companies. He was glad that the company had set a good precedent by approaching the vexed question of running powers between municipal and private enterprises in what he considered was a broad-minded and sensible spirit. The propositions put before the Leeds Corporation by the company were of such a nature that the former body was very pleased to agree with them. Although he had not always done so, he ventured at this moment to back up the proposal for cheap fares, as they had found in Leeds that every concession made to the travelling public had resulted in increased profit. Mr. Leon briefly responded to the vote of thanks. Mr. H. England (general manager of the company), to whose admirable arrangements the enjoyment of the afternoon was mainly due, said that if the public would support the enterprise, the company would give as good a service as any in England. The recent reduction in the service was designed merely to ascertain the conditions under which they would have to work.

LIGHTING AND GENERAL.

Limerick.—The Corporation have concluded a loan of £7,000 for electric lighting purposes.

Little Lever.—The Urban District Council have applied for an electric lighting provisional order.

Surbiton.—The Urban District Council have applied for a provisional order to extend their district.

Armagh.—A special meeting is to be summoned three months hence to deal with the electric lighting question.

Hove.—The work in connection with the supplying of Aldrington with electricity will be commenced next week.

Battersea.—A new switch pillar is to be provided to replace the present pillar in St. John's-road at an estimated cost of £54. 9s.

Croydon.—An enquiry has been held into the application of the Corporation for sanction to borrow £29,765 for purposes of electric lighting.

Chertsey.—The opposition of the Urban District Council to the proposal of the Woking Electric Supply Company to extend its mains has been withdrawn.

Dover.—The Corporation propose to supply electric light and power to about a dozen villages near, and to extend their electric tramway system another two miles.

Cleethorpes.—The agreement between the Council and the tramways company governing the purchase by the Council of the electric power station has been sealed.

Llangollen.—The electric lighting installation was inaugurated last Friday by the directors of the recently-formed Llangollen and District Electric Light and Power Company.

Bedwellty.—The Guardians have decided to instal electric lighting plant in the workhouse at an expenditure of £2,000, Messrs. Lewis and Fletcher being the consulting engineers.

Agency.—The Rhodes Electrical Manufacturing Company, Limited, have appointed Mr. Vincent E. Walters, of 45, Newhall-street, Birmingham, as their sole agent for Birmingham and district.

Wirral.—The architect has submitted to the Guardians a report from the Liverpool and District Electric Lighting Company for providing an installation of 259 lights, estimated to cost £1,093.

Rhodes Electrical Manufacturing Co.—The directors have declared an interim dividend for the quarter ending Aug. 31, 1904, at the rate of 6 per cent. per annum on the ordinary shares of the company.

Bermondsey.—The Electric Lighting Committee are still deliberating upon the terms upon which to supply the Surrey Commercial Dock Company with current for power and lighting for a term of three years.

Sale of Plant.—Particulars of a sale of an entire electric installation, including 167 lots of fixed and unfixed electric fittings, magnificent cut-glass electroliers, etc., by Messrs. W. Dew and Son, Bangor, appear in another column.

Amazon Telegraph Co.—The accounts for the year to June 30 last show that after including £9,525 for debenture interest and sinking fund, the debit balance of £106,181 brought down has been increased to £113,311.

Fareham.—The Postmaster-General having heard that the alterations to the electric wires required by him would cost £55, has agreed to contribute £20 if the work was carried out satisfactorily to the Post Office and the engineer.

Scottish Steel.—At a meeting of Scottish steelmakers held on Nov. 8 it was resolved to reduce the price of ship-plates by 2s. 6d. a ton to £5. 12s. 6d., less 5 per cent.; but that of boiler plates and other material remains unchanged.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Bath Electric Tramways, Limited, £135,000 4½ per cent. first mortgage debenture stock.

Stockton.—The Electricity Committee's last report shows that the cost of production for the September quarter, as compared with the cost in the corresponding quarter of 1903, has decreased about ¼d. per unit, the figures being 2·27d., as against 3·08d.

Fans.—The North British Station Hotel, Glasgow, is to be ventilated with electric fans, which are being supplied by Messrs. Matthews and Yates, of Cyclone Works, Swinton, Manchester, who have also supplied the fans for the company's hotel at Edinburgh.

Kensington.—Notices relative to proposed extension of their mains have been agreed to as follows: Kensington and Knightsbridge Electric Lighting Company—Kensington Court-place, St. Albans-road, and Glendower-place; Brompton and Kensington Electricity Supply Company—Pembroke-road and Philbeach-gardens.

Changes of Address.—We are informed that Messrs. Cowans Limited have removed their London office to 4, Queen Victoria-street, E.C., the telephone number being changed to "7,234 Central." The Key Engineering Company, Limited, have removed to the same address, the telephone number being identical.

West Bromwich.—It appears that the Corporation are still troubled with complaints against Alderman Pitt, chairman of the Electricity Committee, and the foreman fitter regarding unnecessary interference with the workmen. They have taken a lot of evidence, and a sub-committee has been appointed to report.

Spain.—The Government have authorised the Municipality of Mendoza y Rio IV. and the Executive Government of the Province of La Rioja to import certain specified electric lighting materials free of duty. The *Boletins* containing the announcements may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Electricity Supply Co. for Spain.—The third drawing of 5 per cent. consolidated debentures for redemption at par on Jan. 2, 1905, will take place at the registered office of the company, College-hill-chambers, College-hill, London, E.C., on Nov. 21, at 11.30 a.m. The registered holders of these debentures, or their legal personal representatives, are entitled to attend at this drawing.

Lien Registered.—Otto Electrical Manufacturing Company, Limited—Issue on Oct. 21 of a £500 debenture, part of a series created Jan. 22, 1904, to secure £5,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Deakin, The Hall, Wormhill, near Buxton. No trustees. Total amount previously issued of same series, £2,000.

Humidifying Apparatus.—Messrs. Matthews and Yates, Limited, of Cyclone Works, Swinton, near Manchester, have just completed the erection of a humidifying and ventilating apparatus at Messrs. A. Barlow and Sons' Union Mill, Blackley, near Manchester, and we are informed that it is giving excellent results, both as regards the required amount of humidity and in keeping the CO_2 below the limit allowed by the Home Office.

Farnham.—The Urban District Council have consented to the application of the Farnham and District Electric Supply Company, Limited, for a provisional order empowering them to supply electricity within the urban district, subject to clauses being inserted for the protection of the Council's interests. The Council added a rider expressing the opinion that the works of the electric light company should be erected in the Urban Council's area.

Elland.—The output from the electricity works during September—3,825 units—shows an advance on the previous month's output by 1,204 units. The total units generated in September, however, was more than twice the output, being 8,265 units. The consumers number 77, and the 8 c.p. lamps connected total 4,542, whilst the total horse-power in motors is 61. The destructor in the month under review ran 240 hours, and destroyed 258 loads of refuse and 118 loads of sludge.

Hastings.—Certain low-tension mains and high-tension feeders are to be extended up to a transformer to be placed in a pit to be constructed under the public footway at an estimated cost of £100. With a view of obtaining an increase in the day load on the electricity plant by the supply of current for motors, etc., the Council have entered into an agreement with the Langdon-Davies Motor Company, Limited, of 101, Southwark-street, London, for the supply to consumers of alternating current motors on a hire-purchase system.

Cardiff.—The Lighting Committee have recommended the Council to apply for powers to borrow £87,000 for the extension of electrical plant, Mr. Arthur Ellis, the electrical engineer, having presented a report in favour of the extensions. At the present time there are applications for lighting and power equivalent to 46,000 lamps, and the orders cannot be carried out unless the plant is increased. The £87,000 will be spread over two years. The applications for power for motors are considerable and promise to keep the plant going in the daytime, so making the undertaking more remunerative.

Micanite Patents.—We are informed that the Supreme Court of Germany has by their judgment of Nov. 5, 1904, confirmed the validity of the German patent No. 73,830, the property of the Mica Insulator Company, Limited, of the Empire Works, Walthamstow, for the manufacture of micanite plates, and has dismissed, with costs, the appeal of Meirowsky and Co., of Cologne, for the withdrawal of this patent. This information will particularly interest those of our readers who may have observed that a few weeks ago the same company amended their English micanite patents No. 10,450 and No. 6,048.

Leicester.—The county architect reported at the last meeting of the County Council's Standing Committee that the Loughborough Corporation were prepared to supply the electric current to the Loughborough police court. The committee sanctioned the following expenditure: an electric motor, fan, and filter for the ventilating installation, at an estimated cost of £75; and electric pendants, brackets, and electroliers, at an estimated cost of £70. Mr. Pick was instructed to obtain tenders from Messrs. Ashwell and Nesbit and Messrs. Webb and Co., who have already carried out the ventilating and electrical lighting work.

Stretford.—The Electricity Committee have decided to supply current to a house in Upper Chorlton-road, Manchester, situate a few yards beyond the township boundary. The Manchester Corporation have agreed to allow the Council to supply current on the following conditions—viz., in the event of the Manchester Corporation deciding to lay mains along Upper Chorlton-road at some future time, the Stretford Council agree to allow the consumer to be transferred to the Corporation mains. In the event of the Manchester Corporation

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deciding to lay mains in Upper Chorlton-road and taking over the supply in question, the Corporation would be prepared to bear the cost of the service which the Council proposed to lay.

New Issue.—Subscriptions are invited at par for £75 000 of 5 per cent. first mortgage "A" debenture stock of the Kalgoorlie Electric Tramways, Limited. The company was incorporated in 1902, with a capital of £250 000, divided into 250.000 shares of £1 each. The concessions owned by the company, the prospectus states, are as follows: (1) for the town of Kalgoorlie (constructed and running), 6½ miles; (2) for the Kalgoorlie Roads Board District (constructed and running), 8½ miles; (3) for Boulder City (constructed and running), 4 miles, and 1½ miles partly constructed. The remainder of the Boulder line is expected to be completed this month, and it is believed that the annual profits of the company will then amount to at least £20.000.

Gillingham.—The engineer in his last report states that the equivalent of 72 8-c.p. lamps had been connected since the last meeting of the committee, making a total of 11.969 8 c.p. lamps, with 210 consumers connected. An amended plan of the proposed lighting of Rock-avenue has been approved, also proposals of Messrs. Witting, Eborall, and Co., Limited, of Temple Bar House, London, E.C., for motors. With reference to the hire of radiators it was decided that the Council purchase radiators as required on the basis of £3. 1s. for a four-light radiator, to be let at a rent of 7s. 6d. per quarter. Sundry cable and plant is to be purchased from Messrs. W. T. Henley's Telegraph Works Company, Limited, for the sum of £274 at schedule prices.

East Barnet.—At the last Urban District Council meeting a member asked when the Council would be able, according to standing rules, to consider the desirability of rescinding the resolution as to proceeding with the electric lighting scheme of the National Construction Company, and was informed that the time limit would expire in six weeks, at the end of which time the Council could rescind the resolution if they thought fit. The clerk was instructed to inform the New Barnet Tradesmen's Association, etc., that consideration of the Construction Company's scheme had been for the present suspended. Finally a sub-committee was appointed to wait upon the North Metropolitan Company with a view to consulting as to the terms on which they would supply electric light in the district.

Kilmarnock.—The electric light supply was inaugurated on Saturday evening. Arrangements have been made to start the tramway cars on Dec. 10, when an inaugural ceremony will be performed by Lord Howard de Walden, the lord of the manor. Messrs. Kennedy and Jenkin, London, were the consulting engineers. Work has been most expeditiously carried out by the various contractors. The generating station has been erected at Riverbank, near Riccarton, and after the cars have commenced to run the station will be open one night per week to enable the public to inspect the premises and the machinery which has been installed. Mr. A. H. Burbidge, formerly with Messrs. Kennedy and Jenkin, superintended the construction of the works, and he has been appointed by the Town Council as resident engineer and tramway manager.

South Africa.—The *British and South African Export Gazette* says: "The electrical plant for the Aliwal North lighting scheme is now in course of delivery by the makers. It includes, besides the storage battery of the Hart Accumulator Company, Limited, already mentioned by us, a switchboard by Messrs. Crompton and Co., Limited, armoured cables by the British Insulated Wire Company, two 45-kw. dynamos by Messrs. Burstall and Monkhouse, and two 5-kw. boosters and a balancer by the Industrial Engineering Company. Nernst lamps by the New British Engineering Company, Limited, will be used. The Durban Municipality are about placing the following orders for material for their tramway system; 160 private consumers' meters of Messrs. Ferranti's make; 15 tramway feeder meters of Messrs. Chamberlain and Hookham's manufacture; 10 20-kw. Electric Construction Company's transformers and five street boxes for the same; and six miles of assorted cables. The concession for the electric lighting of Vryheid, Natal, has been granted by the Local Board to Mr. E. H. Godfery, Harrismith, Orange River Colony, who will shortly be placing orders for the necessary machinery and equipment. The tender of the Edison and Swan United Electric Light Company, Limited, for street electric light fittings has been accepted by the Johannesburg Municipality."

Wirt Dimmers.—On Tuesday last Messrs. Defries and Sons showed at their Houndsditch works some of the Wirt dimmers they have made to the order of Mr. Maskelyne for the production of the "Coming Race" at his new theatre. The novelty of the apparatus lies in the fact that the "resistances," which hitherto have been made in a large number of pieces connected together by separate joints and sometimes embedded in enamel, are constructed out of a single jointless ribbon of metal wound into as many coils as the number of graduations of brilliancy that are required (in the present case 50). Every turn of these coils is insulated with flake mica, and the whole series of them is arranged between mica discs which are encased between pressed steel plates by means of a single jointless band. The ribbon, which is in some cases as much as 50ft. long, is continuously tapered from end to end. The absence of joints, enamel, make the apparatus reliable and fireproof. This avoids not merely the risk of interruption to the performance, but also of fire, and it is a curious circumstance that of the entire equipment of the ill-fated Iroquois Theatre, Chicago, the only parts that remained uninjured were the Wirt dimmers, which are now operating in the new theatre. The Maskelyne installation includes 27 of these dimmers for the control of the fixed lights, in addition to others for regulating the movable arc lamps which illuminate special points.

Edmonton.—The District Council had before it on Tuesday night offers from the following firms for the execution and maintenance of electricity works under the Council's provisional order: North Metropolitan Electric Power Supply Company, Limited; Foot and Milne, Limited, Westminster; the Industrial Engineering Company, Newton Ironworks, near Hyde; and the National Electric Construction Company, Limited. The first-named company's proposals were based upon a scheme under which they would provide all the capital to be expended on the undertaking and work it, and refund the costs incurred by the Council in obtaining the order and the consulting engineer's fees, amounting to date to £2,800. The company did not propose to provide a separate generating station, but would give a supply from one of its existing power stations. It would agree to the undertaking being purchased at the expiration of 26 years or any subsequent period of seven years at a valuation. At the end of 26 years it was prepared to divide the net profits equally with the Council after it had had 5 per cent. upon the whole of the capital involved. The offers from the other three firms were based upon a scheme under which the Council would provide the capital to be expended. Foote and Milne, Limited, and the National Construction Company were each willing to maintain the undertaking for 25 years. They were prepared to have the agreement determined at the expiration of 15 years without the payment of compensation. The Industrial Engineering Company was prepared to maintain the undertaking for five years, the agreement to be determined at any time within that period upon the payment of such a sum as would bring up the profits to an amount equal to 3 per cent. per annum over and above the sinking fund and interest paid to the Council. After some discussion, the Council agreed to hold a special meeting to consider whether one of the tenders should be accepted, or whether a municipal undertaking should be established.

Bournemouth.—Mr. I. Bulfin, borough electrical engineer, in a recent report to the Tramways Committee on the working of the generating station for the six months ending Sept. 30, 1904, says: "During the period under review 869,227 Board of Trade units have been generated and distributed, being an increase of 112,305 Board of Trade units generated in the corresponding period of 1903. The working expenses for the above six months have been £3,788. 15s. 11d. The total works costs are 1·0461d. per unit generated, as against 1·1188d. for the year ending March 31. 1904, being a reduction of ·0727d. per unit, showing a saving of £263. 6s. 1d. on the units generated as compared with last year, this saving being mostly due to pumping from the artesian bore well during the last 3½ months, and thereby doing without the company's water. The estimated capital outlay on the station is £75,000, and allowing 6 per cent. for sinking fund and interest on this amount = £4,500 per annum, or £2,250 for the period in question = 6213d. per unit generated. The total costs, therefore, are: Total works costs, 1·0461d. per unit generated; interest and sinking fund, ·6213d. per unit generated; total costs, 1·6674d. per unit generated. The total cost per unit for the six months is, therefore, 1·6674d., as against 1·8058d. per unit for the year ending March 31, 1904, being a total reduction of ·1384d per unit generated. The Lighting Committee have taken 44,588 units at 2d. per unit, which has yielded a revenue of £371. 11s. 4d., which further reduces the cost per unit for traction purposes. During the above six months there has not been a single instance of failure to supply current to the line, and there has been a freedom from all breakdown, due chiefly to the care and attention of my assistant (Mr. F. Roose) and my shift engineers (Mr. H. M. Lawson and Mr. H. G. Andrews), and the whole of the staff of the generating station. The automatic cut-outs have acted 260 times, being a reduction of 50 per cent. on the corresponding period of last year. I would ask the committee to consider the advisability of putting the shift engineers on a sliding scale, at a commencing salary as now of £104 per annum, rising by yearly increments of £8 to a maximum of £120 per annum." The report was adopted by the Council at their last meeting.

Electrical Contracts.—Acting for the local engineers at West Hartlepool, Mr. E. Geipel, secretary to the Tees-side Association, wrote to the Electrical Lighting Committee of the Corporation referring to the pamphlet issued by the Corporation. Mr. Geipel says, *inter alia*: "A reference to Regulation No. 16 shows that where the consumer wishes the Corporation to carry out the work on the hire-purchase system it states: 'the Corporation will not undertake the wiring, but will invite tenders for the work from contractors'; see also Section (D), Regulation No. 12. To be assured that the work has been properly done, it is provided that it shall be tested by the borough electrical engineer, and notice that such a test is required should be given by the contractor as per Regulation No. 46. He then proceeds to formulate the following complaint—viz.: that a workman or workmen under the electrical department has or have worked for the Corporation during the day, for which they received their wages as agreed upon, and yet in the evenings have undertaken the carrying out of electrical wiring for consumers (which should have been left to contractors), and made their own charges. This, it is claimed, is an injustice to electrical engineers, who have had much to expend in their training, and now have showrooms, offices, rents, and rates, and taxes to keep up and meet; it is also unfair to their employés, who thus are deprived of labour by those who already have permanent employment by the municipality, and doubly so with the present depression in the borough. We have already suffered to an extent by the Corporation, under Regulation 12, providing motors 'on hire,' and trading in the sale of accessories—such as oil, carbon brushes, etc." In reply to the above, Mr. Higson Simpson, the town clerk, stated that it was not the practice of Corporation workmen to undertake electrical work for customers, and that the only work they had carried out had been at the request of customers to connect up short lengths of wire to meters. The Corporation quite agreed that it was not desirable that their workmen should, except in any such small matters referred to, undertake the work of wiring. The local electrical engineers are not satisfied with this explanation, and intend to bring the matter before Mr. Tweedy Smith, hon. solicitor to the National Association of Electrical Contractors.

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Stourbridge.—The Building Committee's report at the last Guardians' meeting stated that according to an estimate from the architect the cost of wiring, fittings, etc., in connection with the electrical equipment of the workhouse would be £2,700. An electric generator would cost £4,270, and the cost for a unit of current from the local company would average 3½d. If the Board made its own electricity it would cost 2½d. per unit. Estimates were also given for the supply of gas. Much discussion took place, but no decision was arrived at.

Burgess Hill.—The General Purposes Committee's report submitted to the last Urban District Council meeting contained the following paragraph: "Correspondence was submitted from the Board of Trade with respect to the delay of the Council in the establishment of electric lighting works under the order granted to the Council and confirmed by Parliament in 1901. It was resolved to reply, stating that the Council had formulated a scheme and obtained tenders for the works. In consequence of the large amount of capital expenditure involved, and the present state of the money market, no further progress had been made in the matter, and, under these circumstances, the Council requested the Board of Trade to allow the provisional order to remain in force." The resolution for the acceptance of the proceedings was negatived.

London Gazette.—A receiving order has been made out in the estate of Alfred James Hollington, electrical engineer, 93, St. Martin's-lane, Charing Cross. The partnership between Walter Charles Bersey and Charles McRobie Turrell, carrying on business as consulting engineers at Dacre House, Arundel-street, Strand, under the style of Bersey and Turrell, has been dissolved by mutual consent. The partnership between Frederick Bridge and Sydney Mather Bewlay, carrying on business as electrical engineers, etc., at 12, Ryland-street, Birmingham, under the style of Bridge and Bewlay, has been dissolved by mutual consent. At an extraordinary general meeting of the members of the Sir Hiram Maxim Electrical and Engineering Company, Limited, it was resolved that the company be wound up voluntarily, and Mr. Alfred Hardie, of Wynstay, Cyprus-road, Finchley, N., was appointed liquidator.

St. Marylebone.—The last report of the Electric Supply Committee contains the following remarks on change of pressure: "We have now agreed the terms of the conditions upon which the London County Council are prepared to consent to the proposed change of pressure by the Borough Council, and expect shortly to receive from the County Council their approval to the proposed change. As the result of the advertisement inserted in September last in the papers prescribed by the London County Council, giving public notice of the intention of the Borough Council to apply to the London County Council for consent to the change of pressure, we have received three letters from consumers containing objections and enquiries as to the proposed change. The London County Council also received only three letters of objection. All of these have been satisfactorily answered by the electrical engineer." A number of applications from the Post Office authorities to lay pipes has been agreed to.

Bournemouth Telephones.—Two years ago the Town Council appointed a Telephone Committee to report on the desirability of establishing a municipal telephone system in Bournemouth. The principle of the scheme was affirmed at the Council meeting in October, and on Monday Alderman Lawson moved: "To rescind the resolution of the Council of Oct. 4 adopting the report of the Telephone Committee of Sept. 19, 1904." After a long discussion the motion to rescind was lost by 19 votes to 12. The Town Clerk said the National Telephone Company had written stating that, in view of the future extension of their system, it had occurred to them that the Corporation might secure a return on their capital expended in the laying of ducts in connection with their tramway system by letting them on rent to the company, which would at the same time minimise the disturbance of streets which would otherwise be necessary. They were prepared to meet the Corporation on reasonable terms.

Abergavenny.—At the last meeting of the Mon. County Council a report was presented as to the negotiations with the Abergavenny Corporation between the years 1891 and 1904 as to the price of gas for lighting the asylum, and also upon the advantages of lighting the asylum by electricity. It was estimated that the cost of electric installation and buildings would be £6,451, but that the annual saving in favour of lighting by electricity would be £67. Various tenders detailed in another column were accepted. It was stated that the cost of lighting in the past had been looked upon as a very serious item. There were 150 rooms in the institution that had up to the present never been lighted, and where it was impossible to put gas, while the electric light could be installed in those rooms with perfect safety. By electricity the Guardians would save the expense of painting so often, and, moreover, they would be meeting the wishes of their medical officer, who advocated electric light from a sanitary point of view.

Dublin.—Mr. Hammond has submitted an amended offer, which contains the following: "In view of my evidence at the recent Local Government Board enquiry in reference to decreased costs consequent upon the continued great progress of the new system, I am willing to make my offer even more favourable. I stated before the inspector that I estimated that an increased output of 320,000 units beyond the output named in my original report could be generated and distributed at 1¼d. per unit, and an increase of 880,000 units at 1d. per unit. Under these circumstances I beg to express my willingness, in the event of the Corporation giving me the supervision of the undertaking for seven years, to guarantee the Corporation the lower prices named in my evidence. I desire the special attention of the members of the Council to the fact that my proposal is to charge the Corporation not for units generated, but for units actually delivered to the consumers and to the public lighting circuits, and that when the output had reached 3,520,000 units the costs to the Corporation of generation and distribution would be as follows: output per my original report, which included the consumption by 500 public lamps, 2,645,000 units at 1¼d. per unit; output per my recent evidence, 880,000 units at 1d. per unit—total output, 3,525,000; average cost, 1·375d. per unit." On Monday's meeting of the City Council it was resolved to refer the consideration of the matter to a committee of the whole house.

Yarmouth.—The Electric Lighting Committee, in their last report, gives some particulars with regard to the proposed supply to Gorleston. It appears that the town clerk had asked the Port and Haven Commission whether, in the event of the Corporation deciding to take the cables under the water, the Commissioners would allow the cable to be turned up in their dolphin near the Gorleston Ferry, on the west side of the river, the construction on the east side of protection to the cable, 2ft. in advance of the quay face, and also if the Commissioners would forbid the dropping of anchors within 20 yards of the cables. The Commissioners then approved his plans and conditions, and resolved to forbid the dropping of anchors within 50 yards of the cable. Under the circumstances, the cost of the under-water system will be considerably reduced, and its safety be insured. The Local Government Board have already sanctioned a loan for £2,000 for this work, and £1,300 for storage battery and building. The committee state that if both systems were taken to Gorleston, the battery would not be required, reducing the cost under this head to £300, so that £1,000 capital expenditure would be saved. With favourable circumstances, the under-water work should be performed for the £2,000 sanctioned, but with the difficulties attending digging a trench 7ft. deep across the shifting bed of a strong tidal stream, it was impossible to say that the estimate would not be exceeded. The cables must be laid during the ensuing year, so that the matter might be ready for the electrification of the Gorleston trams. The Council have adopted the report, and the surveyor has been instructed to carry out the necessary work subject to further instructions being given by the committee with regard to the electric system to be adopted for the supply to Gorleston.

Colchester.—An enquiry has been held into an application of the Corporation for leave to borrow £16,500 for purposes of electric light extension. The electrical engineer, Mr. A. R. Sillar, explained the technical proposals. The loan is required partly for additional plant to meet the present increasing demand, and partly for other additional plant and further main extensions which would be needed within the next two or three years. The requirements for the ensuing winter include a new 550-h.p. engine, dynamo, and boiler, and necessary additions to the steam and exhaust pipes and other accessories, for all of which contracts have been entered into. For the succeeding period ending with the winter of 1906-7 it is anticipated that a 550-h.p. engine, dynamo, and boiler will be required, with also additional condensing and water-softening plant, and it was pointed out that if the contemplated main extensions were perfected, they would render the supply of current available to the urban portion of the borough and the greater portion of the suburbs. Statistics were given of the output of electricity, which, it was stated, had been for the year ended March 31 last 442,440 units, as against 265,310 for the previous year, being an increase of nearly 50 per cent. During the first three months of the running of the tramway system the output for that purpose had been 105,131 units. It was also stated that the capital expenditure per unit generated had at the end of 1903 decreased to half the expenditure on the first year's working, and it was anticipated that at the close of 1905 it would be reduced to about one-fourth of the original expenditure. From its commencement the undertaking had been financially successful, and the net profit on last year's working was £1,280, after allowing for every proper expenditure and deduction. No call in respect of the undertaking had ever been made on the rates, while, on the other hand, a sum of £500 had been placed to the credit of the general district rate out of the profit of £1,280, the remainder being carried to the reserve and renewal fund.

Cheltenham.—Mr. James Swinburne's report on the working of the electrical undertaking and as to its business and engineering management has been issued to the members of the Council. According to the *Birmingham Daily Post*, Mr. Swinburne points out that Cheltenham is peculiar in many ways. It is spread over a large area in proportion to its population. The private houses of the most well-to-do residents are generally in their own grounds, so that the customers otherwise most profitable are spread over a large area. The public street-lighting is also carried out in a more elaborate way than usual. Dealing in the first place with the accounts, he finds that depreciation should be charged in the case of a municipal undertaking, but that, other things being equal, it should be less than a private concern's depreciation by the amount of the repayment. In practice the case is much more complicated, by the borrowing of more money before the original loan is paid off, for necessary extensions of plant, etc. The obvious way of keeping matters straight, he thinks, is to pay off the first loan when taking up the second. But this method is not adopted, and so the capital accounts become a tangle of loans redeemable at different dates, at all sorts of rates of interest, and having no traceable relation to the plant actually in existence. At Cheltenham plant had been discarded, and the result is that the sinking fund was partly to pay off loans whose corresponding plant is not there. The real state is thus worse than the accounts alone can show, but only to a small extent. He makes the following suggestions as to the accounts: (1) That the interest and sinking fund should be charged as usual; (2) that a depreciation and antiquation fund on the present value of the plant, etc., at a percentage rate that would be charged in private concerns, less the percentage rate for the sinking fund, repairs, and other maintenance charges to come out of this fund; (3) that a rent should be charged for the works, such as the Council would have obtained had they let the ground; (4) properly speaking, the works should be charged with the same rates as they would have paid had they been a private concern. As regards distribution, the expert finds that the main cause of the

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present position of the undertaking is that it has been managed too much with a view to a rosy future than a matter-of-fact present. As an instance, he says, the supply of energy was commenced about May, 1895, from works costing £16,800, but in July of the same year it was decided to apply for a loan of £10,000 for extension, and in February of the following year for a further loan of £15,000. It would have been more prudent to have accepted the view expressed in Mr. Hall's report until there were distinct indications that the undertaking would pay. Mains had been extended in a way which pointed to a complete absence of consideration of their really probable revenue. Expensive outlying consumers appear to have obtained the light on the same terms as those in the compulsory area. This must have been a source of loss. The result is that the system of mains in Cheltenham is a sort of skeleton, with very little on it. Dealing with public lighting, he points out that the 37 arc lamps in 1898 have been increased to 388 in the present year, and it appears to him that a town of 50,000 inhabitants can hardly afford to spend the £6,698 allocated to public lighting in the accounts of 1903 4, to say nothing of the larger sum of £8,610 necessary to make the undertaking pay expenses. From an engineering point of view the arc lighting is carried out satisfactorily. With regard to the price charged for energy supplied to the tramway (a private undertaking), the expert considers it is too low, and that it might be raised without approaching too nearly the cost of generating by the tramway company themselves. Apart from the question of policy in the rapid extension of mains and the installations of sub-stations to deal with a much larger future consumption, and of the policy in putting down so many arcs, Mr. Swinburne holds that the engineering has been carried out well and without extravagance, and a certain quantity of plant has been discarded for adequate reasons. With reference to the future, Mr. Swinburne suggests that a system of energetic house-to-house canvassing for customers be put in hand, and particularly in the streets which already have mains, so as to increase the revenue without a corresponding increase in the capital. As to street-lighting, the capital sunk in the arcs cannot be recovered, but in many of the streets the public would be satisfied with less light, and he recommends that Nernst lamps be put into the arc standards.

PROVISIONAL PATENTS, 1904.

Oct. 31.

23425. Improvements in live-rail protections for electric railways. James Linkleter, Tyneside Works, Tynemouth.

23438. Improvements in magneto-electric apparatus for ignition purposes in connection with internal-combustion engines. Henry Capel Lofft Holden, Gifford House, St. John's Park, Blackheath.

23452. Improvements relating to the insulation of coils of electrical apparatus. Odue Burdette Moore, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 21, 1903, being date of application in United States.) (Complete specification.)

23461. Improved portable electric alarm. Reginald Fox Rowe and William Roland Bloye, 17, Tetcott-road, King's-road, Chelsea.

Nov. 1.

23525. Improvements in connection with electrical radiators. Herbert John Dowsing, 115, Cannon-street, London.

23527. Improvements in or relating to electric cable conductors. William Ernest Hitch, 14, Abbey-road, Oxford.

23559. An appliance for diverging electric currents from a main line or for connecting cables or wires. Evaristo Garsin, 29, Mincing-lane, London. (Giovanni Bogni, Italy.)

23567. Improvements in and relating to electric incandescent lamps. Alfred William Hill and James Harrington, 22, Mazenod-avenue, West Hampstead, London.

23573. Improvements in or relating to driving belts and the like for preventing electrification of the same. Léon Leloup, Robert Obernesser, Jules Tenthorey, and Victor Tenthorey, 139, Queen Victoria-street, London.

23604. Improvements in or relating to electric incandescent lamps. Edwin Riethof and Anton Basch, 111, Hatton-garden, London. (Complete specification.)

23612. Improvements in enclosed dynamo-electric machines. Roger M. Newbold, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 3, 1903, being date of application in United States.) (Complete specification.)

23622. Improvements in galvanic batteries. Paul Möllmann, 6, Lord-street, Liverpool. (Complete specification.)

Nov. 2.

23661. Improvements in dynamo-electric machinery. Samuel Thompson Webster, 34, Castle-street, Liverpool.

23685. Improvements in electric projecting lamps, chiefly for enlarging and projecting lanterns. Leo Kamm, 27, Powell-street, Goswell-road, London.

23696. Improvements relating to electric cables or conductors applicable for submarine use. Joseph Arthur Lovel Dearlove, 7, Southampton-buildings, Chancery-lane, London.

23716. Improvements in devices for preventing sparking of the commutators of electric motors. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 2, 1903, being date of application in Germany.) (Complete specification.)

Nov. 3.

23765. Improved insulating material for electro-technical purposes. Alexander Rudenick, 68, Alterwall, Hamburg, Germany.

23767. An electrically-operated protective or life-saving device for the fronts of tramcars and like vehicles. Alexander Milne, 26, Renfield-street, Glasgow.

23768. Improvement in electromagnets for extracting magnetic impurities from liquefied materials. Herbert William Wilson and the East Anglian Engineering Company, Limited, Stowmarket, Suffolk.

23769. Improved telephone system. Samuel Edward Barnes, 81, Bentley-street, Cleethorpes, Lincolnshire. (Complete specification.)

23797. Improvements in temperature compensating devices for electrical recording instruments. William Henry Bristol, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23807. Improvements in trolley restorers. Edward Lewis Calahan, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 6, 1903, being date of application in United States.) (Complete specification.)

23808. Improved construction of push-button switch. Arthur Charles Burnett and Joseph Richmond, 173, Fleet-street, London.

23811. Improved manufacture of plates and electrodes for electric accumulators and storage batteries. Georges Schauli and George Petrides, 173, Fleet-street, London.

23816. Improvements in electric control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23817. Improvements in electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23820. Improvements in and relating to electrical choke coils. George Stevenson Carson, 77, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 31, 1904, being date of application in United States.) (Complete specification.)

23823. Improved terminal for electrical apparatus. Henry George Pleated, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23834. Improvements in or connected with alternating-current induction motors. Louis John Hunt and the Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool. (Complete specification.)

Nov. 4.

23857. Improvements in the construction of tramway trolley heads. Samuel Shepherd, jun., Bank-buildings, George-street, Sheffield.

23871. An electrical buoy light. Percy Watson, 117, Cleethorpe-road, Grimsby.

23899. Improvements relating to the manufacture of incandescent electric lamps. Alexander Just and Franz Hanaman, 7, Southampton-buildings, Chancery-lane, London.

Nov. 5.

23923 Improvements in incandescent electric lamps and in the method of exhausting the same. Alexander Wingate Kenyon, 9, Tempest Hey, Liverpool.

23932 Improvements in trolley wire supports. David Morton Paton, 65, Chancery-lane, London. Complete specification.)

23952. Improvements in and connected with telegraphic and other transmitting apparatus. James Tarbotton Armstrong and Axel Orling, 61, Chancery-lane, London.

23960. New illuminators applicable to electrical or other stage sights or for forming electric or other letters, signs, or the like illuminative displays. William Goulton, 114A, Chancery-lane, London.

23969. Improved construction of electric arc lamp. Hermann Diamant and Andrea Chiesa, 173, Fleet-street, London.

23971. A new or improved electric device adapted for circuit closing, indicating power transmitting, and possibly other purposes. George Lee Anders and Max Byng, Norfolk House, Norfolk-street, Strand, London.

23972. Improvements in electrical indicating or measuring instruments having springs to convey the current to a movable system. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Akt.-Ges., Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 24, 1904.

1903.

23488. Electrical transmissions of energy through space. Artom. (Date applied for under International Convention, Sept. 12, 1903.)

23715. Apparatus for operating railway signals and points by electricity. Boddam.

23948. Electric tramcars. Conaty.

24023. Electric arc lamps or mercury vapour lamps or the like. Bastian.

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24855. Memorandum and like appliances for use in connection with telephones and for other purposes. Gamble.

24129. Structure of alternators. Zani.

24144. Electrically-controlled valves. Junggren. (Date applied for under International Convention, Nov. 15, 1902.)

25020. Means for automatically governing electric motors, especially applicable for breaking or reducing the current in electric motor vehicles when a given speed of such vehicle is exceeded. Staunton.

25074. Electrical demand or rebate indicators. Case and Reason Manufacturing Company, Limited.

25858. Windings for dynamo-electric machines. British Thomson-Houston Company Limited. (General Electric Company.)

26427. Electromagnetic controlling gear for electric arc lamps, electric circuit breakers, and the like automatic mechanism. Eckstein and Angold.

27722. Alternating-current induction motors. Hunt and Sandycroft Foundry Company, Limited.

28030. Electric meters. Rimington.

28032. Metallic conduits for electric light cables and the like. Waterhouse and Simplex Steel Conduit Company, Limited.

1904.

1364. Gas or vapour electric apparatus. Le Tall. (Cooper-Hewitt Electric Company.)

1609. Means for adjustably suspending electric lamps and other articles. Napier-Clavering.

2458. Brush-holders for dynamo-electric machines. Acly. (Date applied for under International Convention, Jan. 31, 1903.)

2839. Incandescent electric lighting appliances, more especially adapted for use in theatres. Schwabe.

2865. Printing telegraph receivers. White.

4918. Automatic circuit breaking safety appliances for use in trolley wire systems for electric traction. Carter, Hall, and Parsons.

8378. Arrangement whereby ordinary house electric bells can be used for electro-medical purposes. Page.

9215. Electric switches for electric chronographic or time-recording devices. Wilson. (Date applied for under International Convention, April 21, 1903.)

11405. Automatic electric switch for the intermittent lighting of electric lamps or groups of lamps. Pounsford and Love.

12615. Thermo-electric piles. Katz.

13489. Process of and apparatus for the electrical separation of granular material. Schnelle. (Date applied for under International Convention, June 15, 1903.)

14568. Arrangement of electric cables working with high voltage. Siemens-Schuckert Werke G. m. b. H. (Date applied for under International Convention, June 29, 1903.

15551. Prevention of fires caused by short-circuits or by injury to electric conducting wires or cables. Wilhelmi.

16509. Directories or indicators for telephones. Drowns. (Date applied for under International Convention, Jan. 29, 1904.)

17166. Gas or vapour electric apparatus for use as lamps and for other purposes. Flichtner. (Date applied for under International Convention, Aug. 10, 1903.)

18322. System of electric lighting for railway trains. Pieper and L'Hoest.

18383. Indicating device for electrical fire-alarms. Hoenicke.

18827. Electric temperature signalling device. Klopfenstein and Klopfenstein.

18908. Electric time-recording mechanism and apparatus. Kelly.

19334. Electrically-driven fans. Reiss and Klemm. (Date applied for under International Convention, Oct. 12, 1903.)

19585. Magnetic compasses. Herrick. (Date applied for under International Convention, Sept. 12, 1903.)

20134. Controlling apparatus for electric motors for working lifts and like apparatus. Klinkenberg.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-½
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5½-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	3½-3⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	88-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	93 96
—— 4½ per cent. 2nd Debenture Stock	100	..	69-73
Callender's Cable, Debentures	100	..	104-106
—— Ordinary	5	..	9¼ 9⅜ xd
—— 5 per cent. Pref.	5	..	5-5¼
Crompton and Co.	3	..	1¼-2
—— 5 per cent. Debentures	100	..	90 95
Edison and Swan United, "A" Shares, 1-99,261	3	..	⅛-¼
—— "A" Shares, 01-017,139	5	..	1-3
—— 5 per cent. Debentures	100	..	79-84
—— 4 per cent. Deb. Stock, Red.	100	..	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1-1¼
—— 7 per cent. Cumulative Pref.	2	..	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	91-96
W. T. Henley's Telegraph Works, Ordinary	5	..	10¼-11¼
—— 4½ per cent. Preference	5	..	5¼-5⅝
—— 4½ per cent. Debentures	100	..	108-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	19¼ 20¼
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	37-39
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	11⅛-12⅛
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9⅛-10
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock. Red.	100	..	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅝ xd
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103 xd
Brompton and Kensington, Ordinary	5	..	10¼-11
—— 7 per cent. Preference	5	..	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	7⅜ 7⅝
—— Nos. 20,001-30,000	5	..	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	8¼-9
—— 70,001-80,000	5	..	8-8¼
—— 4½ per cent. Cum. Pref.	5	..	5⅜ 5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¼-5
—— 40,001-80,000	5	..	4¼-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	103-106
Chelsea Electricity Supply	5	..	6¼-6⅜
—— 4½ per cent. Debentures	100	..	109-111
City of London, Ordinary	10	..	10¼-11
—— 6 per cent. Cumulative Pref.	10	..	13¼-14
—— 5 per cent. Debenture Stock	100	..	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104-106
County of London Electric Supply, Ordinary	10	..	9-10
—— 6 per cent. Cum. Pref.	10	..	11⅜-12¼
—— 4½ per cent. Debentures Prov Certs. All pd. Red.	100	..	100 103 xd
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼ 6⅜
—— 6 per cent. Cum. Pref.	5	..	5⅞-6⅛ xd
—— 4½ per cent. First Mort. Deb.	100	..	106-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	1¼-2⅛
—— 5 per cent. Debenture Stock, Red	100	..	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	101-104
Havana Electricity, Limited, 1-15,000	10	..	9¼-10⅛
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7⅛-8¼
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	..	89-101 xd
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	..	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-81,000	5	..	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	..	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	5	..	2-2⅛
—— 6 per cent. Pref.	5	..	5¼-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	97-99
Metropolitan Ordinary	10	..	15⅜-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	112-117
—— 4½ per cent. Cum. Pref.	5	..	5⅛-5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	..	97-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.	100	..	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	..	100-102
Notting Hill Electric Lighting	10	..	14¼-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	99-102
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310	5	..	6-6¼
—— 4 per cent. Debenture Stock	100	..	98-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2⅜-3¼
—— 4 per cent. Debenture Stock	100	..	83-87
South London, Ordinary		..	4¼-4⅜
South Metropolitan Electric Light and Power Co., Ord.	1	..	3/7-1
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	107 110
—— Ditto, June, 1904		..	
St. James's and Pall Mall, Ordinary, 101-80,080	5	..	14¼-14⅜
—— 7 per cent. Pref.	5	..	8¼-9
—— 5½ per cent. Deb.	100	..	99-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4⅞-5
Westminster, Ordinary	5	..	12⅜ 13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6¼ 6⅜
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-250,007	5	..	5 5/16-5 7/16
—— Ord.	5	..	6¼-7⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	105½-106½
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98 101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3¾-4¼ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	99-101
British Columbia Electric Railway Co., Ord. Def.	100	..	103-106
—— Ord Pref.	100	..	102-105
—— Non. Cum. 5 per cent. Pref.	10	..	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	102-104 p ot
—— 4½ per cent. Vancouver Power Deb.	100	..	97-100
British Electric Traction Ord. 1-300,000 & 60,001-80,000	10	..	9¾-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	11⅛-11⅜
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	..	95-97 xd

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5		3¼-4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5½-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5½-5⅝
—— 5 per cent. Deb. Stock, Red.	100	–	105-108
—— Prov. Cert., all paid	100	–	102 105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7 -7⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	105-108
Cape Electric Tramways, Nos. 1-480,000	1	–	1½-1⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4⅝-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	–	101-104 xd
Cork Electric Tramways and Lighting Co. Ordinary	10	–	9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 5 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-5,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18 19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000	5		3⅞-4⅛
—— 4 per cent. Debenture Stock	100	–	90-93
Kidderminster and District Lighting and Traction, Pref.	5	–	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10⅛-10⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	102-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	5/16-7/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	..	102-104
Milwaukee Electric Rail and Light. 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	–	¼-1½

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	2-12½
—— 5 per cent. Cum. Pref.	10	–	9⅝-9⅞
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	–	103-106
Potteries Electric Traction, Ordinary 20,001-40,00	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8½
—— 4½ per cent. Debenture Stock	100	–	101-104
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,152 5 per cent. Preference	1		1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	–	p.c.

Electric Railways.—

Central London, Ordinary	100	–	91-94
—— 4 per cent. Pref.	100	–	100-102
—— ,, ,, deferred	100	–	82 86
—— 4 p.c. Deb. Stock (Prov. Scrip Certs., fully paid)	100	–	108 110
City and South London, Consolidated Ordinary	100	–	46-48
—— 4 per cent. Debenture Stock	100	–	104-107 xd
—— 5 per cent. Pref. Stock '21	100	–	122-125
—— ,, ,, ,, '26	100	–	117-120
—— ,, ,, ,, '01	100	–	113-117
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10½
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	–	99-99½
Waterloo and City, Ordinary	100	–	88-90

Telephones.—

National Telephone, Preferred	100	–	106½-107½
—— Deferred Stock	100	–	97-98
—— 6 per cent. Cum. First Pref.	10	–	13-14
—— 6 per cent. Cum. Second Pref.	10	–	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅜
—— 5½ per cent. Deb. Stock, Red.	100	–	97½-98½
—— 4 per cent. Deb. Stock, Red.	100	–	104½-105½
—— 4 per cent. Prov. Cert.	–	..	67½-68½
Oriental Telephone and Electric Company	1	..	15/16-1 1/16 xd
—— 6 per cent. Cum. Pref.	1	..	1¼-1¼ xd

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 29	1,152	1,227	– 74	— *h*	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	Nov. 5	187	180	+ 7	+ 486	8	8	,, 15	14,160	3,201,586	316,049	1·03	10·11	1,770	5 04
Barking Corporation	,, 5	44	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 6	1,021	915	+ 35	+ 410	23·53	23½	March 31	56,0 3	11,327,932	1,319,701	1·158	9·98	2,383*b*	6·1
Birmingham Tramways	,, 5	5,371	5,068	+ 303	—	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 28	911	783	+ 123	+ 3,015	24	23	,, 25	43,374	7,742,692	951,484	—	10 94	—	4·58
Blackpool Corporation	Nov. 3	350	331	+ 19	+ 5,821	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 5	334	216	+ 18	+ 309	16½	16½	Dec. 31	32,021	2,258,984	600,757	3·34	12·75	2,001	7 05
Bolton Corporation	,, 6	1.6 4	1,687	+ 7	+ 374	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 2	872	894	– 22	+ 1,981	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 5	3,926	3,506	+ 420	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 6	854	866	– 12	+ 3,265*h*	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 4	4,6 9	4,521	+ 138	—	51¼	51½	Dec. 31*g*	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 5	955	778	+ 177	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 6	310	283	+ 27	—	8¼	—	March 31*j*	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 5	1,838	1,863	– 24	+ 1,627	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 5	171	182	– 11	+ 196	—	—	Dec. 31*g*	9,987	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 5	6,833	6,858	– 25	– 277*h*	6	6	,, 31	362,471	44,933,938	1,292,674*a*	1·87	64·87	58,229	35·60
City & South London Railway	,, 6	2,801	2,9 7	– 136	– 1,791*h*	6¼	6⅜	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Colchester Corporation	,, 2	186	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 3	457	461	– 6	– 2 539	—	—	,, 31*g*	25,657	6,353,823	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 4	214	231	– 17	– 114	7·23	7·23	March 31*a*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 5	185	177	+ 8	– 2/6	4½	4½	,, 31	11,255	2,871,332	280,901	0·94	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 4	111	94	+ 17	— *h*	7	6⅔	Dec. 31*g*	6,234	888,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 4	3,756	3,800	– 144	—	47	46	,, 31*g*	134,643	—	3,429,356	—	—	—	— *k*
Dublin S. District, Electric	,, 4	838	800	+ 38											
Dundee City Tramways	,, 2	817	842	– 25	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 5	636	656	– 30	+ 1,480	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 5	14,524	13,716	+ 801	— *h*	145	123	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	,, 2	229	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 2	2,628	2,546	+ 82	+ 3,538	33	30½	March 31	68,283	16,322,054	1,387,885	1·00	11·79	2,059	8·77
Huddersfield Corporation	,, 5	1,183	1,137	+ 46	—	35	35	,, 31	65,545	11,893,287	1,652,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 5	2,172	1,899	+ 273	+ 9,153	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 5	372	372	—	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 2	116	137	– 21	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 3	198	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 5	5,361	4,834	+ 527	+10,954	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 5	1,613	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 29	10,177	10,226	– 49	+12,993	103	103	Dec. 31*g*	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	Nov. 6	1,483	1,605	– 117	— *h*	6·57	—	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	Oct. 29	12 4·7	9,731	+2,736	—	46½	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 24	160	175	– 15	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 27	126	125	+ 1	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 29	12.0 8	11,591	+ 467	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	Nov. 4	1,793	1,170	+ 623	+ 9,239*h*	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 5	103	86	+ 17	+ 1,193	2½	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 5	3,592	3,548	+ 44	—	43	38½	,, 25	185,027	39,715,120	4,059,807	1·1	10·94	4,111*b*	7·19
Newport (Mon.) Corporation	,, 5	482	421	+ 61	+ 206	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	29	,, 31	91,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 3	416	—	—	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 5	81	—	—	—	7⅔	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 6	4,471	4,477	– 6	+ 2,919	34¼	—	,, 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 3	885	967	– 81	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Oct. 19	272	243	+ 29	+ 1,292	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	Nov. 4	471	345	+ 125	+ 7,475	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 6	1,117	1,094	+ 23	+ 720	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	—	—	—	—	—	3⅔	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 5	662	599	+ 63	—	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 3	1,074	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 2	700	448	+ 252	—	7½	—	,, 31*g*	20,878	4,263,066	417,335	—	12·006	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation *e* Including one section of horse traction *g* 1903. *h* Half-year's figures. *j* Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Faraday House.—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., yesterday commenced a special course of lectures to the senior students of this institution upon direct-current motor construction.

Corps of Electrical Engineers (R.V.).—The annual dinner of the corps is to be held at the Criterion to-morrow evening at 7.30, when the members will doubtless muster in full force. Inadvertently we stated the date in our last issue as being the 12th.

Royal Statistical Society. — At the inaugural meeting of the present session of the Royal Statistical Society on Tuesday, Sir Francis S. Powell, the president, presented the Guy medal to Mr. D. A. Thomas for his paper on "The Growth and Direction of our Foreign Trade in Coal."

Northampton Institute.—The Right Hon. Lord Reay, G.C.S.I., G.C.I.E., LL.D., will distribute the prizes at the Northampton Institute for the session 1903-4 on Friday, Dec. 9, at eight o'clock. The prize distribution will be followed by a conversazione, which will be continued on the following day.

New Paper.—The Faraday Society having decided to issue their own *Proceedings* in future, the publishers of the *Electro-Chemist and Metallurgist* propose to issue only one more number of that journal under its present title, but they hope to bring the paper out upon an enlarged scale in January next under the title of *Metals* (with which will be incorporated the *Electro-Chemist and Metallurgist*).

Metric System.—Our readers will remember that at their opening meeting of the session the Rugby Engineering Society held a discussion on the advantages of a metric system as compared with the present system of weights and measures in force in this country. After the discussion a vote of the meeting was taken, and the society passed its opinion in favour of the introduction of the metric system. In the resolution by which this decision was arrived at the opinion was expressed that the advantages of the metric system to mechanical and electrical engineers are so great as to outweigh the temporary inconvenience caused by the transition period.

Glasgow Section.—The third annual dinner of the Glasgow Section of the Institution of Electrical Engineers was held in the banqueting hall of the Grosvenor Restaurant, Glasgow, the function being presided over by the chairman of the Local Section, Mr. R. Robertson. There was a numerous gathering of electrical engineers belonging to Glasgow, London, and other places, a large contingent of the civic dignitaries, and a number of Pressmen. The banquet proved highly successful, and Mr. E. G. Tidd, the local hon. secretary, wound up the speeches by declaring that if the members wished to support him in his work, the best way was to come forward with papers and participate in the discussions. The parent institution was represented by Mr. R. K. Gray and Mr. G. C. Lloyd, the secretary.

Thermal Storage.—This system of storing energy in heated water has not come so rapidly to the front as was expected five or six years ago. We are pleased to see, however, that the electrical engineer to the metropolitan borough of Hammersmith (Mr. G. G. Bell) has advised his committee to employ the system in connection with their new boiler plant. In this case four storage vessels, each capable of holding 50 tons of water, will be employed, and will be used to store heated feed water throughout the day. This hot feed water will then be passed into the boilers at night, with advantages which will be apparent to all steam engineers. The thermal-storage equipment, which will be capable of holding 200 tons of hot feed water at boiler pressure, will cost only £2,616, and we agree with Mr. Bell that this is a reasonable price for the advantages secured.

Some Physical Properties of Current-Bearing Matter.—An article on this subject by Mr. Paul R. Heyl appears in the October number of the American *Physical Review*. The contribution is supplementary to a descriptive *résumé* in the *Journal* of the Franklin Institute for March of the work that has been done in determining the physical properties of current-bearing matter. It may be stated at once that the results presented are negative. The experiments show that any change in the tensile strength of iron for a current density of 2,000 amperes per square centimetre cannot exceed one-half of 1 per cent., and for copper with a current density of 1,000 amperes per square centimetre the alteration cannot exceed one-fifth of 1 per cent. Any change in the melting point of tin for a current density of about 2,500 amperes per square centimetre can hardly exceed 2deg. There is some reason to believe that a more powerful method would definitely show a small rise in the melting point.

Personal.—We hear that Mr. W. B. Esson, after occupying the post of chief engineer and manager to leading electrical firms for the past 20 years, during which period he has been responsible for the carrying out of a large number of important schemes, has commenced practice as a consulting engineer at 1, Victoria-street, Westminster, where his extensive experience will be available for all matters connected with electrical undertakings. We also learn that Mr. J. Gordon Wilson, who for many years has been connected with Messrs. Siemens Bros. and Co., has now resigned his position of chief electrical designer to the firm, and has started consulting engineering work in Edinburgh. Mr. Wilson has entered into partnership with Mr. Norman A. Thompson, who lately occupied the post of manager and resident engineer to the Clyde Valley Electrical Power Company, and the firm of Messrs. Thompson and Wilson will have their offices at 22, North Bridge-street, Edinburgh.

Manchester Section.—This branch of the Institution of Electrical Engineers will open its session at the Grand Hotel, Manchester, to-night at 7.30, when Mr. C. D. Taite, the chairman, will deliver his inaugural address. On the conclusion of this a smoking concert is to be held. The programme for the session is as follows: Nov. 29, "Compensated Alternating-Current Generators," by Mr. M. Walker; Dec. 13, "High-Tension Switchgear," by Mr. L. Andrews; Jan. 17, "Electric Driving in Textile Factories," by Mr. H. W. Wilson; Jan. 31, "Some Points on the Selection of Electric Cables," by Messrs. L. B. Atkinson and C. J. Beaver; Feb. 14, "Manchester Tramways Power Supply," by Messrs. S. L. Pearce and H. C. Gunton; Feb. 28, "Mechanical Construction of Steam-Turbines," by Mr. W. J. A. London; March 3, annual dinner; March 14, "Low-Tension Thermal Cut-outs," by Prof. Schwartz and Mr. W. H. N. James; March 28, "Use of Electrical Energy in Mines and Collieries," by Mr. M. B. Mountain; and April 11, general meeting. As in previous years, the general meetings will be held at the physical laboratory, Owen's College, by permission of the authorities. The Students' Section has also arranged a number of meetings to be held at the municipal school of technology, and visits will be paid to several neighbouring works.

Egyptian Business.—The complaint has frequently been made in consular reports that English firms are not sufficiently keen in securing reliable representatives abroad.

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It will be remembered that in our last week's issue Mr. R. A. Dawbarn made the same remark with respect to South Africa, where, he said, the representatives of English firms left much to be desired. News has just come to hand of the commencement of a combined agency in Egypt which has much to recommend it. The companies concerned are five in number, and their businesses are such that they do not compete one against the other. These five firms have floated a company with a capital of between £20,000 and £30,000 under the title of the British Engineering Company of Egypt, Limited. The firms interested are Messrs. Dick, Kerr, and Co., Callender's Cable and Construction Company, Limited, Messrs. Babcock and Wilcox, Limited, Messrs. Gwynnes, Limited, and Messrs. J. Gibb and Co. Offices worthy of the firms interested are being erected at Alexandria, and we have no doubt that the combination will tend not only to the good of these firms, but will also greatly assist in the development of engineering work in Egypt. The advantage of having actually on the spot a first-class staff able to deal with any class of engineering business is one which cannot be over-estimated, and considerations of economy would prevent each firm from keeping a separate expert staff. We trust that this form of co-operation will be extended to the Colonies.

Educational Reform.—The multiplicity of examinations for entrance into the professions is engaging the attention of the Board of Education. It is proposed to bring these tests of knowledge into close connection with the work of each school. A committee has considered the whole question, and suggests that a general system of school certificates should be instituted and given on examinations—including an oral examination in modern languages—controlled by a university, a combination of universities, or an examination board representative of a university or universities, and of the local authorities which are prepared to co-operate with them, together with representatives of the teachers, and that a central board should be established for England, consisting of representative of the Board of Education and of the different examining bodies, whose duties it should be to co-ordinate and control the standards of examination, and secure the interchangeability of certificates. This central board, it is suggested, should be constituted by the Board of Education as soon as a sufficient number of recognised examining bodies have signified their willingness to be represented thereupon. It is proposed that the certificates shall be of two kinds—a junior certificate, limited to pupils under 16 years of age who have received not less than three years' instruction in a school accepted for examination, and a senior certificate for pupils who have received not less than four years' tuition. The London County Council's Education Committee has expressed its approval of this movement, which, it is to be hoped, will result in the present too numerous examinations being reduced to one or two on a more systematic basis.

Thermo-Electromotive Force.—A paper on this subject was read by Mr. C. B. Thwing before the American Physical Society, and an abstract of the paper appears in the *Physical Review* of New York. The author remarks that on the hypothesis that an electric current in a metal consists of a displacement of negative corpuscles, it might be expected to follow that the direction, as well as the magnitude of the pressure tending to produce such a flow in a metallic circuit due to unequal temperatures at two points in the circuit, would depend upon the rates of expansion of the metal at the two temperatures. The coefficient of expansion of many metals, and of a number of alloys having high thermo-electric force, was determined both between 20deg. and 60deg. and between 60deg. and 100deg. with a good degree of accuracy, and the thermo-electric force of the same specimens was determined over about the same range of temperature. Comparing the rate of increase of coefficient of expansion from 40deg. to 80deg. with that of lead, the thermo-electric power of which is reckoned at null, it was found: (1) That for nickel and bismuth and for nickel alloys having, like these metals, a negative E.M.F. the rate of increase of expansion is negative and numerically larger for the metals having a high E.M.F. (2) That for metals and alloys like antimony and its alloys having a positive E M.F. the rate of increase of expansion is positive and numerically larger for the metals having a high E.M.F. (3) That for alloys of Ni-Cu, Sb-Zn, and Sb-Cd, all of which have an E.M.F. much higher than either constituent, the coefficient of expansion is abnormally low as compared with the value computed from those of the constituents, the value in the case of one of the Sb-Cd alloys being but one-third of the calculated value. These remarks harmonise with the hypothesis referred to above.

The Rhodes Scholarships.—At the Hôtel Métropole last week Dr. G. R. Parkin delivered an address to the members of the Royal Colonial Institute upon the Rhodes scholarships. The speaker paid a high tribute to the imperial aspirations of Cecil Rhodes. Admitting that the Colossus made at least one grave error of judgment in political morals, Dr. Parkin considers that when his environment in the early mining town life of South Africa is remembered, our wonder must be that he adhered so consistently to noble conceptions of the use of wealth. Dr. Parkin feels emboldened to assert that in Cecil Rhodes we had "a man whose mind moved on a larger constructive line for the good of his fellow-men than any other Englishman of our time." Having alluded to the services Rhodes rendered to the Empire in South Africa, including the Cape-to-Cairo Railway, the speaker detailed the history of Rhodes's scheme for welding the Anglo-Saxon race—the creation of the Rhodes scholarships. Dr. Parkin humorously describes the fluttering in the Oxford dovecotes when the bequest was announced. "The fact," he remarks, "of 200 young men being drawn to her from the ends of the earth—from South African veldt and Western prairie, from New Zealand bush and Rocky Mountains—awakened visions of untamed cowboys and boundary riders, of bowie-knives and revolvers, invading the High-street — rather trying to the imagination of cloistered scholars"! But the feeling was transient, and Oxford as a whole welcomed the larger opening. The contingent of Yale students who recently entered into residence on the Isis have awakened the admiration of university educationists by the seriousness with which they devote themselves to research. Dr. Parkin, it may be mentioned, was privileged to assist in the arrangements for carrying out the trust, and his account of its organisation is deeply interesting. Wherever Dr. Parkin has been in the Colonies the potentialities of the scheme as a mighty binding force have been freely recognised, and in the United States he has found the idealism of Mr. Rhodes accepted as a truly noble one. The speaker concluded by enlarging upon the advantages of the trust in enabling students from abroad to obtain a wider knowledge of the affairs of the universe.

New Patent Regulations.—The new patent regulations, which come into force on Jan. 1, have just been issued, and Messrs. W. P. Thompson and Co., patent agents, whose remarks on this subject we published a few weeks ago, direct further attention to the leading provisions. If the invention is found to be described or claimed in some

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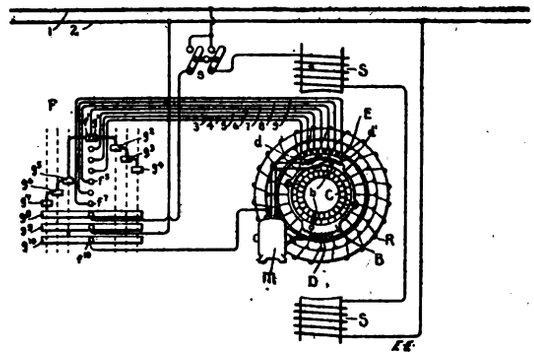
one or more British patents published during the immediately preceding 50 years, the attention of the inventor will be directed to the fact, and he will be required to cut out the old matter within two months of the date of the official letter, or to acknowledge in his patent that he is aware of the prior patents. This acknowledgment must take the form of an insertion after the claims in the specification as follows: "Reference has been directed, in pursuance of Section 1, Sub-Section 6, of the Patents Acts, 1902, to the following specification of letters patent (giving the name and number)." If the description in the specification is not sufficiently clear, the inventor may be required to amend or amplify it, but if he do so, it is within the comptroller's discretion to date the patent as of a date subsequent to the original date of the application, but not later than the date when the amendment was made. The decision of the Patent Office officials is subject to appeal to the comptroller, followed, if necessary, by appeal to the law officer. If the applicant, having passed the examination process, desires to have a patent sealed on his application, he must on or before the last day on which the patent can be lawfully sealed pay an additional fee of £1. It is important to remember that, under these new rules, provisional protection will be granted for only six months instead of nine months, as hitherto. Under the new system several distinct matters cannot be deemed part of one invention simply because they relate to an existing machine, apparatus, or process, and the work of searching will thus be kept within reasonable limits on each application. These regulations may be an improvement on the present system, but they leave a lot to be desired, for even if the examiner approves an application, and a patent is granted, its validity is not assured. In this connection the words of the President of the Institution of Electrical Engineers at last week's meeting are of considerable interest. A report of same will be found in another column, and, as Mr. Siemens points out, an elaborate system of preliminary examination, such as is practised in the United States, which still leaves the inventor open to a lawsuit, is delusive. The new regulations have been hailed in some quarters as an important reform, but we fear the inventor's millennium is not yet.

The Institution.—In the presence of a very large meeting the 1904-5 session of the Institution was inaugurated yesterday week. After the formal business had been concluded Sir William Preece proposed a vote of thanks to the retiring president, Mr. R. K. Gray. Sir William eulogised Mr. Gray's great services to the Institution, and spoke, after an acquaintance extending over 30 years, in glowing terms of his personality and generosity. The admirable manner in which Mr. Gray had lately conducted the party of members through the United States was dwelt upon by Sir William in enthusiastic terms. Prof. S. P. Thompson, in seconding, referred to Mr. Gray's invaluable efforts when the Institution lost the services of the late Mr. McMillan. "His devotion to the Institution during that emergency," said Prof. Thompson, "could never have been exaggerated." He had served as the Institution's figure-head during the visit to Northern Italy, and only just recently he had piloted a large party around the United States. "We, indeed, owe a great debt," concluded Prof. Thompson, "to our past-president, whose tenure of office has been marked by unique events." The new president, Mr. Alexander Siemens, in conveying to Mr. Gray the vote of thanks, which was accorded amid great enthusiasm, said, "As your immediate successor, I regret you have given me an example which it will be hopeless to attempt to follow." Mr. Gray feelingly acknowledged in brief terms the kind manner in which his services had been appreciated, and expressed his thanks for the great assistance he had received from the Council and the staff. Mr. Siemens then delivered his inaugural address, part of which we published last week, the remainder appearing in this issue. Colonel Crompton proposed a vote of thanks to the new president for his highly interesting, if somewhat controversial, paper. Mr. J. E. Kingsbury, in seconding, remarked that whilst the paper might be controversial in some respects, he thought the points dealt with were of vital importance to the profession. He had given them some instructive information in regard to the metric system, and the advice in regard to British industries given in the concluding lines was most valuable. Mr. Siemens, in acknowledging the vote of thanks, said he was very sorry he had been unable to exclude controversial matter, but he thought the subjects, and particularly the metric system, were of great importance. In concluding the proceedings, Mr. Siemens announced that he had been invited, as president of the Institution, to attend the twenty-fifth anniversary of the establishment of the German Institution. This will be celebrated on the 25th inst.

Distant-Control Apparatus.—A device for the distant control of machinery electrically has been patented in the United States by Mr. M. R. Hanna, who has assigned it to the General Electric Company. The *Western Electrician*, of Chicago, gives the following description of the operation of this device in controlling the brush position of motors on a car or train; but the invention can also be used for a number of other applications. In the accompanying diagram S represents the field or stator of a motor connected through the switch, *s*, and the line-wires, 1 and 2. The rotor, R, is provided with a commutator, C, on which the brushes, *b*, bear. Brush-holder ring, B, has gear teeth cut on its lower side, and these teeth are engaged by the worm, D, driven by pilot motor, M.



Thus, as motor, M, revolves, B will be rotated in one direction or the other, depending upon the direction of rotation of motor, M, and the brushes, *b*, will be shifted. Brush-holder ring, B, carries two movable contacts, *d* and d^1, which are secured to ring, B, but insulated therefrom and from each other. These movable contacts engage the segments of the stationary commutator, E, which is secured to the frame of the machine. The segments of stationary commutator, E, are connected through the conductors, 3 to 9, to the controlling switch, F. Controlling switch, F, comprises 10 stationary fingers, f^1 to f^{10}, and 10 movable contacts, g^1 to g^{10}. With the controller in the position shown, and with switch, *s*, closed, there is no tendency for the motor, M, to rotate. It will be seen by the diagram that the current from motor, M, is flowing in parallel through the two leads connected to *d* and d^1. The motor is so arranged that when the current is flowing through both of these leads there is no tendency for the motor to rotate. Now, if controlling switch, F, is moved in one direction or the other—as, for instance, towards the left, until contact finger

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f^2 engages contact g^2—it will be seen that the circuit through movable contact d^1, through the controller, F, has been shifted from contact finger f^1 to contact finger f^2, and consequently from conductor 6 to conductor 5. Movable contact d is in engagement with the commutator segment to which conductor 5 is connected, consequently current will flow from the motor through movable contact d alone. The motor will revolve, rotating brush-holder ring, B, in a counter-clockwise direction, and will continue to revolve until movable contact, d^1, makes contact with the segment to which conductor 5 is connected. Movable contacts, d and d^1, being thereupon brought into contact with the same segment, current again flows through the two in parallel, and the motor ceases to rotate. As controller, F, is shifted to another position the same operation is repeated. Thus it will be seen that each position of the controller corresponds to a certain position of the motor brushes, and by simply moving the controller to any one of its positions, motor, M, will automatically bring the brushes of the large motor to the proper position, and will then stop. Furthermore, it is evident that the brush-shifting devices and pilot motors for any number of main motors may be connected to a single controlling switch, F. The brush position of any number of motors may be controlled from a single point. The inventor has designed pilot motors for use in this device both for direct and alternating currents.

Tramways and Light Railways Association.—By permission of the London County Council, Mr. A. L. C. Fell, the Council's chief tramway officer, piloted a party of members on Friday last around the Greenwich power station and the New Cross and Clapham sub-stations and car-sheds. At present the structures, and particularly the power station, are of more immediate interest to builders than to electrical engineers, though considerable progress has been made. At the present time one-half only of the power station is being erected. The delivery of the bulk of the plant is expected early next year, and the portion of the station now in course of construction will probably be at work by the end of that year. The boiler-house and engine-house are parallel with each other, and when the whole station has been completed will measure 440ft. by 80ft. each. The boiler-house will contain 48 water-tube boilers on the ground floor, arranged in two rows, with four chimneys, each 14ft. internal diameter and 250ft. high. Each boiler will be fitted with superheaters, and will evaporate 16,300lb. of water per hour, at a pressure of 200lb. per square inch. Chain-grate stokers will be used. Immediately over the boilers is an economiser floor on each side of the boiler-house. Large steel coal bunkers are being erected above the economiser floor, and will deliver coal to the furnaces of the boilers by means of chutes. The storage capacity provided in the completed station is 10,000 tons. The engine-room will contain eight vertical-horizontal engines of 6,500 h.p. each, and each engine will have mounted on its shaft a three-phase generator of 3,750 kw. capacity. Four of these combined sets are being erected at present. The type of engine is a new one for this country, and it possesses several important features, as each engine is, in reality, two complete compound engines, with the vertical high-pressure cylinder and the horizontal low-pressure cylinder on each side of the generator. There are only two main bearings for the shafts, and the cranks are overhung. The vertical and horizontal connecting rods, on each side, work on the same crank pin. Separate steam inlets and condensers are provided for each half engine, so that in case of emergency one half can be run without the other by removing the connecting rods. As the cranks are set 135deg. apart, eight distinct steam impulses are obtained per revolution, resulting in a very even turning movement, so even that an independent flywheel is not required. The drainage of the engines is perfectly natural, as the low-pressure cylinder is horizontal. Each engine will carry on its shaft, between the cylinders, a three-phase generator as mentioned above. The output of each machine will be 350 amperes per phase at 6,600 volts between phases, and 25 cycles per second. The speed will be 94 revolutions per minute. In addition to the main engine sets, two auxiliary steam-driven sets are being provided, each of 250 h.p., and these will be used as a stand-by for the excitation of the large machines as well as for partly lighting the station. Separate exciters for each generator have been provided to avoid complication in the switchgear. The supply of water for the condensing plant in the basement of the engine-room will be provided by centrifugal pumps in a separate pump-house. The pumps will be driven by three-phase motors, and will draw their water from the Thames through 30in. pipes. All the auxiliary plant will be electrically driven. At present the Council's operating charges amount to 7d. per car mile, which Mr. Fell hopes will be reduced to less than 6d. when the Greenwich station is available. When the New Cross car-shed is finished it will have accommodation for 295 cars. The sub-station, which operates the lines within the radius of about two miles, is equipped at present with three 300-kw. synchronous motor-generators, and there is room for two others. The alternating-current side is operated at 6,600 volts, three-phase, and 25 cycles per second, and the direct-current side gives an output of 550 volts. The speed of each set is 300 revolutions per minute. The Clapham sub-station contains at present only a low-tension distribution switchboard. When the main station has been completed, this sub-station will be equipped with machinery and switchgear similar to the other sub-stations.

Electrical Typefoundry.—A large printing plant has recently been opened by the American Typefounders' Company at Communipaw, New Jersey, in which electricity is employed throughout for power and lighting. A description of the installation appears in the *American Electrician*. The general lay-out is such that extensive additions may be made should future occasion require it, but at present the power generating plant is capable of furnishing all the power needed both for motors and electric lighting. It is installed at a point on the shop grounds about 200ft. north of the main group of buildings, and from here electric current and steam are delivered to the various buildings through conductors and pipes located in a covered trench. The boiler equipment consists of two 150-h.p. Heine water-tube boilers, which are equipped with "Tread-kill" rocking grates and with improved Argand blowers. The feed-water pumps deliver through a 500-h.p. Cochrane feed-water heater, and thence to the boilers. The connections provided in the feed-water system are very flexibly arranged. There are three pumps, one of which may be used as a fire-pump. They are located conveniently for access in the open space in the boiler-room between the boilers and the engine-room partition. The feed-water heater is located to the left of the pumps. The generating equipment consists of three direct-connected units. Two of the engines are tandem compound of 125 h.p. each, the other is a 60-h.p. Woodbury engine. An automatic oiling system is provided, and the engine cylinders are provided with shifting valves and are drilled and tapped for indicator connections. The engines are operated non-condensing, and are provided with the usual centrifugal flywheel governor. The generators are all of C. & C. make, two being of 75 kw. capacity and the other of 30 kw. capacity. They are compound-wound machines,

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and generate an E.M.F. of 125 volts. A gauge board is provided on the wall of the engine-room, containing two high-pressure steam-gauges, a low-pressure steam-gauge, a recording steam-gauge, and a clock. The switchboard is 19ft. long and stands 8½ft. high, the panels being of a uniform height of 7½ft. and surmounted with an ornamental copper grill. The arrangement of the panels from left to right is as follows: one 5ft. distributing panel, three 3ft. generator panels, and one 5ft. storage battery panel. The distribution panel has 12 pilot lamps in a double row across the top, four 50-ampere circuit breakers, three 400-ampere circuit breakers, one 150-ampere circuit breaker, four 800-ampere circuit breakers, and one 1,000-ampere double-pole switch for connecting the street service should this become necessary. In the centre of the panel there is a voltmeter of the double-reading type, serving also as a ground detector. It is controlled by a push-button switch. The three generator panels are all equipped alike. Each panel has a pilot lamp, Empire voltmeter and ammeter, Thomson integrating wattmeter, field rheostat, plug for parallel connection, one 750-ampere double-pole switch, one 750-ampere single-pole switch, and one 750-ampere circuit breaker. The storage battery panel has three pilot lamps, Empire voltmeter and double-reading ammeter, one 150-ampere battery circuit breaker, one 30-ampere circuit breaker for the booster motor, one Bristol recording voltmeter with a 25-ampere double-throw switch, one 25-ampere circuit breaker, one 200-ampere double-pole main switch for battery charge and discharge, one 100-ampere motor switch, and a 10-point end-cell switch. A swinging differential voltmeter is mounted on a bracket on the left end of the board, and is used for coupling the generators in parallel. All of the instruments excepting the recording meters are set in the back of the board, and have dials illuminated by incandescent lamps from the rear. The general electrical distribution is on the two-wire system at 125 volts. All of the motors, and also the lamps, both arc and incandescent, are supplied with current from the same 'bus bars in the power plant. The distances from the switchboard to the various points of current consumption are not great, so that even with the maximum distance the E.M.F. generated is sufficiently economical. Only a few arc lamps are used, and these are of the enclosed type. The greater part of the illumination is by incandescent lamps. The type-casting machines are equipped with Stow multi-speed motors, built by the Stow Manufacturing Company, of Binghampton, N.Y. The motors are back geared, and the speed is varied through a wide range by the rheostat and the method used in the Stow motors of changing the magnetic reluctance of the field. The plant is reported to have given entire satisfaction.

Transposition of Electrical Conductors.—At a recent meeting of the American Institute of Electrical Engineers Mr. F. F. Fowle presented a paper on this subject, of which an abstract appears in the *Electrical Review* of New York. The author commenced by distinguishing between alternating-current systems for the transmission of power and intelligence respectively. Whereas the former are characterised by high power, large currents, low or moderate frequencies, and only one fundamental frequency, telephone systems are characterised by low pressure, small currents, and high frequencies, available over a large range. He then considered the electric and magnetic fields set up surrounding conductors, showing that where there are not more than three circuits, each consisting of a pair of wires, it is possible to place them so that there will be no mutual interference; but when the number exceeds three, it becomes practically impossible to prevent this. Discussing the transposition of conductors as a means of eliminating these disturbances, the author enumerated the further conditions necessary to dispose of the disturbances. The current in the disturbing circuit must be constant in magnitude and in phase throughout the distance *l*, as illustrated in Fig. 1, and the pressure must likewise be constant in magnitude and in phase. That is, 1 must be so short a portion of the wave-length in the disturbing circuit that these conditions are sensibly fulfilled. At low frequencies the wave-length is not the primary consideration, but rather the drop in line pressure and the decrease of the line current, due respectively to wire impedance and to the leakage and the static charge. The induced currents due to electric induction

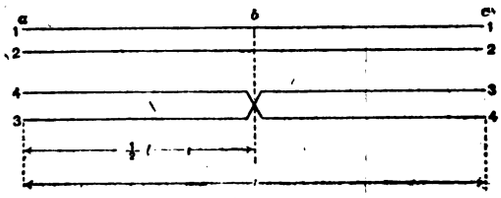

FIG. 1.

cannot, unlike those due to magnetic induction, be made to vanish entirely. The treatment of induction between telephone circuits has been by empirical rule rather than theory It has been determined by experiment with receivers of a given sensitiveness and transmitters of a given power, how frequently two adjacent circuits should be transposed in order to eliminate the cross-talk. Using two-mile sections, transposed at the centre, the cross-talk is distinguishable with transmission sufficiently powerful for 1,000-mile service. Half or quarter-mile sections, transposed at the centre, are satisfactory; this results in a minimum transposition spacing of one-quarter mile. The existence of cable at each end of the line in any considerable length will reduce the cross-talk. It is necessary to devise different types of transposed circuits, no two transposed alike, in order to treat the cases occurring in practice.

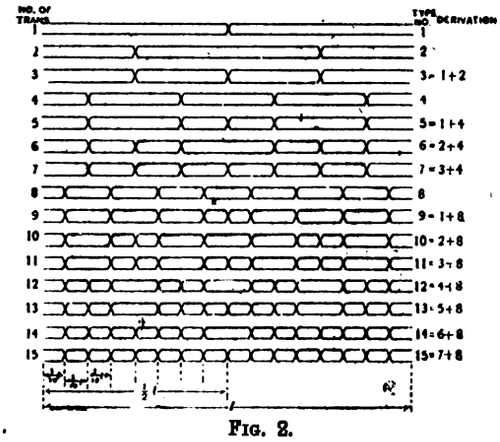

FIG. 2.

The manner of doing this is shown in Fig. 2. The "exposure" of circuit 1 to circuit 2 is one-fourth; of 1 to 3 is one-fourth; of 2 to 3 is one-half; because a transposition at the junction of two sections, each transposed at its centre, has almost no beneficial effect. The exposure of 1 to 5 is one-eighth; of 2 to 6 and 3 to 7, one-eighth; of 2 to 8 and 2 to 9, one-sixteenth; and so on. The derivation of the types is simple; the first three are obvious. The fourth is obtained by doubling the number of divisions of the transposition section from two to four, etc. The choice of a convenient length for *l* is an important matter. An eight-mile section has been extensively used, but is probably too cumbersome. A much more convenient section would be one four miles in length. If there are only a few circuits, a two-mile section may be used.

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NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(Continued from page 625.)

The necessary operations for the successful working of a reversible motor can be attained either by mechanical or electrical means. A simple form of the mechanical method is shown in Fig. 8. This illustrates a starting switch made by Messrs. Royce, Limited. It will be seen from the figure that the pulley is mounted on a shaft to which is affixed a weight. This is so balanced that the slightest movement

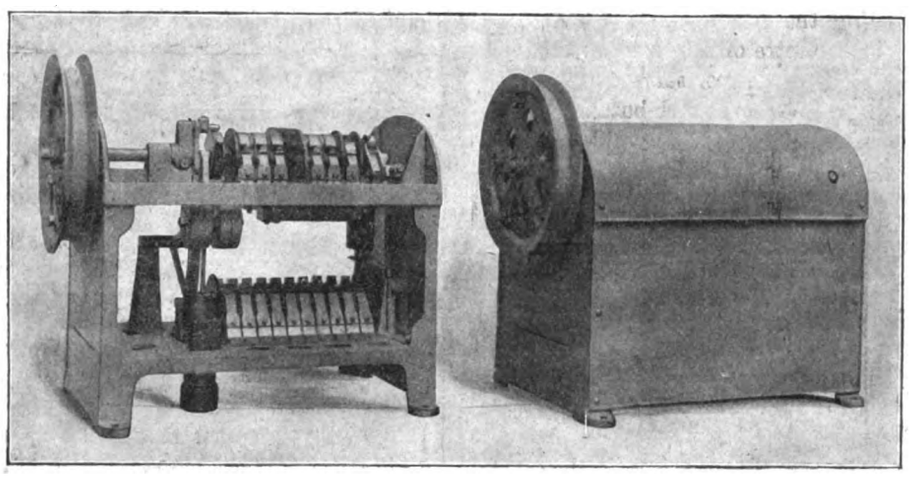

FIG. 8.

in either direction will cause the weight to fall over on one side of the shaft. This causes the shaft to revolve, the speed being regulated by teeth gearing, and as the shaft revolves the resistance is cut out of the armature circuit. The speed of the motor can be further controlled by pulling the rope to a greater extent and so inserting resistance in the shunt circuit.

The Sturtevant Company, Limited, make an elaborate type of electrically-controlled switch, which is shown in Figs. 9 and 10. The rheostat contacts are mounted on one side and the reversing switch on the other. This switch is

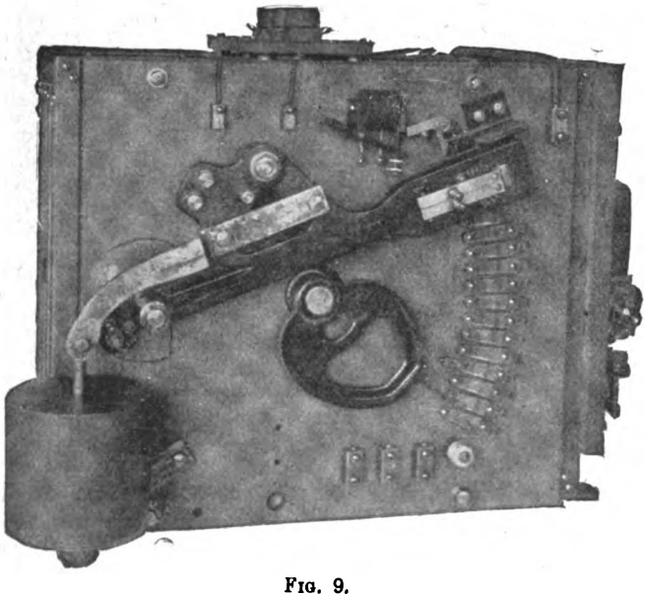

FIG. 9.

designed on the same lines as the self-starting switches. A grooved pulley is mounted on the extended shaft, and the operating rope, which passes through the cage, is passed round and secured to this pulley, so that if the rope is pulled down the reversing switch is turned in the direction necessary to drive the cage downwards, and if pulled upwards, the reversing switch will be turned in the direction to propel the car upwards also.

The function of the reversing switch is to set the direction of the rotation of the motor, and also to open and close the main solenoid switch circuit. This circuit never carries more than about half an ampere, and as it never directly makes or breaks the motor circuit, the sparking is reduced to a minimum. When the reversing switch is brought into the "off" position, it turns the cam, which is mounted on the opposite end of the same shaft in such a direction as to force the rheostat contact lever into its highest position, with the result that all the resistance is inserted into the motor circuit, and in which position it is held by a small detent. When the reversing switch is brought into the "on" position in either direction, the cam on the rheostat front is moved into a position in which the contact lever is free to fall to the lowest position if released by the detent. The solenoid circuit of the main switch is at the same time excited, with the result that it attracts its plunger and closes the main circuit, thereby supplying current to the motor armature through all the rheostat resistance. This main current passes through a small electromagnet on the upper part of the rheostat front, and trips the detent which was holding the contact lever up, consequently the contact lever falls by gravity at the speed to which the dashpot has been

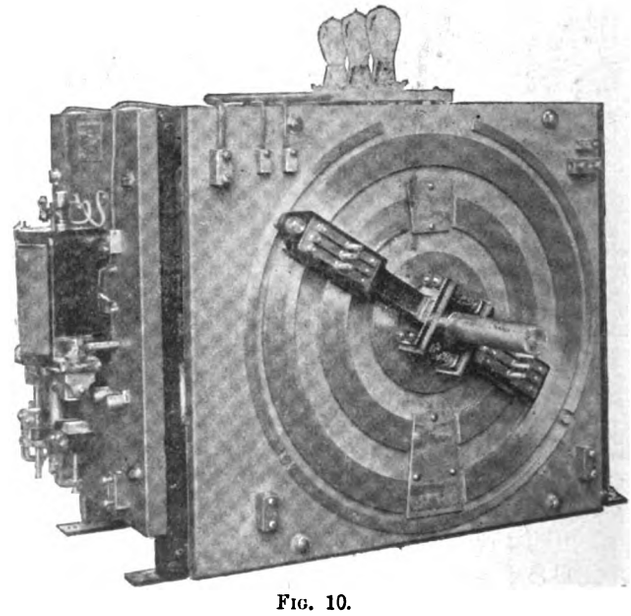

FIG. 10.

previously adjusted, and so slowly cuts out the rheostat resistance, and brings the motor up gradually and easily to its proper speed.

One main point is that the motor circuit is always made and broken by the solenoid controlled main switch, which is equipped with large carbon contacts for making and breaking the circuit, and also with blow-out magnets for preventing arcing. The solenoid main switch and the rheostat contact lever are electrically interlinked in such a manner that the solenoid main switch will not close except when all the rheostat resistance is in series with motor armature. This

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means that in sudden reversal it is impossible under any circumstance to reverse the current through the armature until the motor is at rest. It will be noted that lamps or other high resistance are inserted to absorb the self-induced current of the shunt when this circuit is broken, while in addition, after the solenoid has performed its lifting effort, its current consumption is reduced to a negligible amount by the automatic insertion of a high resistance in series with its exciting coil.

An extension of this arrangement is also supplied, if necessary, in this case. No ropes are employed, but a car switch (illustrated in Fig. 11) is placed in the cage, and the whole apparatus is operated by means of this switch, which opens all the circuits when the handle is in its central position, and causes the cage to either ascend or descend as the handle is moved to the right or the left. This car switch does not handle the main current required for the motor, but the whole apparatus depending for its successful working on the closing and opening of various solenoid switches, all the car switch has to handle is the small currents required for energising these solenoids.

The movement of the car switch from its central position first excites two out of four solenoids, causing them to close their switches, and so determines the direction of rotation of the motor. After this has been so determined, the solenoid main switch closes and supplies current to the motor through all the rheostat resistances, while at the same moment the brake solenoid is excited, causing it to release the magnetic brake. An additional solenoid, known as the accelerating solenoid, is then energised and pulls up the contact lever at the speed to which the dash-pot has been adjusted previously, thereby slowly bringing the motor up to its normal speed by gradually cutting out the resistance. Should the attendant forget to stop the cage at the extreme limits of the travel the circuit will be automatically opened by the limit switch, and the cage brought to a standstill in precisely the same way as when it is stopped by the attendant. The same arrangements are adopted of interlinking the main switch and the rheostat contact lever as in the former case, so that there is no danger of the motor being reversed too suddenly, and the same precautions are taken of automatically inserting a high resistance in the solenoid circuit, and also to absorb the self-induced current of the shunt when this circuit is broken.

(To be continued.)

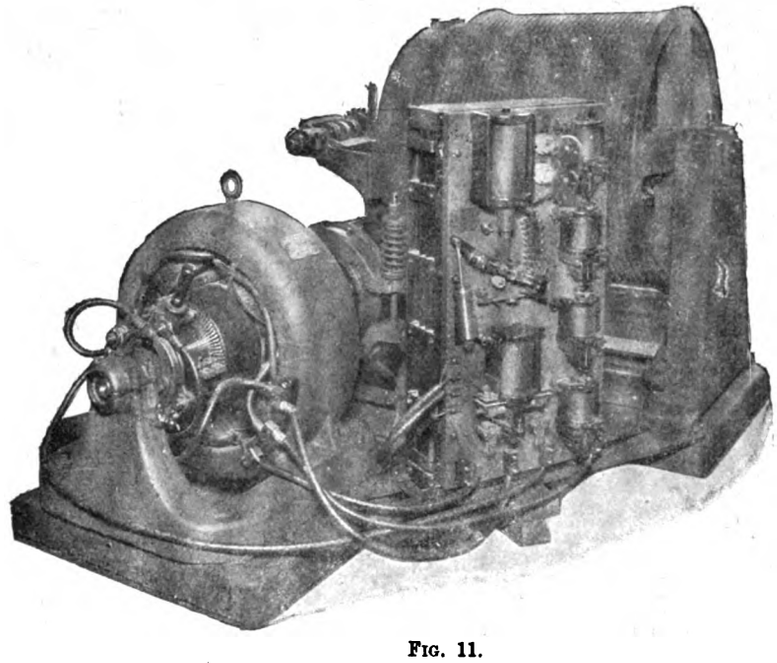

FIG. 11.

TEST ON 500-KW. CURTIS TURBINE SET AT CORK.

In view of the great interest taken by engineers in the performance of steam-turbines, we think that the publication of a series of tests carried out on a 500-kw. continuous-current Curtis steam-turbine set at the Cork Electric Tramway and Lighting Company's station, and which was supplied by the British Thomson-Houston Company, Limited, of Rugby, may be of interest.

These tests were conducted by Mr. Charles H. Merz, the consulting engineer to the company, by whose courtesy we are enabled to publish the results obtained. The object of the tests was to ascertain the steam consumption at varying loads, and for this purpose five tests were made—at quarter load, half load, three-quarter load, full load, and 25 per cent. overload respectively. The tests were generally of 1½ hours' duration, although the last test, at 25 per cent. overload, was slightly under one hour. Great care was taken in each case that before the test was commenced all conditions of load, etc., should be absolutely steady.

The weight of condensed steam was measured by a tank and weighbridge, which was tested before and after the test and found to be accurate. Vacuum gauges were connected to the low-pressure chamber of the turbine and to the body of the condenser. These gauges were in agreement. Under conditions of full load, however, the vacuum registered in the turbine exhaust chamber was 2in. lower than that registered in the condenser, showing that the pipe connection from the turbine to the condenser was not sufficiently large. The barometric pressure throughout the test was 30·16in.

The output of the machine was measured by two ammeters, a standard voltmeter, and a recording watt-

LOG-SHEET.—TEST OF 500-KW. CURTIS TURBINE.

Particulars of test. Load.	Duration.	Average load during test in kw. Standard.	Switchboard.	Average units.	Total water, lb.	Water per kw.-hour, lb.	Vacuum, in.	Steam pressure, lb.	Superheat, deg. F.	Speed, revolutions per minute.
¼	1½ hours.	128·5	123·25	196	4,879	24·9	28·8	155	51	1,835
½	1½ ,,	252	248·12	375	8,400	22·64	28·6	155	50	1,820
¾	1½ ,,	393·7	393·9	590·65	12,377	20·95	27·8	153	70	1,822
Full.	1½ ,,	512	511·4	764	15,755	20·6	26·9	153	104	1,820
1¼	54 minutes.	615·8	611·3	552	11,530	21	26·2	151	124	1,800

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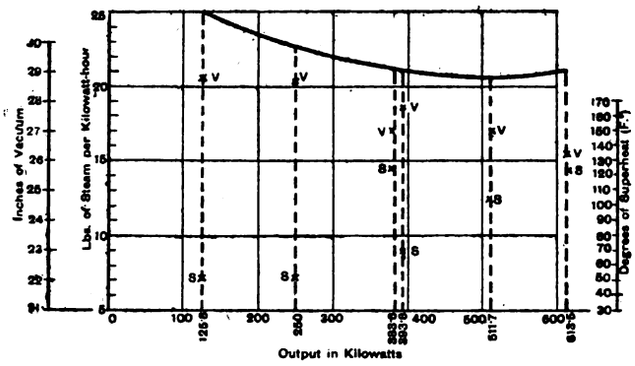
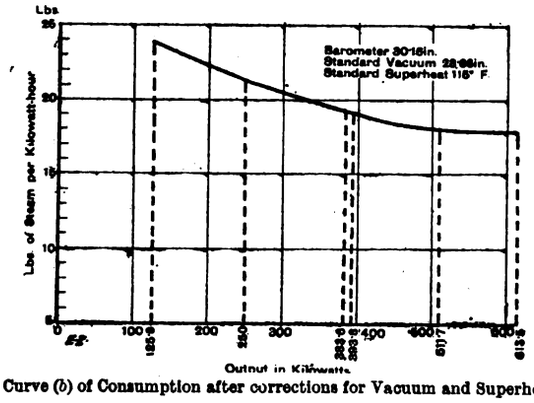
meter. The figures entered on the log-sheet attached are the mean figures of all readings at each load, readings being taken every six minutes. The readings given are the corrected mean readings after each instrument had been carefully recalibrated against a standard in the Newcastle-upon-Tyne Electric Supply Company's test-house.

The tests were started by taking a reading of the wattmeter and by commencing to fill the water-tank, and three minutes after the start ammeter and wattmeter readings were taken. Six minutes after the first wattmeter reading



Curve (*a*) of actual Consumption of Steam with 500-kw. Curtis Turbines. Barometer 30·16in.

a second wattmeter reading was taken, and the condensed steam was weighed. Six minutes after the first ammeter and voltmeter readings second readings of *these* instruments were taken, and so on. Hence all readings were taken every six minutes, the ammeter and voltmeter readings midway between the wattmeter and condensed steam records.



Curve (*b*) of Consumption after corrections for Vacuum and Superheat.

A general summary of the results of the tests is given by the log-sheet attached. Steam consumption curves are also attached: (*a*) curve actually obtained; (*b*) curve made out with correction to 26·66 vacuum and 115deg. superheat.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY ALEXANDER SIEMENS, PRESIDENT.

(Concluded from page 707.)

However important capital and labour are to an industry, the third factor, "management," is none the less essential for its satisfactory progress. Under this term everything is included which appertains to: (*a*) the selection of site for works, their planning and their equipment; (*b*) the commercial work connected with the business; (*c*) the arrangements for carrying on operations; (*d*) the designing of new apparatus and the investigation of new methods of manufacture. It is easy to understand that in every one of these directions good management can do much to lower the cost of production, but this is hardly the time to discuss all these points in detail. Only on the last I venture to make a few remarks, as the proper design is a matter in which the members of this Institution are interested, more particularly those who have only recently graduated from a college. A good design should have for its aim the lowering of the cost by employing simple component parts which can either easily be obtained or cheaply manufactured. The first requirement is fulfilled by utilising standard sizes, and in this respect the work of the Engineering Standards Committee is of the greatest possible importance to the industries of this country. In addition to these "public standards," much can be done to facilitate work by adhering to standard parts in each factory, so that it is not necessary to carry an immense variety of parts in stock.

A number of graduates do not realise that the object of their working practically in the various shops, in addition to studying at a college, is to teach them by their experience what the difficulties of the various operations really consist of. It is not so important that they learn to overcome these difficulties as easily and as quickly as a skilled workman, but that they acquire the habit of thinking how to avoid these difficulties when they are designing new work, and how to take advantage of the material at their disposal. In other words, a designer should have an intimate acquaintance with the scientific principles that come into play and with the ways in which they are applied, and he should know, if possible from personal experience, the capabilities and the limitations of the workman and of the machinery by which the operations are carried out. It is, however, by no means sufficient for preparing suitable designs to be well acquainted with the means employed to execute them; it is just as important to form an accurate conception of the problem that has to be solved, and to possess a thorough knowledge of previous attempts in the same direction, and of the causes of their success or failure.

Another branch of knowledge required for the good management of factories is a careful training in the way of conducting experimental investigations, coupled with the good judgment as to which investigations are worth taking up. No doubt the list of qualities that ought to be found in a good manager could be extended still further, but enough has been said about all the three principal factors to show the great number of different points which have to be considered in connection with the internal working of modern industries. Besides these internal factors, there are all the external circumstances which influence the well-being of the industries, and it is easy to see, even without entering at length into further details, that no true picture of the state of an industry can be arrived at if only a few features of their complicated constitution are to be taken into consideration.

These remarks about industries in general apply naturally to the young electrical industry quite as much as to the oldest-established one; there are, however, some features of its development which have greatly contributed to its rapid rise, and could, perhaps, be imitated in other industries to their great advantage. At first the long time during which weak battery currents alone were employed, chiefly for telegraphic purposes, permitted the completion of important scientific investigations, which in the end led to the discovery of those fundamental laws which form the basis of all practical applications of electricity. Nor has science deserted the industry when it began to deal with powerful currents. I will only remind you of Dr. John Hopkinson's mathematical demonstration in this room, that alternate-current machines can be worked in parallel. This example is particularly interesting, as in this case science has pointed out to the engineer how he could solve one of his problems. Usually the function of science has been to prevent its followers from being deceived by appearances or by plausible fallacies. By such negative indications alone science can give definite answers, while its deductions of a positive character cannot be accepted without further proof, owing to the uncertainty whether all premises necessary for the correct solution of the problem have been taken into consideration. For this reason deductions arrived at theoretically should be tested by practical applications before further conclusions are based upon them. Here again the electrical industry has had the great advantage of possessing from its very beginning most sensitive instruments, which, in addition, are easily handled, so that the verification of theories has been a comparatively easy matter, and it has been possible to control by accurate

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measurements all operations not only in the laboratory, but also in the workshop.

One feature of electrical measurements has contributed more than anything else to the rapid rise of the industry, and that is the adoption of the same units of measurement in all countries. The idea of such a system originated with Prof. Wilhelm Weber, of Göttingen, about 70 years ago, but the British Association for the Advancement of Science has the honour of having taken the first step to realise the proposal of Weber by appointing a committee to suggest practical electrical units. This committee, after due deliberation, chose as the basis of their system the centimetre, the gramme, and the second, and I should like to know why they chose the metrical units, unless they had convinced themselves that these were the best for the purpose. At that time (1861) there was no question of international units, nor had the metrical system been adopted as universally as it is now; all the more weight ought, therefore, to be attached to the decision of this committee, which consisted of eminent scientific men and prominent engineers, so that both the theoretical and the practical aspects of the question were kept in view during their deliberations. Certainly there is no doubt about the beneficial effect of the adoption of this system by all countries, and I have no recollection of ever hearing that the decimal division adopted in it has given rise to any difficulties. It is true some modifications have become necessary, which were discussed and accepted at a series of international congresses called for the purpose, but so far as I am aware nobody has ever suggested that it would be to the advantage of any country to start a system of electrical units of its own. In spite of this favourable experience, we all know that there exists still an obstinate resistance against the general introduction of the metrical system into this country, although it has been shown over and over again that the reasons advanced for this obstruction are based on fallacies, and are opposed to the experience of other countries. Such an attitude is very largely due to want of practice with a thoroughly consistent system of weights and measures.

In this connection it is significant that all engineers who have had to deal for any length of time with metrical measurements unhesitatingly prefer them to the English want-of-system. I am, of course, aware that some prominent engineers profess to have tried to work with metrical units, and have been unable to work as quickly and easily with them as they could with their accustomed units. About them one is tempted to say that their conclusion in this particular matter is about as reliable as that of a man who tries to skate, and, after his first attempt, gives it as his opinion that you cannot move faster by skating than by walking. Another big outcry is raised against the metrical system on account of the great disturbance of all business transactions that would result from the change of weights and measures, and appalling figures are marshalled as to the expense of giving effect to it. It does not appear that other countries have been ruined by discarding obsolete weights and measures, nor should the expert opinion of the inspectors of weights and measures be ignored, who unanimously consider the introduction of the metrical system to be a pressing need to put an end to the existing confusion, and advocate, in addition, that such an introduction should be made compulsory.

The very same thing has been recommended by two or three parliamentary committees after hearing innumerable witnesses for and against the change. Why should such well-considered opinions be calmly ignored, and why should the bogie of expense be trotted out before the public when the real sentiments of the opponents about the disturbance of trade, caused by a change of weights and measures, are disclosed by the fact that they themselves advocate a revised British system, based on the inch, the introduction of which would have the same disturbing influence as that of the metrical system, but would lack the advantage of making the international metrical system the universal one? For it cannot be doubted that the example of Great Britain would immediately be followed by the British Colonies and by the United States, so that the whole community in all civilised countries would enjoy the same advantages as the electrical engineers already possess. Against this argument the opponents of the metrical system usually point out that even in France some instances can be found where the old measures are used in preference to the metrical ones, but on examination it turns out that only the old names are preserved in some districts and in some trades, but that in reality the measures in use are based upon metrical units.

The few exceptions are only proving the rule; and it would be as wrong to say that the metrical system is not universally used in France or Germany, as it would be to contend that English is not the language of the United Kingdom, because you can find people in some remote parts who do not know that language.

As a last resort the expense of changing the screw-threads is urged against the change to the metrical system, and the Continental practice of calling the system "Whitworth thread" is considered an incontrovertible proof that the metrical screw-thread is impracticable. If all taps and dies and leading screws had to be exchanged at once, it would certainly be a costly affair, but such a measure is not likely to be adopted, as no advantage could result from it. For the real difficulty with screw-threads is that giving dimensions on paper is not sufficient to ensure that the screws, manufactured according to such instructions in different works, are really interchangeable. This subject has been investigated by a committee of the War Office, and their conclusions throw a very interesting light on the controversy. In their opinion it is only possible to obtain interchangeable screws if the leading screws by which they are made have all been cut on the same screw-cutting lathe, or are at least cut on benches which are fitted with a leading screw manufactured on the original bench. If another link is interposed, differences in the screw turned out become perceptible. As a consequence of the finding of this committee a screw-cutting lathe has been set up at the National Physical Laboratory, where leading screws for screw-cutting lathes are to be manufactured. The same experience has been made in other countries where nominally "Whitworth's threads" are used. It is not possible to make screws interchangeable by prescribing their dimensions; the only way is to obtain taps and dies or leading spindles cut by the same tools. If it is not a case of extreme accuracy, there is no difficulty in cutting English threads by means of a metrical leading screw or *vice versâ*. By using a wheel with 127 teeth on the driving axle an accuracy of 1 : 6350 can be obtained, which is sufficient for ordinary purposes. In any case it is much to be regretted that such a useless encumbrance of our daily life, and such an obstacle to foreign trade, as the English system of weights and measures has not yet been abolished.

Among other external factors which influence the technical side of industries are the patent laws of the various countries—a subject on which the most divergent opinions have been pronounced. It would lead me too far if I attempted to discuss all the features connected with the patenting of inventions, but I should like to draw your attention to the fallacy of considering a preliminary examination, as practised in the United States, for instance, to be of any advantage to an inventor. That system of examination involves as much trouble and expense as a lawsuit, but it is no bar to a lawsuit being commenced later on, and then the same case has to be argued over again. A favourable result of such an examination is, therefore, in no way a guarantee of the validity of the patent—on the other hand, I willingly admit that anticipations may be detected by this search. It is, however, the business of an inventor to find out for himself what has been done before, and to make himself thoroughly acquainted with his subject before he begins to suggest improvements. In this work he should be assisted by the staff of the Patent Office, where a reference library for technical subjects should be at his disposal, containing not only patents, industrial designs, or models and trade marks, as prescribed by Article XII. of the International Convention for the Protection of Industrial Property, but also files of the principal technical and scientific periodicals and transactions. Searching such records will prove to be a liberal education, and will in the end be of greater advantage to the inventor than having this work done for him by the members of the staff, who cannot be as

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well qualified to make the search as the inventor himself, as their acquaintance with the essential features of a new device is necessarily inferior to his.

Other branches of legislation besides the patent laws affect industries directly or indirectly, either by prescribing measures for safeguarding health and life, or by laying down rules for the building of factories, or by dealing with the liability of employers in case of accidents. With all these I do not propose to deal in further detail, as I hope that by merely outlining the influences under which industrial work is carried on, I have made it clear that they are very numerous and of the most varied character. It is, therefore, extremely difficult to foresee what consequences a serious alteration of some of the existing conditions will entail, while it would be quite wrong to draw conclusions about them from a comparison of the industrial state of a country at the present time with its position before railways, telegraphs, and other modern contrivances revolutionised the intercourse between nations. By their aid manufacturers in any country are now in a position to make themselves quickly acquainted with the latest improvements affecting their business that may have been discovered anywhere, and they can also ascertain without much delay and with very little trouble what the requirements are of the remotest communities. In this respect manufacturers of all countries are now competing on an equal footing, where formerly those of one country may have had great advantages over the others.

Another cause of change has been the desire of many countries to create their own industries instead of depending on foreign supplies, and it is not very wonderful that the British industries have new rivals where 60 years ago they had absolute command of the markets. If complaints are now raised that this foreign competition is ever increasing, and proposals are made to protect British industries against it, two points require particular attention. One is that it is hopeless to endeavour to re-establish the former monopoly, and the second that it might be useful to investigate whether the former industrial supremacy has not led to neglect in many respects, for which we now have to suffer. Whatever remedies may be proposed to enable British industries to hold their own in the general competition, there is in my opinion only one safe test for selecting the right ones, and that is that their adoption should lower the cost of production for the benefit of the whole community.

A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITIES OF GAS-TURBINES.*

BY R. M. NEILSON, ASSOCIATE MEMBER

(*Concluded from page 674.*)

It will be seen that it has been assumed that the gas and steam expand adiabatically separate from each other. The adiabatic curve of the one is different from that of the other, as the specific heats are different; and while the gas falls to a temperature of 140deg. C. (413deg. absolute C.), the steam falls only to 184deg. C. (457deg. absolute C.). This will be correct if the steam and gas are not mixed. It is much simpler to consider this case than to consider the case where the gases are intimately mixed. In this latter case the diagram Fig. 16 would be altered, and it could not so easily be seen where the loss of efficiency came in. In practice, however, it will probably be found convenient to mix the gases. This will alter the diagrams and the efficiency somewhat; but what has been considered gives a good idea of the general effect of the employment of steam in conjunction with gas. If the steam and gas are not mixed, a condenser could be employed for the former. The steam could then be expanded to a much lower temperature and pressure, and the efficiency would be considerably raised.

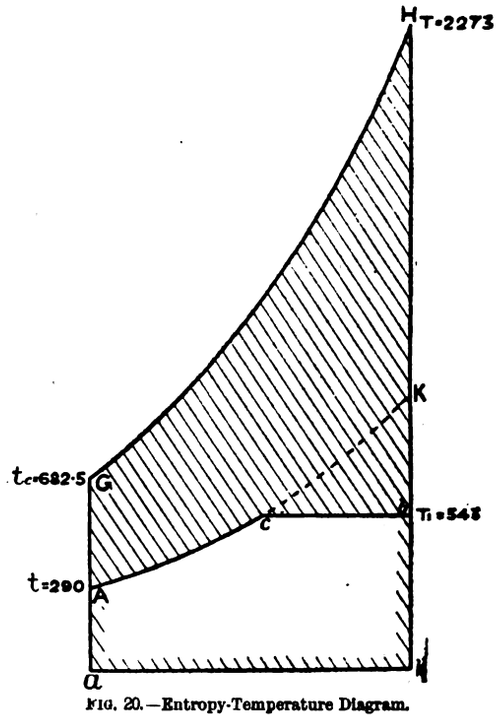

FIG. 20.—Entropy-Temperature Diagram.

Cycle II. could be modified in the same way as Cycle I. was modified by combining steam with the gas. A case of this nature has not been worked out, but Case 1 of Cycle II. could probably be modified in this way. Case 2 of Cycle II. could not be so treated on account of the high ratio of negative work to gross work that would occur.

One might try to improve on all these cycles by extending the adiabatic expansion line of the gas below atmosphere, instead of stopping it at atmospheric pressure. It would, of course, be necessary to compress the fluid back again to atmospheric pressure; but if this compression is isothermal, or between the isothermal and adiabatic, there will be an increase in efficiency. Carnot's cycle is, in fact, being approached in the lower part of the diagram.

Figs. 19 and 20 are respectively pressure-volume and entropy-temperature diagrams of Cycle I., Case 3, modified

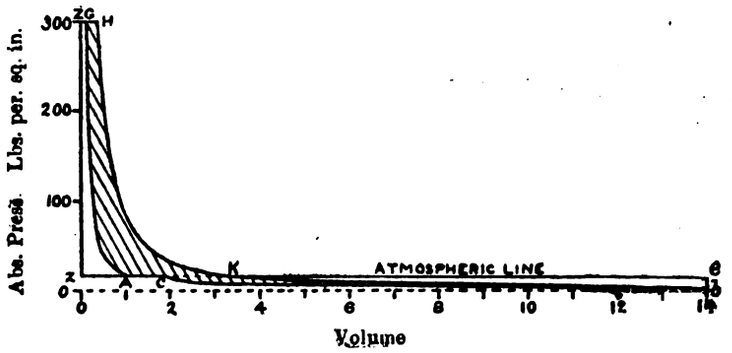

FIG. 19.—Pressure-Volume Diagram.

by continuing the adiabatic expansion to a pressure of 2lb. per square inch absolute. The scale for volumes in Fig. 19 has for convenience been made half of that of the other diagrams. K *b* represents the addition to the adiabatic line of expansion, and *b c* represents isothermal compression of the gas from 2lb. absolute at *b* to 15lb. absolute at *c*. There should be no difficulty in a turbine in extending the expansion from K to *b*. There may be difficulty, however,

* Paper read before the Institution of Mechanical Engineers.

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in getting isothermal compression from b to atmospheric pressure at c. As the volume at b is 14 times the initial volume, it will be desirable to get the fluid discharged as quickly as possible. A rotary compressor will probably be best for this purpose. A compression sufficiently near to the isothermal and sufficiently remote from the adiabatic to appreciably raise the efficiency should be obtainable. The temperature at b is 270deg. C. (543deg. absolute C), and if the compression is isothermal, this will, of course, be the temperature all along the line $b\,c$. The gases could be passed through or around water-cooled tubes to keep down the temperature during compression. With the gas at a temperature of 543deg. absolute C. it would not do to spray water into it, unless sufficient water were sprayed to cool the gas below the boiling point of the water, which is 326deg. absolute C. at this pressure. If compression takes place along the isothermal line $b\,c$, a net amount of work will be gained, represented by the area K $b\,c$. The gas will be discharged into the atmosphere at c, the volume at discharge being 1·874 of the original volume (at A) Even if the compression is not isothermal, an amount of work may be gained which will wipe out the extra losses in the machine, provide for pumping out the cooling water, and may leave a margin of net gain.

In Fig. 20 the heat absorbed by the fluid is represented by the area a G H k, the heat rejected by the area a A c b k, and the heat converted into work by the area A G H $b\,c$. As the heat absorbed remains unchanged, while the heat converted into work is increased by the area K $b\,c$, E, is, of course, increased.

$$E = \frac{\text{area A G H } b\,c}{\text{area A G H } k}.$$

This enlarging of the diagram, of course, affects the ratio of negative work to gross work. Referring to Fig. 19,

$$\text{gross work} = \text{area } z\,\text{Z H K } e\,b\,c$$
$$\text{negative work} = \text{area } z\,\text{Z G A} + \text{area K } e\,b$$
$$\text{net work} = \text{area A G H } b\,c$$
$$\frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area Z G A} + \text{area K } e\,b}{\text{area } z\,\text{Z H K } e\,b\,c}.$$

In the free-piston explosion engines, at one time in fairly common use, of which the best known is the Otto and Langen, the expansion was carried to a pressure considerably below the atmosphere. The compression to atmospheric pressure which followed this must have been between the isothermal and the adiabatic.

If this continuation of the adiabatic expansion below atmospheric pressure is not found to be advisable to the extent that has just been described, it may be found advisable to a less extent. If it is found advisable in any case, it is more likely to be so in a case in which the high pressure of the gases after combustion is reduced to a low pressure in divergent nozzles before the gas is allowed into the turbine casing, than in a case in which the whole fall of pressure takes place in the turbine casing. In the former case very high vane speeds are necessary, and the friction between the rotating parts and the fluid in the casing is an extremely important matter. The reduction of the pressure within the turbine casing from atmospheric pressure (or above that) to one-quarter or one-eighth of that amount may, therefore, very much reduce the frictional losses. It is true that the rotary pump, if such is employed for completing the cycle, has to deliver at atmospheric pressure, but the rotating parts of the pump can revolve at a much lower speed, and the friction therefore be of much less consequence.

With such high-speed turbines there is another question to be considered. It has been stated in discussing Cases 3A and 4A of Cycle I. and 1A and 2A of Cycle II. that the velocity of the gases escaping from the divergent nozzles would be over 4,000ft. per second if the heat energy converted into kinetic energy was as mentioned. The author is not, however, aware of any results of experiments having been published in which velocities of these amounts were obtained when the pressure of the medium into which the divergent nozzle discharged was atmospheric. It is supposed by some that there is a maximum limit to the velocity of a gas leaving a divergent nozzle and escaping into a given medium which is at a given pressure, etc., and that this limiting velocity is dependent on the pressure in the medium into which the nozzle discharges, and is less when the pressure in this medium is greater, and *vice versâ*—that is to say, it is supposed by some that, after a certain velocity of discharge has been attained, no increase in the initial temperature or pressure will increase this velocity; but a reduction of the pressure in the medium may increase this velocity. The author does not express any opinion himself on this point, but if it should be found that the reduction of the pressure inside a turbine casing below atmospheric pressure enables us to convert the heat energy of our gas into kinetic energy more effectively, this will be a further argument in favour of so reducing the pressure. Whether or not there is an advantage to be gained remains to be proved, but there is at any rate a possibility of gain by thus extending the expansion, and a possibility which, in the author's opinion, should not be ignored. In dealing with large volumes and small pressures there is, as already mentioned, an immense difference between turbines and reciprocating engines.

Cycle IV.

The fourth cycle which will be considered in this paper is one in which a high ideal efficiency can be obtained with a low compression, and without having an abnormally high ratio of negative work to gross work. Figs. 21 and 22 are respectively pressure-volume and entropy-temperature diagrams for an engine working on this cycle. In explaining the cycle it is best to start at E^1. At this point the temperature of the fluid is 1,592deg. C. (1,865deg. absolute C.), and the pressure is 30lb. absolute.

Let the fluid be heated by combustion at constant pressure along the line $E^1\,C^1$ till the temperature reaches 2,000deg. C. (2,273deg. absolute C.). Now let the gas expand adiabatically from C^1 to D^1 till the pressure is atmospheric. The temperature will then be 1,592deg. C. (1,865deg. absolute C.). Now let the gas pass through a regenerating chamber and be cooled at a constant pressure from D^1 to F^1 till the temperature is 80deg. C. (353deg. absolute C.). The gas escapes at F. into atmosphere, and thereafter cools at constant pressure to 17deg. C. (290deg. absolute C.) at A. A new charge is taken at A and compressed adiabatically to B^1, where the pressure is 30lb. absolute and the temperature 80deg. C. (353deg. absolute C.). The fluid is now passed through the regenerating chamber, and is heated at constant pressure along the line $B^1\,E^1$, taking back the heat given up by the last charge. This will raise its temperature to 1,592deg. C. (1,865deg. absolute C.) and place the fluid in the condition it was at the start.

Referring to Fig. 21, the gross work is represented by the area g^1 G^1 C^1 D^1, the negative work by the area g^1 G^1 B^1 A, and the net work by the area A B^1 C^1 D^1.

$$\therefore \frac{\text{negative work}}{\text{gross work}} = \frac{\text{area } g^1\,\text{G}^1\,\text{B}^1\,\text{A}}{\text{area } g^1\,\text{G}^1\,\text{C}^1\,\text{D}^1} = 0{\cdot}16\ (0{\cdot}1553).$$

The heat absorbed by the fluid (other than that obtained in the regenerator which was given up by a previous charge) is represented in Fig. 22 by the area e E^1 C^1 d. The heat rejected (other than that given to the regenerator) is represented by the area a A F^1 f. The heat converted into work is represented by the difference of these two areas.

Now, area A B^1 C^1 D^1

$$= \text{area } a\,\text{B}^1\,\text{C}^1\,d - \text{area } f\,\text{F}^1\,\text{D}^1\,d - \text{area } a\,\text{A F}^1\,f$$
$$= \text{area } a\,\text{B}^1\,\text{C}^1\,d - \text{area } a\,\text{B}^1\,\text{E}^1\,e - \text{area } a\,\text{A F}^1\,f$$
$$= \text{area } e\,\text{E}^1\,\text{C}^1\,d - \text{area } a\,\text{A F}^1\,f.$$

$\therefore$ area A B^1 C^1 D^1 represents the heat converted into work.

$$\therefore E = \frac{\text{area A B}^1\,\text{C}^1\,\text{D}^1}{\text{area } e\,\text{E}^1\,\text{C}^1\,d} = 0{\cdot}84.$$

The ideal efficiency is high; but the highest actual efficiency which could practically be obtained would be very much below this. Besides the losses in the motor proper and in the pump, there would be a very great loss in the regenerator. It would not be practicable to reduce

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the temperature of the exhausting gases in the regenerator to 80deg. C., or to raise the temperature of the fresh gases in the regenerator to 1,592deg. C.

If the losses in the regenerator and in the passages leading to it and from it amounted to 50 per cent. of the heat which is ideally given to or taken from the regenerator, these losses would have to be made up by extra heat given to the fluid by combustion, and the efficiency would fall to 0·3. This does not take into account the losses in the motor proper and in the pump. The heat losses in the motor would probably be very great. This cycle may, however, when used with turbines give results sufficiently good to justify its use. It certainly seems to promise better results with turbines than with reciprocating engines on account of the lower frictional losses than might be expected with turbines. With reciprocating engines the large volumes and the low pressure of the fluid would cause extremely high percentage losses in friction.

The cycle has the disadvantage that gas at a very high temperature has to be conveyed from the regenerator to the turbine. This practically forces us to have the turbine quite close to the regenerator. It would seem to be necessary to build the regenerator of brickwork, and to build the turbine into this brickwork. This will very much limit the usefulness of the cycle, as it will be quite unfeasible in many cases either to have a regenerator of the nature required at the place where power is wanted, or to transmit the power from a place suitable for holding the regenerator. Nevertheless, there will be cases in which it will be quite practicable to build a regenerator beside the turbine, and this cycle would therefore seem to be worthy of consideration. A rotary pump driven from the turbine spindle could easily be used for compressing the gases, thus simplifying the mechanical moving parts.

The several cases can be compared in the table. It will be seen that high ideal efficiency is, as a rule, accompanied by a high ratio of negative work to gross work. Cycle IV. is, however, an exception to the rule. The cycle has the highest ideal efficiency and the lowest ratio of negative work to gross work. As has been already pointed out, however, the efficiency which we could actually hope to obtain with this cycle would be very much below the ideal, and the cycle has other objections, as already stated. Cycle I., Case 1, has a high ratio of negative work to gross work, although the efficiency is the lowest. This is because all the heat is supplied to the gas at a comparatively low temperature.

Engineers interested in any particular cycle can work out other cases for themselves if they consider it necessary, but it is suggested that, after a careful perusal of this paper, the effect of any change can be guessed at with fair accuracy. It might be possible to use the exhaust gases from a turbine working according to Cycle I., Cases 1 and 3, or Cycle II., Case 1, to heat the fluid after compression, and so to save fuel. Consider Fig. 4. The heat supplied to the fluid is represented by the area *a* B C *d*. Part of this heat might be obtained from the hot exhaust gases and the efficiency of the cycle thus raised, as will be clear from the description just given of Cycle IV. With Cycle I., Cases 1 and 3, and Cycle II., Case 1, there should be no necessity to use a regenerator of brick or such like refractory material. The exhaust gases could be passed through tubes, and the fresh air passed over the outside surfaces of the tubes, or some equivalent construction employed. Many other cycles or modifications of cycles might have been investigated, but the author has considered it inadvisable to burden the paper with them. As regards the Carnot cycle, an engine working on this cycle would have the same value for E as one working on Cycle I. for the same values of t and t_c, and if the isothermal expansion were carried far enough, it would, under ideal conditions, do the same work per cycle for the same amount of fluid, and have the same ratio of negative work to gross work. The maximum volume of the fluid would, however, be very much greater, and although this is not such a serious matter with a turbine as with a reciprocating engine, it is, nevertheless, not a condition to be accepted without due recompense.

FIG. 21.—Cycle IV. Pressure-Volume Diagram.

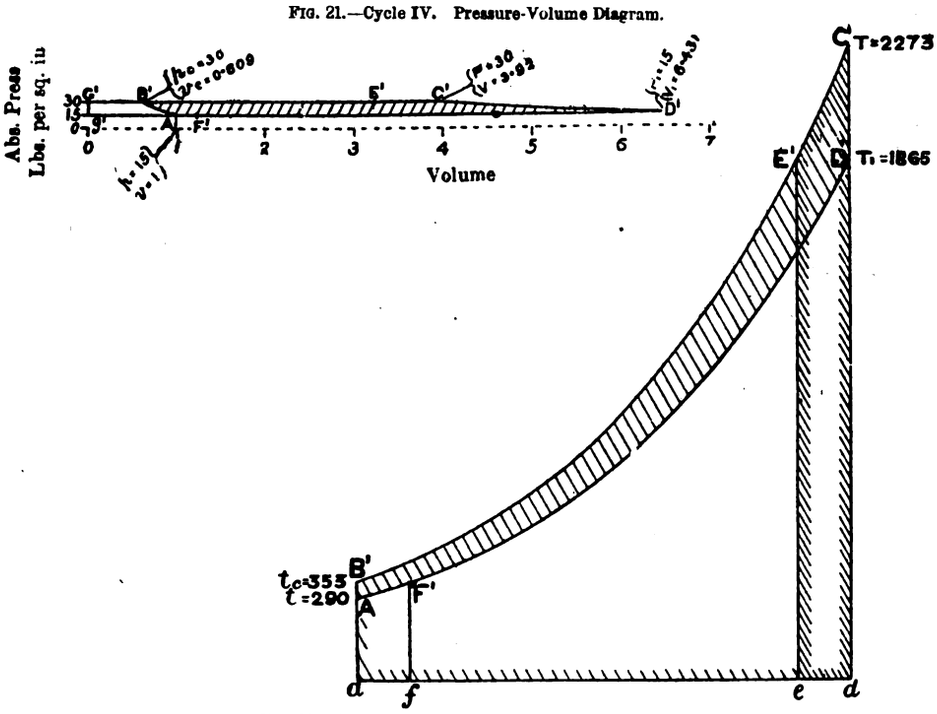

FIG. 22.—Cycle IV. Entropy-Temperature Diagram.

TABLE COMPARING THE SEVERAL CYCLES AND CASES.

Cycle.	Case.	Compression. Temp. abs. C.	Compression. Press. lb. per sq. in. abs.	Max. temp. abs. C.	Max. press. lb. per sq. in. abs.	Ideal efficiency (E).	Ratio of neg. work to gross work.
I.	1	389	42	973	42	0·25	0·40
I.	2	309	42	2,273	42	0·25	0·17
I.	3 & 3A	682·5	300	2,273	300	0·58	0·30
I.	4 & 4A	909	818	2,273	818	0·68	0·40
II.	1 & 1A	500	101	2,273	459	0·55	0·25
II.	2 & 2A	750	417	2,273	1,265	0·68	0·38
III.	2	682·5	300	2,273	300	0·33	0·41
IV.	—	353	30	2,273	30	0·84	0·16

If an engine working on Cycle I. has $T_1 = t_c$, then an engine working on the Carnot cycle with the same values of t and t_c would require, in order to do the same work, to commence its adiabatic expansion at the point where the engine working on Cycle I. leaves off. If p and P_1 on the Cycle I. engine are atmospheric pressure, then on

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the Carnot cycle engine the whole of the adiabatic expansion would take place below atmospheric pressure. It is interesting to compare the Carnot cycle with other cycles, but it hardly seems useful in the present investigation to devote any more space to this

Although the practical efficiency of an engine is usually of great importance, there are many occasions on which a very poor efficiency will be tolerated if other conditions are satisfactory. Small gas-engines using lighting gas, costing 2s. to 3s. per 1,000 cubic feet, are employed in great numbers although the fuel cost per brake horse-power hour is very high. Small electromotors are extensively used consuming current which costs over 2d. per Board of Trade unit. The fuel cost and the energy cost respectively in the two cases are high, but the user prefers to put up with this rather than employ a power plant which has a higher initial cost or which requires more attention or is generally more inconvenient.

If, therefore, small gas-turbines could be sold at a low price, and if they required little attention and did not readily get out of order, they might be in great demand, even although the gas consumption per brake horse-power hour was high. With the average user of a small engine, producing, say, 100 brake horse-power hours per week, a reduction of £10 in the initial cost is of more consequence than a reduction of two cubic feet per brake horse-power hour in gas consumption. The same user would no doubt be quite willing to allow an additional five cubic feet of gas per brake horse-power hour if he was saved trouble and anxiety and small expenses in the working of the engine.

To produce a gas-turbine cheaply, it would seem necessary to entirely avoid reciprocating parts, and to be content with a low compression. Cycle I., Case 1, would seem to lend itself to cheapness of construction and simplicity, but it might be advisable to reduce the compression at the expense of efficiency. A rotary pump could undertake the compression.

In many cases the vibration of a reciprocating engine is extremely objectionable; and a motor that ran with practically no vibration would be popular even if its initial cost was greater and it was more extravagant of fuel. In motorcars, for example, oil or spirit explosion engines are used for their lightness and compactness; but the vibration they cause is objectionable. If a satisfactory turbine were obtainable, there is no doubt that motorcar builders would eagerly buy it and instal it on their motorcars, even if the cost was greater and the efficiency less than many arrangements of explosion reciprocating engines now in use.

One might mention many other uses to which gas-turbines could advantageously be put if they were obtainable as fairly efficient and reliable machines. In many factories and engineering works electric motors fed by current from a central station are used to drive individual machines or groups of machines in order to save the losses and inconveniences produced by driving by belts or ropes. Gas-engines (reciprocating) have been used to a limited extent for the same purpose, but the foundations required by these and the vibration caused by them have prevented their extensive use. If a gas-turbine were obtainable which could be set down anywhere like an electric motor it would serve splendidly for this purpose, and in order to displace electric driving it would only require to possess an efficiency greater than the efficiency of the central-station engine multiplied by the efficiencies of dynamo, mains, and motor.

Suction gas producers are coming into extensive use, and by their means gas-engines can take the place of steam-engines in places where they otherwise could not. Whatever objections there may be to the supply of gas to gas-engines from these suction producers, these objections should be less rather than greater with turbines than with reciprocating engines.

The power of a gas-turbine could be effectively varied with an insignificant variation of speed by cutting out one or more of the nozzles or admission ports which admit the fluid to the turbine buckets or first set of buckets when several are employed in series, the fluid being passed through the acting ports or nozzles at a uniform pressure and with a uniform velocity. To enable the acting nozzles or admission ports, no matter how many may be in use, to deliver the fluid always in the same uniform manner, it will be necessary, if one flame supplies all the nozzles or admission ports, to control the fuel and air supplies to the flame in conjunction with the mechanism which cuts off the nozzles or admission ports. It will, however, be usually advisable to supply the air and fuel to the flame at a constant velocity, and, although this could be done when one flame supplied a varying number of nozzles, this would involve complications; and it may, therefore, be found expedient to have a separate flame and a separate combustion chamber for each nozzle. This will, however, involve the necessity of igniting or extinguishing a flame for each change of power, and although this could be done automatically, it is objectionable. Much careful consideration will be required to determine which is the least evil to put up with and which course had better be taken.

It is hoped by the author that this comparison of the several cycles treated on will be of some use in showing what may be expected from any of these, and which will be best suited for a motor which is required to work under given conditions, and which it is important should have given characteristics. One cannot, however, compare the several cycles and estimate the actual efficiencies, etc., which one could expect to obtain in practice in anything like so satisfactory a manner as could be desired, without having more information obtained by experiment on the following three points: (1) Losses in pneumatic compression to high pressures—(*a*) with reciprocating compressors; (*b*) with rotary compressors; (*c*) with a combination of reciprocating and rotary compressors. (2) Expansion of hot gases in divergent nozzles. (3) Radiation losses and transference of heat from gases to metals at high temperatures.

It would immensely aid the solving of the gas-turbine problem if a thorough set of experiments on these three points were made and the results published. This would, of course, cost a considerable amount of money, but the information obtained by the engineering world would be very good value at the price. Money has been spent and is being spent by engineering and scientific societies on investigations which, while no doubt interesting and instructive, are not of so far-reaching importance as experiments which would materially aid in the production of a successful gas-turbine.

SMALL TALK BY THE LOW-CASTE WIREMAN.

BY "JACK BLOGSON."

The following effusion makes no pretence at taking a logical line of thought. It is, in fact, simply a big grumble at the present state of electrical work and systems. However, it is to be hoped it will strike a goodly number of readers as possessing some horse sense, particularly regarding the position an apprentice finds himself in at the end of his term. Evidently it all reduces down to a conflict between influence and training, and who can say but the former gains the day in nine cases out of ten. Whilst reading the "Old 'Un's" letters, which lately appeared in this journal, one would fancy most aspiring (perhaps impecunious) young engineers would feel a trifle envious of the imaginary "Young 'Un," with his free choice of shop and college. Some of the latter letters indulged in a pretty hard shot at the unspeakable, beer-guzzling, horse-backing, working-man, who is so infinitely below the "Young 'Un's" standing. Now, how many shop foremen will dispute the fact that the state of things represented is completely reversed, as this dazzling high flown pupil usually manages to borrow some cash from the foreman (especially on a country job), which is usually paid back on what is known as the "Kathleen Mavourneen" system—"It may be for years, and it may be for ever."

But to resume the grumbling. The following will no doubt be of interest to some readers: Eight pupils, apprentices, or whatever name you please to apply to them, paid fees averaging each £100 to a certain firm of electrical contractors. In return they were supposed to acquire "the art, trade, and profession of electrical engineers."

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Some, when they had their term completed, were generously proffered a situation by the manager at sums varying from 20s. to 25s. per week, they at this time being well qualified to execute wiring work, the rate for which is 8d. per hour. Others, owing to the lack of capacity, and perhaps thirst, were ignominiously fired out with an excellent reference personally written by the governor.

Now, a brief account of how these individuals fared up to the present may interest readers. Taking them in numerical order: No. 1 turned out a fairly good plant and wire man; not being afforded an opportunity of acquiring a knowledge of estimating and draughtsman work, and having no influence to pitchfork him into a good berth, he developed into a journeyman wireman. No. 2, good post in power station (desperate pitchforking). No. 3, very indifferent man; travelling round like a wandering Jew victimising contractors. No. 4 has abandoned the electrical business, and has settled down to farming at home. No. 5 has an income at his back, and has consequently been on the lookout for a nice congenial job at, say, £800 per annum. Vain hopes! No. 6 opened a high-class bar and billiard-rooms; getting rich rapidly. No. 7 secured a good station job (foreign) on his own merits. No. 8, in America; no tidings.

Now, any young fellow can, with a little trouble, get into a shop providing he does not want a salary to commence with, and if he has that invaluable gift—observation—and applies himself to study, there is no earthly reason why he should not develop into a good workman in time. What, then, is the mental calibre of a person who demands and accepts large sums, as in the foregoing cases, without giving his pupils any more facilities of becoming a thoroughly experienced engineer than the youth whose aim is simply to become a wireman? Now, again, referring to our eight examples. Nos. 7 and 2 are practically the only cases who have secured decent posts. The latter may certainly burst up the station, but as the old proverb has it, "The devil takes care of his own." Nos. 1, 3, and 8 have descended to the level of the "Old Un's" fourth caste—wireman or workman. No. 5 is the personification of what the "Young One" should develop into. No. 6 deeply regrets the time he spent at the business, but can argue the point about the correctness of his meter readings with the power-house officials until they become black in the face. He regards it now as very surprising that apprentices will work hard for the employers or masters and pay them to let them (the apprentices) do so. Now, several of the above youths were well posted both practically and theoretically on finishing up, and if they could possibly step into even a ticklish job would certainly manage to hold it, they, of course, then being fresh from practice, science classes, etc. But folks cannot possibly wait for 18-carat chances to arrive, or subsist on their unfortunate relatives for a lifetime. The immediate result of this is: our smart apprentice, instead of becoming a future shining light in the electrical firmament, tackles a conduit job instead and gets his fingers pulled in with the wires by the new nipper, who has come to the line with the very sensible intention of being a workman or wireman, no more or less. Why even a wireman's job is scarcely worth all the trouble, training, and experience required to fill it properly.

Let us consider the various classes of work he is called on to execute, and which every qualified man can do: wiring in several systems, casing, both socket and screwed conduit, lead-covered and concentric, telephone and bell work, motors, arc lamps, ability to work from plans and blue prints, perhaps some gas and oil engine work thrown in, etc. Though the list looks a bit formidable, a good man has had experience at everything above specified, and that without, perhaps, ever troubling his brains as to the meaning of $4\pi nc$L. Another very noticeable thing is the way the various sub-divisions of the electrical business blend together in this country. It is nothing unusual to find a workman who was, we will say, on house-wiring a while since, running a plant to-day, to leave, perhaps, in a month and tackle telephone work. Of course, the individual may acquire a better training, but would it not be better to specialise things a little?

I have before me now a copy of the rules of the International Brotherhood of Electrical Workers. Some of those could certainly be used universally with the greatest advantage. Space will allow only a few to be quoted. Section 48 is of interest. It provides for the salaried business agent to visit as many jobs as possible in his district weekly, asking each workman for his card, and punching same. This speedily stops non-union and union men working on same job. The I. B. E. W. class electrical workers under the following headings: (1) armature winders; (2) journeymen wiremen; (3) shopmen; (4) maintenance men; (5) switchboard and dynamo attendants. The wireman's work comprises "the installation and repair (unless done in shop) of all devices by which the energy or force known as electricity is utilised." A shopman's work is done in shop only. A "maintenance man" is defined as a man in charge of an isolated plant; his work includes keeping arc lamps and motors in order, "but shall not include running new circuits for light or power, or the construction or installation of signs or display lights." Switchboard and dynamo attendants, Class 5, refers to station work. Section 61, Rule 10, is extra good: "Not more than one man connected with a firm, whether a partner or stock holder, shall do journeyman's work, and he must have a working card . . . Taking in a partner or working member simply to have a *cheap man around* (the italics are mine) will not be recognised." Section 61, Rule 13, forbids all apprentices or helpers working on a job unless a journeyman is also on the same job. Section 73 says: "Any member who refuses to show his wages when requested by another shall be fined 5dol." Section 73 may possibly lead to some trouble on this side of the water, but, certainly, if some of the I.B.E.W. rules were adhered to by men and masters, and a system of examination organised and adopted, it would certainly give a *bonâ fide* man a chance, and also stop the influx of cycle mechanics, scene shifters, labourers, etc., whose presence is so detrimental to the industry both in the eyes of trained workmen and the public.

MANCHESTER STREET-LIGHTING.

The following is the full text of an interesting report presented by Mr. S. L. Pearce, the chief electrical engineer to the Manchester Corporation, to the special Street Mains Sub-Committee. We have, however, cut out the list of streets as not being of general interest. The report is dated Oct. 11, 1904, and reads as follows:

Report on Street-Lighting with New Arc Lamps.

Gentlemen,—I now have the pleasure to report that the whole of the alterations to the existing system of street-lighting, together with certain extensions thereto as sanctioned by you in March last, have been carried out, and that important data and figures have been obtained therefrom as to costs and illuminating effect, these results being embodied in the present report. It may be of interest to state briefly what has been done during the past few months. The six old open-type 10-ampere Crompton lamps in front of the infirmary on Piccadilly have been replaced by nine nine-ampere enclosed Gilbert lamps. In addition, 12 six-ampere lamps of the same make have been placed on the centre poles of the tramways running from Portland-street to Mosley-street. The old 16 Brockie-Pell 10-ampere open-type lamps in Albert-square have been replaced by six ampere Gilbert lamps to the same number. In St. Ann's-square the old six Brockie-Pell lamps have been replaced by new Gilbert lamps, and two more have been added, one on either side of the centre of the square. These latter took the place of the gas lamps that were taken down. We have, therefore, in all, now 45 lamps, and so far the new Gilbert type of lamp has given great satisfaction, burning with a clear and very steady light for at least 120 hours without recarboning, trimming, or any attention. The current consumption is, as stated by the makers, 600 watts, or six amperes at 100 volts, equivalent to seven-tenths of a unit per 1,000 candle-power hours.

Under the superintendence of Mr. Ratcliff, the head of the testing department at the Polygon, an extensive system of comparative tests have been made between (1) the new arc lighting, (2) the intensified gas system, and (3) the ordinary incandescent gas lamps on a portable street photometer, kindly lent me for the purpose by the technical school authorities. The results of these tests are shown in the form of curves appended to this report. The readings were all taken at a height of about 4ft. 6in. from the ground, this being the most regular height for measurements of this class. The results are expressed in

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the usual illumination units—viz., "candle-feet"—or, in other words, the particular illuminating effect at any point is expressed in terms of the equivalent number of candles at a distance of 1ft. away from that point. Ordinary street-lighting illumination varies from ·03 to 1·5 candle-feet. Anything over one candle-foot is very good, and over 1·5 candle-feet exceptionally good. Lines are shown giving the mean illuminating effect, and also approximate curves for the candle-power given from the different lights. The curves show clearly the effect from lamp-pole to lamp-pole. The maximum candle-powers observed were as follows: Piccadilly, nine-ampere arcs, 1,152 c.p.; Albert-square, six-ampere arcs, 850 c.p.; Piccadilly, six-ampere arcs, 753 c.p.; Sackville-street, intensified gas (three burners), 525 c.p.; All Saints', incandescent gas, 312 c.p.; Parker-street, "Scott-Snell" gas (one burner), 291 c.p.; Cheetham Hill-road, incandescent gas, 147 c.p.

difference in the candle-powers of the respective lamps, this is an interesting result, as it disposes of the statement that the electric arcs in Manchester do not diffuse their light so well as the gas.

Diagram 3 shows the curves for the centre-pole arcs in Piccadilly and incandescent gas in Cheetham Hill-road. The lamp-poles in the latter locality are 200ft. apart, and the curves show that at a greater distance than about 50ft. from the posts there is no illumination at all. This would be a good route for the adoption of arc lighting.

The question of comparative costs I have already submitted an estimate to you in my report of March 10, and the results obtained have practically borne out those figures, and little modification is necessary. The price hitherto charged for current for street-lighting has been 2d. per unit, but considering that the load factor is a very high one, approximately 40 per cent., the price could be fairly reduced to 1½d. and still

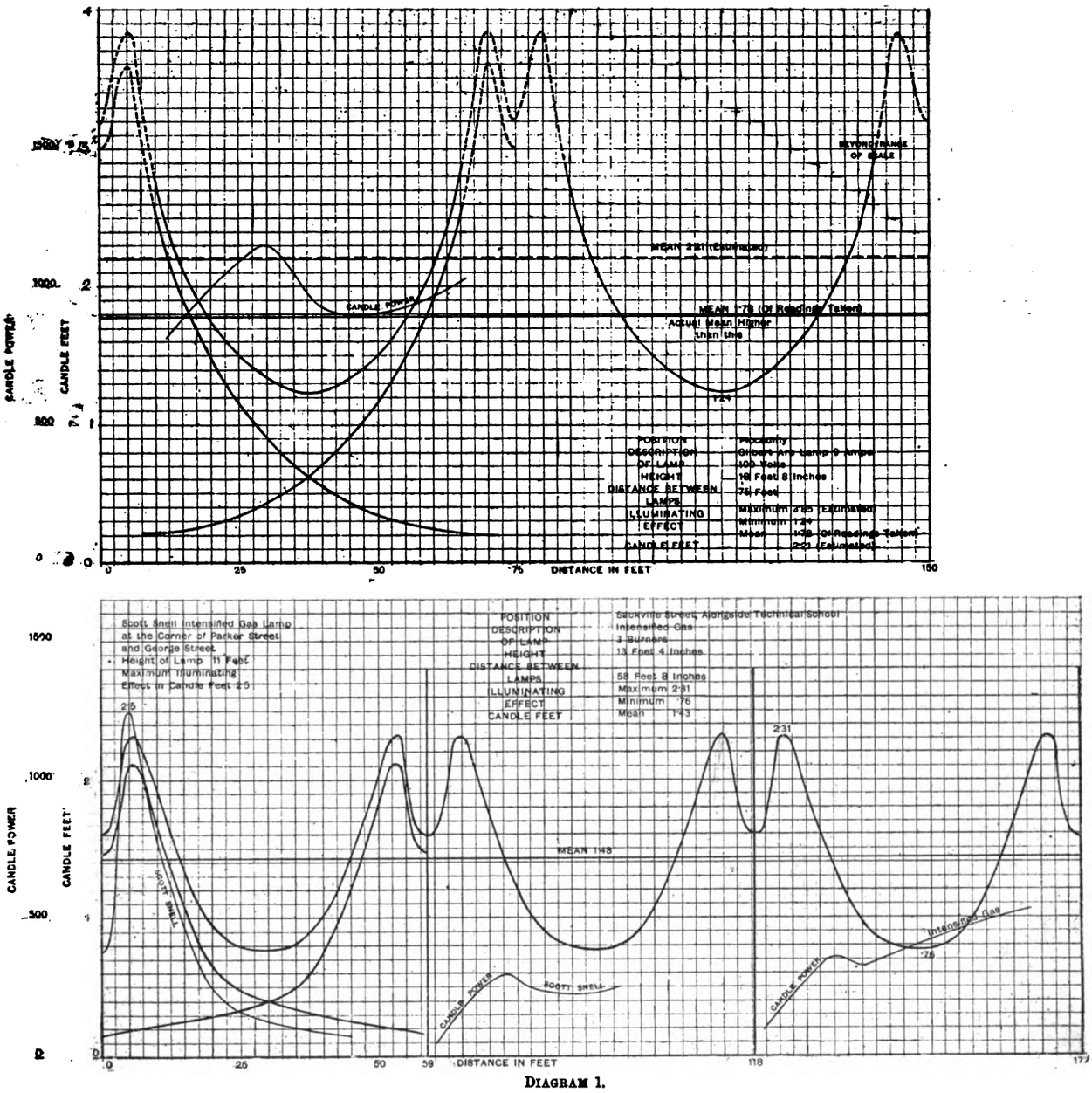

DIAGRAM 1.

Diagram 1 shows the curves of illumination for the nine-ampere arcs on Piccadilly and the intensified gas lamps round the technical school, which are to a great extent self-explanatory. With the arc lamps the light was so intense within a distance of 10ft. of the poles that the readings were off the scale of the instrument, and the curves had therefore to be calculated beyond a certain point with the help of the results from the six-ampere lamps.

Diagram 2 shows the curves of illumination for the six-ampere arcs in Albert-square and the incandescent gas lamps at All Saints'. It is interesting to compare the former with the "intensified" lighting round the technical school, the lamp-posts being approximately the same distance apart, the mean illuminating effect in the case of the arc lamps being 2·03 candle-feet, as against 1·43 for the intensified gas. It will further be observed that the lowest mean illuminating effect is for the arcs 1·08 candle-feet, and for gas ·76. Allowing even for the allow a margin of profit. The latest available costs show that for a demand of this nature the running and standing charges together only amount to ·95d. per unit, so that there would be a profit of ·3d. per unit, based on the 1½d. rate, irrespective of the fact that the fixed charges are going on now the whole time, whether the demand is made or not. We have at the present time 24 all-night lamps and 21 lamps that are switched out at 11 p.m. Averaging these together, I find that under the new working conditions, and with current at 1½d. per unit, the equivalent price per lamp per annum works out at £11. 17s. 6d. The price charged on the basis of the old working was approximately last year £19 per lamp per annum. It is evident that a substantial reduction could be made in the event of the department obtaining consent to extend the present street-lighting system. Comparing the costs of production for street-lighting as between "arcs" and the "intensified gas," I take the last figure furnished me by the gas department for the latter

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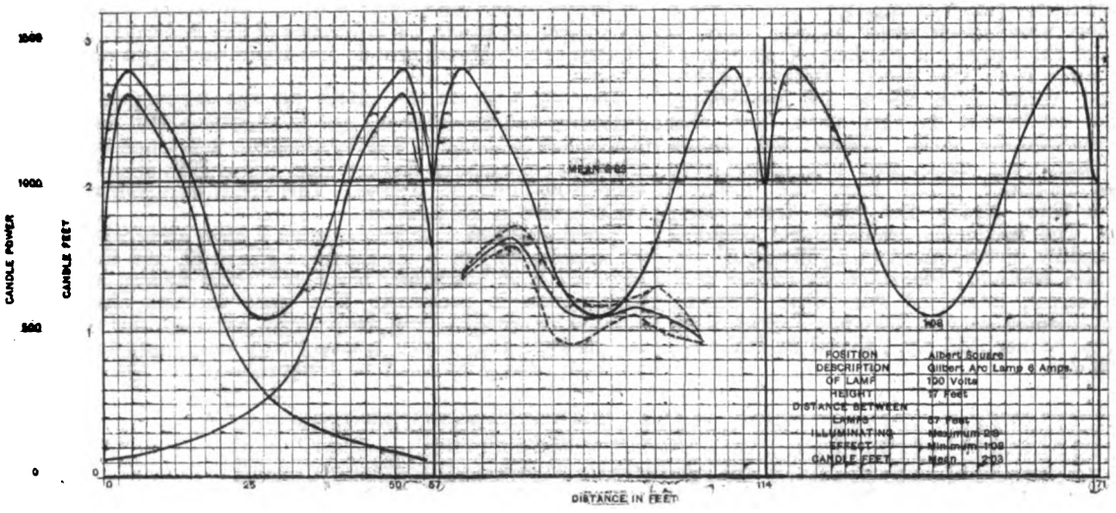


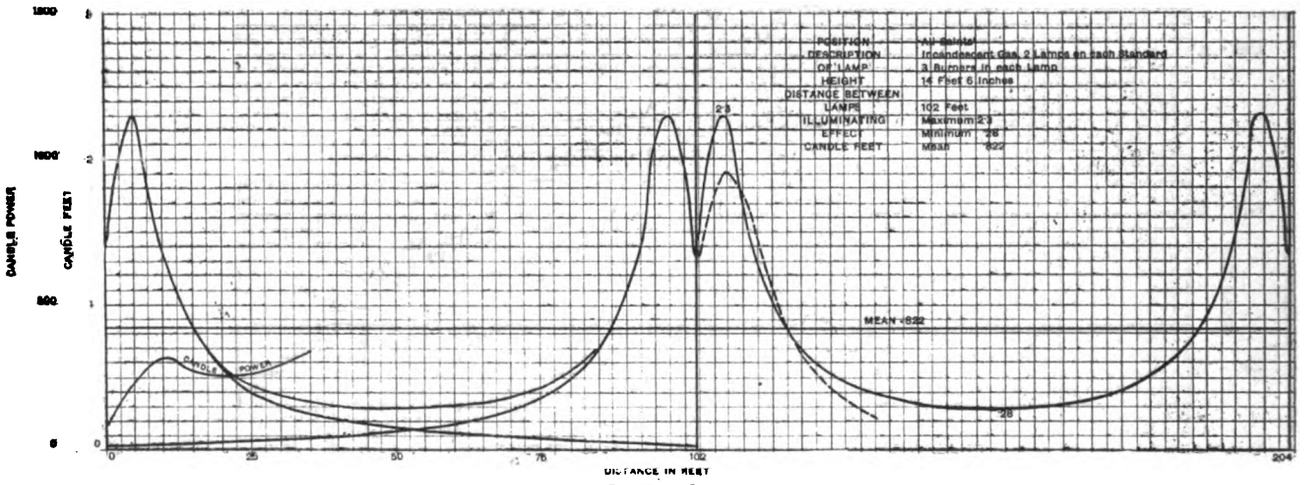
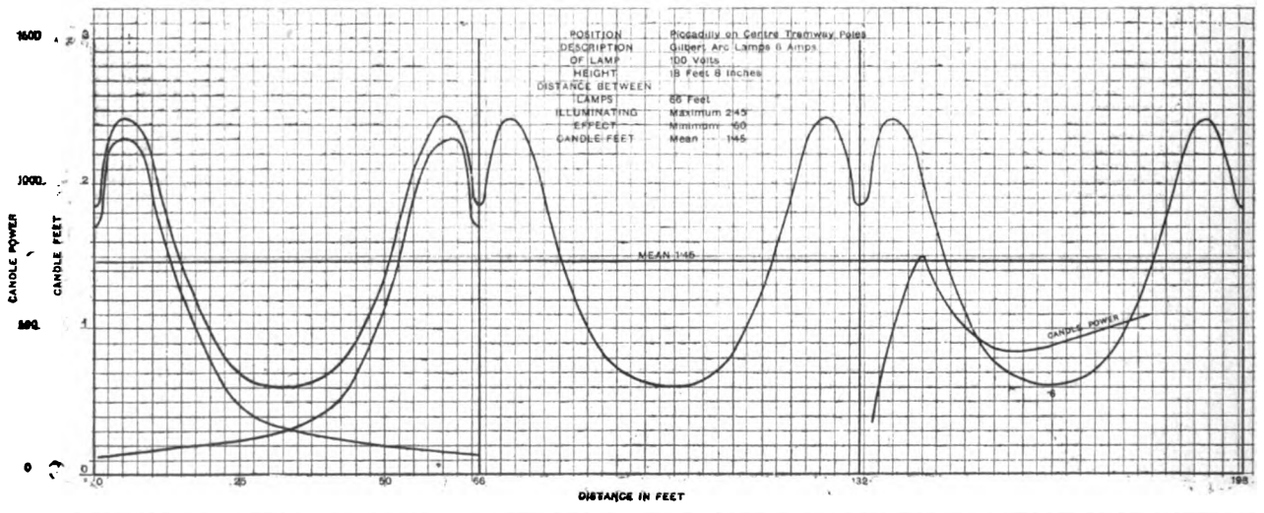


DIAGRAM 2.



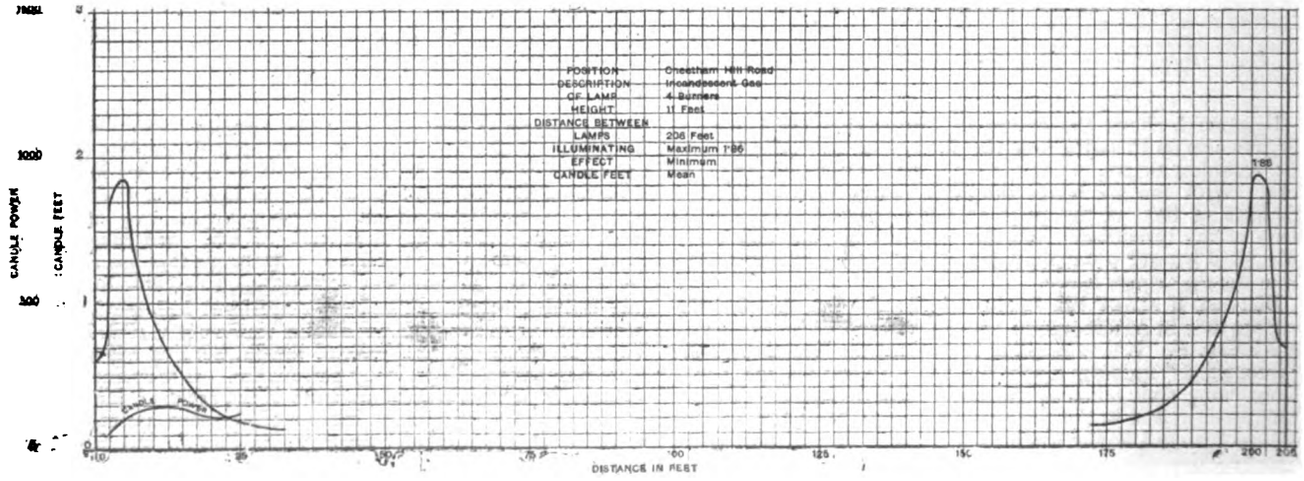


DIAGRAM 3.

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method, which is at the rate of 1·08d. per 1,000 candle-power hours. I believe this figure also includes for 10 per cent. depreciation.

Gas.—At 4,000 hours of burning, degree of illumination equivalent to 1,000 c.p. : cost = 4,000 × 1·08d. = £18.

Electricity.—Under the same conditions as above : number of units used = $\frac{4,000 \times 7}{10}$ = 2,800 ; 2,800 × ·95d. = £11. 1s. 6d. ; carbon and trimming = 8s. ; depreciation 10 per cent. = £1. 3s. ; total, £12. 12s. 6d. ; equivalent to ·75d. per 1,000 candle-power hours. I have taken the same figure for depreciation for comparison. From calculations made, I find that the costs of illumination in Albert-square and Sackville-street work out as follows :

Albert-square Arcs—Consumption, 600 watts per hour ; mean candle-feet (M.C.F.), taken from curves = 2·03 ; Board of Trade units per M.C.F. per hour = $\frac{600}{2·03 \times 1,000}$ = ·295, which at ·95d. per Board of Trade unit = ·28d. ∴ cost per M.C.F. per hour for arcs = ·28d.

Sackville-street—Intensified Gas—Cost of production, 1·08d. per 1,000 candle-power hours ; equivalent to ·565d. per 525 candle-power hours ; mean candle-feet, taken from curves = 1·43 ∴ cost per M.C.F. per hour for gas = $\frac{·565d.}{1·43}$ = ·395d.

The above calculations, as far as they affect the "arcs," are based on actual measurements taken on the site. These results are based on the results of working of the past few months, and are therefore reliable, and there is only one conclusion to be drawn—viz., that the electricity department can carry out a system of street-lighting that compares more than favourably with the "intensified gas system," both from the point of view of annual cost and illuminating effect.

As the committee are probably aware, we have at the present time a large amount of arc lighting cable laid in various parts of the city. I find this amounts to no less than 22 miles, and the approximate cost of same is £13,000, not one penny of which is bringing in any return ; in fact, the cables never have been put into use yet.

SOCIETY OF ENGINEERS' CONVERSAZIONE.

A most enjoyable time was spent by the members of the Society of Engineers and their guests on Wednesday night last, when a conversazione was held at the Royal United Service Institution, Whitehall, to celebrate the society's jubilee. The president (Mr. D. B. Butler) and Mrs. Butler held a reception from 8.30 p.m. to 9 p.m., the guests, as they arrived, passing thence into the museum, where the band of the 23nd Middlesex Rifles (Volunteers) discoursed sweet music. Variety in the way of entertainment was provided by the Imperial Glee Singers and by Mr. George A. Goodwin, past-president, who delivered an interesting lecture entitled "Japan and the Far East," illustrated by photographic lantern views, before a large audience in the lecture theatre. Mr. Perry F. Nursey, the secretary of the society, must be congratulated on the success which attended the arrangements for the function.

HARROGATE ELECTRICITY ACCOUNTS.

The accounts of the Harrogate Corporation electricity department for the year ended March 31, 1904, show a total expenditure on capital account to that date of £98,751. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith.

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	108,190	0	0
Sundry creditors	1,762	15	9
Sinking fund account	3,133	5	4
Reserve fund account	1,100	0	0
Surplus	4,064	2	6
	£118,250	3	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	98,751	1	4
Stores on hand	812	6	6
Sundry debtors for current supplied	4,962	17	6
Other debtors	51	14	3
Securities held (cost price)	3,133	5	4
Cash with treasurer	9,438	18	8
Cash in treasurer's hands (reserve fund)	1,100	0	0
	£118,250	3	7

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	4,653	1	10
Distribution of electricity	796	6	9
Attending and repairs to public lamps	411	0	6
Rents, rates, and taxes	610	5	8
Management expenses, salaries, etc.	1,180	3	11
Special charges—insurance, etc.	18	17	0
Total expenditure	7,669	15	8
Amount carried to net revenue account	8,387	10	2
	£16,057	5	10

Cr. Income.	£	s.	d.
By sale of current per meter	13,457	9	7
Sale under contracts	744	9	4
Public lighting	778	0	1
Rental of meters and other apparatus	392	2	3
Sale and repairs of lamps	449	15	5
Sale and repairs of other apparatus	235	9	2
	£16,057	5	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,249,226
Quantity sold	Public lamps	97,910	
	By contract	30,365	952,291
	Private consumers by meter	804,016	
Quantity used on works			15,405
Total quantity accounted for			947,696
Quantity not accounted for			301,350
Total maximum supply demanded (kilowatts)			780

Number of public lamps : 60 arcs, 255 8-c.p. incandescents.

FORTHCOMING EVENTS.

FRIDAY, NOV. 18.

Institution of Mechanical Engineers.—At 8 p.m., general meeting.

Junior Institution of Engineers.—At 8 p.m., Mr. W. H. Lindley will deliver his presidential address on "Municipal Engineering on the Continent."

North-East Coast Institution of Engineers and Shipbuilders.—General meeting.

Institution of Electrical Engineers (Manchester Section).—"Compensated Alternating-Current Generators," by Mr. M. Walker.

SATURDAY, NOV. 19.

Corps of Electrical Engineers (R.V.).—At 7.30 p.m., dinner at the Criterion.

Institution of Electrical Engineers (Leeds Section).—Visits to Messrs. W. T. Glover and Co.'s cable works and the Formby power station of the Lancashire and Yorkshire Railway.

MONDAY, NOV. 21.

Junior Institution of Engineers.—Visits to Dudley Port and Birmingham to inspect the central station of the South Staffordshire Mond Gas Company and the Nechells Gasworks of the Birmingham Corporation. Train leaves Euston at 9.20 a.m.

TUESDAY, NOV. 22.

Institution of Civil Engineers.—At 8 p.m., "Distribution of Electrical Energy," by Mr. J. F. C. Snell.

WEDNESDAY, NOV. 23.

Institution of Electrical Engineers (Birmingham Local Section).—At 7.30 p.m., the chairman (Dr. W. E. Sumpner) will deliver his address.

Society of Arts.—At 8 p.m., "The Systematic Promotion of British Trade," by Mr. B. H. Morgan.

THURSDAY, NOV. 24.

Institution of Electrical Engineers.—At 8 p.m., "Hydro-Dynamical and Electromagnetic Investigations regarding the Magnetic Flux Distribution in Toothed-Core Armatures," by H. S. Hele-Shaw, F.R.S., Alfred Hay, D.Sc., and P. H. Powell, M.Sc.

FRIDAY, NOV. 25.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., "Electric Power in Machine Shops," by Mr. H. C. Jenkins.

SATURDAY, NOV. 26.

Glasgow Technical College.—At 7.30 p.m., "The Electrical Drive of Large Reversing Engines Working Intermittently," by Mr. M. Georgi.

December 1.—Annual dinner of the Institution of Electrical Engineer at the Hotel Cecil.

December 1.—Society of Arts, "Running Powers," by Mr. Stephen Sellon.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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MR. SWINBURNE'S REPORT ON CHELTENHAM.

This report contains much that is good, some that is bad, and a little rather indifferent. As regards the latter, we must not be dogmatical, because Mr. Swinburne is probably as justly entitled to his opinion as we are to ours—is just as likely to be correct—hence to tilt at him on this account would be dangerous. The good in the report needs no comment, but the bad must lead to discussion. Perhaps on one indifferent point we might venture a word: "Residents . . . not dependent on local prosperity." Is not this conclusion doubtful, and have not these residents been attracted because of the salubrity of the town, its varied attractions, and its low rates? The attractions are partly due to public works, and the lower rating is partly due to the increase in number of ratepayers, which increase again is due in some measure to the action of the authorities. Local prosperity really has much to do in attracting households with fixed incomes. A salubrious town, not prosperous, with high rates and no attractions, has few fixed-income households. On the contrary, such a town, very prosperous, with many attractions and low rates, has many fixed-income households, and the increased number further diminishes the rates per individual. The broad fact about Cheltenham is that its electricity supply has not been pecuniarily successful, that it has not furnished a profit, nor, indeed, covered its expenses. Mr. Swinburne, we are sorry to see, takes up a position in regard to accounts which we think wholly untenable and utterly fallacious. We shall meet with a direct negative the implied statement that a "local authority borrows at a low rate," the comparison, of course, being with a company. A real comparison is impossible because of the differing conditions. Many companies obtain capital and pay *no interest* whatever. The *rate of interest* at which a company gets its capital depends entirely upon the success of the company. Then is not the statement equally fallacious, that "an industrial concern provides capital for running at a loss during the first few years." We have seen a good many prospectuses, but we seldom see one that admits of a possible loss even on the first year's working, much more for several years. They mostly estimate for an immediate profit—small it may be, but still a profit; and to hear the excuses made at the annual meeting when such profit does not accrue would make an angel weep, and if, perchance, the profit should be a negative one—that, is a loss—no chairman would think of stating that the loss was provided for in the capital account. We are not referring to the period of construction. Investors know that profits cannot be earned before work is begun, but they do not expect to wait three or four years after work has commenced before getting a return for their investment. Highly speculative enterprises do not come within our purview. A speculation differs entirely from an ordinary investment in a humdrum concern. Further, we do not think Mr. Swinburne's reference to working capital is justified. The question of working capital depends altogether upon the concern. Some businesses require a very large working capital; others require a very small working capital, or none at all. Finally as regards these comments—otherwise they will become unwieldy—that blessed word "antiquation." It is a word imported into the discussions upon electrical matters, as if antiquation of machines electrical was something unique and applicable only to such machines. Can Mr. Swinburne or anybody else point out any general acceptance in the making of extra depreciation allowances for any class of machines hitherto used during the whole history of the world? Antiquation exists in

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every class of machine wherein progress towards perfection is possible. Every good patent means antiquation of goodness knows what value of machinery, but the user of a boiler, or an engine, or a lift, or a machine does not antiquate it and scrap it, though by so doing he might possibly get something more efficient. No company can pursue the course of scrapping because of antiquation, and they do not. What happens is that the users of the older and, perhaps, less economical machines have to put up with diminished profits if products are sold at the same prices. The newer the mill or factory the more perfect the machinery, but the mill to be built five years hence will contain still more perfect machinery; but the former owner depreciates only in the usual way, not extra because of antiquation. However, this question will have to be thrashed out at greater length and more in detail elsewhere. As regards Mr. Swinburne's conclusions, they are correct, and may be summed up in the words that all commercial undertakings should be carried on with rigid regard to the known rules necessary for and leading to success.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COST OF PRODUCTION AND MR. SIEMENS'S PRESIDENTIAL ADDRESS.

SIR,—At the present moment, when the future of our industries hangs in the balance, it is appropriate that Mr. Siemens in his presidential address should have drawn our attention to the fundamental factor which must govern such future. This factor is "cost of production," nothing else matters. Yet there is a reservation from a purely philosophic point of view.

Mr. Siemens is correct in saying that "the progress of civilisation is in proportion to the cheapening of articles of consumption." From a practical point of view—not the general, but the relative—cheapening of production is of importance to us. A man or a nation is concerned to produce an article more cheaply than another man or another nation. This sounds a prosaic reason for happiness, yet poets have expressed the same truth. Emerson says, "If a man can write a better book, preach a better sermon, or make a better mousetrap than his neighbour, though he build his house in the wood, the world will make a beaten path to his door!"

Mr. Siemens has not treated the subject from this comparative standpoint, and whilst we must thank our President for pointing out the important truth mentioned above, we regret that he has not brought it to its proper conclusion, and the result is that he does not set forth the true laws that govern cost of production, but leads us into by-paths that hide the truth. After introducing this subject, we, speaking as electrical producers, had the right to expect an answer this question: Is the English electrical industry capable of producing as cheaply or cheaper than its Continental or American rivals? If Mr. Siemens thinks the answer should be in the affirmative, then we would ask, "Why are millions worth of electrical machinery imported from abroad?" If the answer should be in the negative, then we wish to hear from the presidential chair the reasons and the remedy.

We cannot deduce from Mr. Siemens's address a decided opinion, but from its general pessimistic tone we must surmise that English industries are not capable of producing that cheapness which he considers essential, and he makes this concluding remark, "It is hopeless to endeavour to re-establish our former monopoly." Surely Mr. Siemens said nothing that should lead him to give such desponding advice, and we, as a firm engaged in producing industries, wish to raise a protest against such a melancholy pronouncement, which if believed in must inevitably have the effect of striking terror into the hearts of English manufacturers.

Surely a country that not so long ago could make "mousetraps" better than any other country can hope to do so again! England has a healthy climate, an unrivalled geographical position, a good soil, great mineral resources, and an industrious population. Surely if we at present do not produce as well and cheaply as other countries, whose natural resources are worse than ours, there must be a reason for it of an exceptional character.

Mr. Siemens somehow endeavours to blame somebody—our workmen and trade unions are accused of restricting output, and thus increasing cost of production. Our patent laws and the "want of the metric system" are mentioned. I hold that these and similar reasons are secondary, and would disappear if the primary reason were removed. Cheapness of production nowadays depends upon the manufacture of large quantities, and to enable a large output the first essential is demand—that is, customers and their orders.

We do not at present manufacture in England as cheaply as our rivals abroad, because our factories are not as large and our output not as continuous. In other words, our rivals have a larger market for their products. This larger market is given to foreign manufacturers by the help of their and our Governments. Their Government gives them security by means of custom duties of their home market; our Government gratuitously places at their disposal our own home markets. Thus we in England are deprived of that reasonable security so necessary to procure large output and demand which our rivals possess.

It is evident that Mr. Siemens, whilst telling us in dismal language that we have lost the faculty of cheap production, does not give us the true reason, which is lesser demand than that enjoyed by our rivals. It is true that had he come to this very obvious conclusion, he would have had to touch upon the fiscal question—a contingency which he deprecates—but the question of cost of production is so intimately connected with the trading systems of the world, that it would have been better not to dwell on the subject at all than to be diffident in attacking its logical conclusions.—Yours, etc.,

G. BYNG.

GERMAN TELEPHONES.

SIR,—I notice in your issue of the 11th inst. you devote a leading article to the question of "Why, in certain telephone work for the Richmond Guardians, German telephones were adopted instead of British-made instruments," and that a letter also appears in your correspondence column on the same subject. You suggest that there may be several reasons, but confine yourself to the one which you think the most charitable. May I suggest one or two other reasons, and at the same time, in the spirit of the two lines of poetry heading your correspondence column, ask you to spare space therein for the publication of same?

First, then, I understand that the German make of telephone was specified by the architect. Now, I take it an architect is a person selected on account of his superior knowledge of certain matters to advise his clients according to his experience and opinions, and prepare specifications based upon such advice, with a view to ensuring that his clients get the best value for their money. In specifying the particular type of German-made telephones, he doubtless had this fact well in his mind, and specified that which his experience found to be the most reliable. Obviously, therefore, an architect is quite an unnecessary extravagance if his opinion is not to be accepted as paramount, and if any contractor with an imaginary grievance, or for other reasons, is allowed to walk round the specification, the services of the architect could be dispensed with, and public bodies might as well throw open their work to contractors, and invite them to send in estimates and specifications *ad lib.*—with what results can be left to the imagination.

Secondly, I note that there are already some British and German made telephones in use at Richmond, the former being of the same make as those which were offered as an alternative by the "Disappointed Contractor." I suggest the probability, Sir (with bated breath, and no thought of treason), that the German-made telephones may have proved the most satisfactory when working alongside the British-made article.

Thirdly, it is more than probable that some of the types

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of instruments specified as most suitable were such as are not made by British firms.

Beyond these points, I notice that the "Disappointed Contractor's" tender for British-made telephones was about 10 per cent. lower than for German make. Since the wiring of the job either with English or German made instruments could not possibly vary, the logical conclusion is that he could not buy the latter so cheaply by 10 per cent. as he could the former. This fact is quite antagonistic to the general opinion that German goods are dumped down in this country and sold at ruinously low prices, in competition with British-made goods. Here is a case where, according to the "Disappointed Contractor's" showing, the German goods are 10 per cent. dearer in price, and yet are preferred to British make.

There must be something distinctly superior about the German-made telephones to account for this, and the architect is consequently justified in specifying same. If my deductions are incorrect or illogical, then there must be some other reason why the "Disappointed Contractor" can quote 10 per cent. lower for British-made than for German-made telephones. These reasons would, of course, be best known to himself, but if he were so disinterestedly anxious to further the interest of the British industry, I do not doubt that many of his fellow-contractors would thank him to tell them how he manages it. "Puzzled" might think it out.—Yours, etc., ENGLISHMAN.

Nov. 16, 1904.

BASTIAN METER COMPANY.

SIR,—It has come to my knowledge that a rumour has gained considerable currency to the effect that I have terminated my connection with the above company, and I should esteem it a great favour if you will grant me space in your columns to give this rumour an emphatic denial, as it is calculated to do me and my business serious damage. As a matter of fact, I and my relatives have considerably increased our holdings in the company during the last few months, and although I have nominally resigned the managing directorship, nevertheless I take precisely the same active interest in the management as heretofore.—Yours, etc., C. ORME BASTIAN.

LETTERS FROM AN OLD HAND TO A YOUNG ONE.

XIV.—ON SUBORDINATION.

MY DEAR YOUNG 'UN,—I am now about to address you for the benefit of your health and the good of your soul, so to speak. If anything I may say appears to you to be unjust or harsh, you are at liberty to reply in your next, provided that you are polite.

I have noticed in your letters a growing tendency to carp at your employer. He seems, judging from your epistles, to be everlastingly in one of three conditions—he is either doing well that which he ought never to be doing at all, or he is doing badly that which he ought to be doing well, or he is not doing at all that which he ought to be going for baldheaded. Consequently I have been keeping an anxious eye on the share market, for the reason that I am to a certain small extent financially interested in your firm. I am glad to say, however, that up to the present there has been no panic on the Stock Exchange about the position of your concern, the manufactures of the company bear a good name, and I am therefore impelled to the opinion that you have been raising the "Wolf" cry.

Now, to a man of your decent disposition and average intelligence, it does not need to be elaborately demonstrated that to have the reputation of being an unfair critic is about the most unfortunate character you can get. Most fellows of the better sort have an instinct for equity, and I have known cases where a man has yielded a point or two that he believed to belong to him rather than run the risk of falling into unfairness.

It is puerile to take up the position that master and man are natural enemies, and fair game for each other's venomous criticism. When I was a boy at school I imagined that I was doing a great and glorious thing in shielding a schoolmate from well-deserved castigation. The argument, so far as I can recollect it, was: The master is bigger than us, therefore he can, and will, thrash; therefore he is our enemy; therefore we must exercise our utmost ingenuity and, if necessary, suffer tortures, to make his life a misery. And we did it. And precious little fools we were. A good many workmen reason on the same lines with respect to their employer, only as they daren't play monkey-tricks for fear of losing their job they take it out in criticism. It is no use saying to this type of malcontent, "Put yourself in his place," because he knows he will never have a chance of getting there. Consequently he can make foolish utterances, with the knowledge that he will never have to eat them afterwards. If you analyse the shop criticisms you hear, you will deduce two things; first, that certain criticisms become general property, each man saying that thing because it is fashionable, and each one believing it because everybody else says it; second, that any man bringing a fresh criticism into the market goes about for the rest of the day with the swagger of a new recruit on his first evening out, to the admiration of all beholders. If you can preserve your independence of thought to the extent of detaching yourself from an opinion that is generally accepted as an axiom unless it appeals directly to your own reason, you will see that many shop criticisms are short-sighted and one-sided; if you can keep your natural fairness intact through the rasping influences of shop-life, you will understand there is no glory in picking holes in a man's coat unless some tangible good can come of the ventilating process.

The boss of a works has a very difficult job. He has not merely to fashion his own work in all its details with the aim of making it successful, but he has to originate master-thoughts for all the intelligences under him. Detail thought is fairly simple. The workman who cannot think out the details of the job he is on is an idiot, and should be given an outside berth with no screw attached. But master-thinking is different. Phil May was a genius at line-drawing. He could express as much with three curves and a wiggle as most men could get with a maze of cross-hatching and stippling. His method was to get his picture down somehow, and then to eliminate, line by line, all unnecessary strokes till only the master-lines remained. The picture, splendid in simplicity, was then presented for the beholder to fill in his own mental conception of light and shade. The works manager, if he manages at all, is the master-line man. He puts in the sweeping strokes of policy. His is the sphere of broad effects. You are given a little bit of the general picture to fill in with light and shade to the best of your ability. You are a subordinate, but you are as good a man as your boss if, and only if, you perform your function as well as he does his. If you jab in your finishing touches in a slipshod manner under the conviction that the whole picture is a mess, the probability is that your part of the show will be conspicuous by its wretched execution. The man has not been invented yet who can at one and the same time growl at the general scheme and put in good work on the part entrusted to him. On the other hand, a good morsel of detail work may possibly save a general scheme from wreck.

Another thing that wants guarding against is selfishness. Don't try to run the show if someone else is paid to do it. If you are capable and the boss isn't, the surest way of convincing the shareholders that you are the better man is to make the excellence of your particular department scintillate against the general background of mediocrity provided by your chief. If you are really superior to your boss it will not be long before other people are in the know besides yourself, provided that you express the state of the case in works rather than words. I understand that the truth about the Russian disaster on the Yalu was that one of the subordinate generals thought he knew a lot better than his commander-in-chief. He pushed his own success and crumpled up the entire army. Consequently he got himself disliked. Don't you!

As a final exhortation, let me implore you, if you really must quarrel and criticise and kick because of your employer, to make a confidant of the household cat. Previously lighting your pipe, esconce yourself in front of the fire in your private sitting-room and induce the cat to repose on the hearthrug. Produce that state of satisfaction in the

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beast which is indicated by loud rumbling noises, either by stroking it, addressing it in endearing accents, or other blandishments. Carefully note that the door and windows are completely closed, and then pour out your sorrows to the cat. Let yourself go—let there be no reserve; consider the cat as your wife or your familiar demon. The animal will probably turn its greenish eyes upon you with silent sympathy. It may even be moved to rub its head against your trouser-leg or to leap upon your lap. However this may be, you may be perfectly certain that it will not repeat what you have said. And this is the greatest qualification that a cat can have, from the point of view of a subordinate like yourself, whose ideas are divergent from and superior to those of his boss. Anyway, don't write to me again indicating that you can see further and know better than your chief, because I shall just pitch your letter into the fire.—Yours, THE OLD 'UN.

ELECTRICITY IN FACTORIES.

PROPOSED NEW REGULATIONS.

In our issue for Oct. 21, on p. 602, we published a draft received from the Home Office of some proposed regulations dealing with the use of electricity in factories. Before these come into force an enquiry will be held before a committee, and it is extremely desirable that anyone having objections to the regulations should bring forward the same in good time. That some such regulations are good for the whole industry we have no doubt, but it is equally important that the wording actually adopted should be such that clauses do not prevent the spread of electrical driving in factories, nor hamper developments in the application of electricity to factory work generally. We have carefully gone through the proposed regulations and have talked the matter over with a number of firms interested. The following are some of the amendments which have been suggested, and we publish them in order that others may again look through the regulations and see whether these amendments could not themselves be improved upon before the committee meets to hear evidence. These amendments are:

(*a*) *Clause* 1.—The totally enclosing of wires in strong metal casings is objected to on the grounds of (*b*) inaccessibility of conductors; difficulty in maintaining satisfactory insulation resistance between conductors and earth; in totally enclosed metal tubing, owing to the condensation of moisture in such tubing; difficulty of inspecting the condition of conductors when in service; difficulty of localisation of faults and the remedying of same, due to the inaccessibility of conductors; increased first cost. It is suggested that cables supported on insulators, spaced a suitable distance apart, are readily accessible and enable the insulation resistance to be maintained at its maximum value. It is suggested that Clause 1 be amended as follows: (*c*) "All wires in connection with the supply shall be so arranged that there shall be a minimum danger from shock or fire. Where readily accessible, the wires shall be completely enclosed in strong metal or other approved casing."

(*a*) *Clause* 2—(*b*) It is suggested that where suitably-designed automatic circuit breakers are used it is unnecessary to use switches in series with them, as an automatic circuit breaker is an equally reliable device to a switch, and, in general, is better adapted to open a circuit under emergency conditions. The addition of a switch under the circumstances increases the first cost of the installation without increasing the safety of the arrangement. It is, therefore, suggested that this clause be amended as follows: (*c*) "All mains and branch circuits should be protected by switches and fuses, or by automatic circuit breakers. Where circuit breakers are used on one pole only they shall be fitted either with a free handle device, or equivalent, to prevent the possibility of a circuit breaker being held in on a short-circuit"

(*a*) *Clause* 3.—From the word "provided" on the seventh line to the end, involves the provision of a separate switch for single arc lamps, even when connected in series, and prevents the control of such lamps in groups when the pressure exceeds 250 volts from earth. (*b*) As various manufacturers are already supplied, and more will undoubtedly be supplied in the near future from a system of power supply which is also furnishing power for traction purposes at 500 volts, and on which systems the negative pole will consequently be earthed, in the case of groups of arc lamps or other similar devices in series between the conductors there will be 500 volts pressure from earth. It is suggested that the extra cost and complication of a separate switch to each lamp, owing to the grouping of lamps connected across a 500-volt circuit, besides the extra cost involved in the wiring, is unnecessary. It is, therefore, recommended that this clause be amended from the word "provided" on the seventh line to the end as follows: (*c*) "That where arc lamps are connected in series across conductors on a circuit, the pressure of which cannot exceed 650 volts from earth, it shall be sufficient if one double-pole switch, conveniently placed, be provided for each such series of arc lamps."

(*a*) *Clause* 5—As regards the words "all metal holders for incandescent lamps." (*b*) It is suggested that this clause would increase the cost of the installation of electric lighting in factories in many cases to a prohibitive extent, and would entirely prohibit the use of plain pendant fittings in positions for which they are eminently suited. The provision of earth-wires for the metal parts of all such fittings, even if practicable, would be a very serious item. Further, in the event of the lighting being connected to a three-wire system, with a grounded neutral and an earth occurring on to the metalwork of the fitting, the full potential between the outers of the three-wire system would exist between the fitting and earth. The following amendment is therefore suggested: (*c*) Omission of the words, "All metal holders for incandescent lamps." The amended clause will then read: "The frames of all motors and metal casings of all wires, switches, and fuses and cut-outs shall be efficiently connected to earth."

(*a*) *Clause* 6.—While this apparently refers to apparatus under the control of public supply authorities, is it intended in Clause 6, paragraph (*a*), that the provision of a fuse in the neutral is prohibited only in so far as the service lines are concerned, and that fuses may be used on both poles of branch distribution circuits, one pole of which is connected to the neutral service lines. This applies particularly to lighting installations which are supplied from one outer and the neutral of a three-wire system.

METHODS OF CABLE-LAYING.

BY LEONARD ANDREWS, A.M.I.C.E., M.I.E.E.

If there is one subject more than any other upon which engineers hold widely different opinions, it probably is the much-discussed question of laying electric light mains. Some pin their faith to armoured cables laid directly in the ground, others prefer plain lead-covered cables laid in troughs filled with bitumen, whilst many others will have nothing but some form of drawn-in system. Each particular system has its peculiar advantages, and it is impossible to obtain any system in which all the advantages of other systems are combined. The advantages and disadvantages of some of the systems that have been most largely used are summarised below:

ARMOURED CABLES LAID DIRECT IN GROUND.

Advantages.—For open country work, where there are no gas and water pipes, armoured cable can be simply and cheaply laid directly in the trench by merely unwinding the cable drum over the trench, thus avoiding all risks of straining the cable. This advantage disappears if the cable has to be threaded under the many gas and water services that exist in most streets.

Disadvantages.—Difficulty in localising faults. Steel armouring liable to be attacked by salts or acids in the subsoil. Armouring practically no protection against spikes and picks. Highly susceptible to electrolytic troubles.

LAID SOLID IN TROUGHS FILLED WITH BITUMEN.

Advantages.—High insulation between lead sheath and earth. Freedom from electrolytic troubles. Excellent for distributors.

Disadvantages.—Difficulty in localising faults. Provides no means of increasing the capacity of feeders, and consequently entails a very heavy and to some extent unnecessary expenditure on copper when the earning powers of the undertaking are small. As the ultimate requirements are usually

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underestimated, the streets have often to be reopened to lay another feeder.

DRAWN INTO IRON PIPES.

Advantages.—A faulty length of cable is easily drawn out and replaced by a sound length. Spare ways may be laid to provide for extensions.

Disadvantages.—Pipes rust very quickly, and if cable is protected with braiding a rust joint soon forms between the braid and the interior of the pipes, entirely preventing the withdrawal of the cable. Lead sheathing being uninsulated from earth, the strain on the insulation between conductors and earth is greatly increased. Liable to electrolytic troubles unless pipes are efficiently bonded throughout.

COMMON EARTHENWARE PIPES LAID DIRECT IN GROUND.

Advantages.—Cheap.

Disadvantages.—Impossible to keep watertight, therefore increased strain on insulation, and electrolytic troubles are almost certain to cause cable to break down in course of time. No protection against picks, etc.

MOULDED CONCRETE.

Advantages.—Affords good mechanical protection to cables.

Disadvantages.—Impossible to keep watertight, therefore ultimate damage to cables liable to be as great as in the case of common pot pipes.

HIGH-CLASS EARTHENWARE DUCTS.

Advantages.—If well laid on a solid bottom, and all ducts are carefully examined for cracks before laying, a dry conduit may be secured.

Disadvantages.—Insufficient mechanical protection. Liable to be rendered inefficient by any subsidence of the subsoil.

HIGH-CLASS EARTHENWARE LAID SOLID IN CONCRETE.

Advantages.—Undoubtedly constitutes, when well laid, an excellent conduit system.

Disadvantages.—Very high first cost. High percentage of breakages. Ducts can only be obtained in short lengths, entailing a large number of joints. Cost of laying very high. Cost of cartage and handling high.

ORDINARY BITUMEN DUCTS.

Advantages.—Efficient insulation between lead sheath and earth is secured.

Disadvantages.—The heating of the conductors due to C^2R losses causes the cable to stick to the ducts, with the result that the cable can often not be drawn out, and the great advantages of a drawn-in system are consequently lost.

FIBRE CONDUIT LAID SOLID IN CONCRETE.

Advantages.—The cost of this system is considerably less than that of a high-class earthenware conduit, even when the latter is laid direct in the ground. Excellent mechanical protection is secured, and there is no risk of injury from subsequent disturbance of the ground. The conduit is an excellent insulator, and is absolutely watertight. The strain between conductor and earth is, therefore, reduced to a minimum, and electrolytic troubles are entirely overcome. It is very simple to lay. One man has laid over 6,000ft. in 10 hours. It is very light, and the cost of cartage and handling is consequently low. It is entirely unaffected by salts or acids. It is tough and mechanically strong. The percentage of breakages is in consequence very small. It is supplied in 5ft. lengths. It does not become sticky with a rise in temperature. Experience has shown that cables that have been laid some years can be drawn out as easily at the end of that time as they can be drawn into a new earthenware conduit.

Disadvantages.—Is not quite so cheap as a common earthenware pipe.

The system last referred to is comparatively new in this country, though it has been used in the States for about 10 years. It was first brought to the writer's notice a few months ago, and he has since persuaded a number of engineers in this country to lay some trial lengths, and they all, without exception, report favourably upon it. The conduit is composed of a mixture of wood fibre, bitumen, and paraffin wax, the method of construction being such that all ingredients are thoroughly mixed in the exact proportions which long experience has shown to best meet the conditions required. Each length of conduit has spigot and socket joints that fit perfectly into each other, making an excellent joint of the same external diameter as the rest of the pipe.

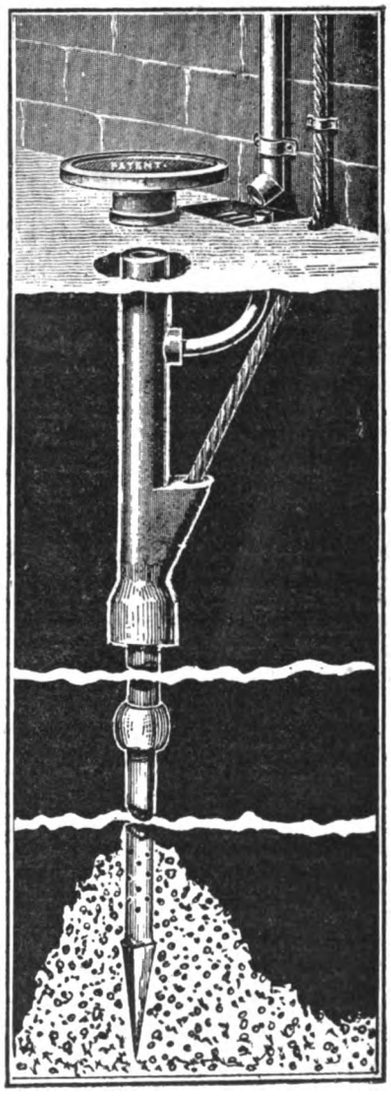
The method of construction employed in New Jersey, where over 260,000ft. of this conduit have been used, was as follows: After the excavation was made a bed of concrete was placed on the bottom of the trench, then a line was drawn taut on one side, next to which was laid the first line of duct. The remaining lines of duct were laid parallel to the first and separated ½in. from each other by means of wooden pegs. After the first layer was laid, it was covered with concrete and well grouted, sufficient concrete being used to cover the first layer to the depth of ½in. The succeeding layers were laid in exactly the same way. The majority of the ducts were laid in five layers of six ducts per layer. Owing to an obstruction, a portion of the system was laid in two layers of 15 ducts per layer. This was an exceptionally difficult installation, owing to the large quantity of water present necessitating the frequent use of an electrically-driven hydraulic pump. Even though the conditions were unusually severe, the contractor made a record, one man in the trench and two helpers above laying over 15,000ft. of duct (nearly three miles) a day, exclusive of concrete.

A heavier build of fibre conduit with screwed couplings is largely used for laying single-way ducts directly in the ground, in positions where the cost of concrete would be prohibitive.

TRADE NOTICES AND NOVELTIES.

Hedges's Tubular Earth.

The accompanying illustration shows the arrangement of Mr. Killingworth Hedges's patent tubular earth for lightning conductors, known as the "Air-to-Earth" system. This earth has three principal parts—the upper, which is electrically connected to the cable or tape; the lower, which forms the actual earth; and the cap marking the position. To sink it, the perforated steel-pointed end is attached to a length of wrought-iron pipe fitted with barrel-shaped sockets. A driving-piece is then screwed into the top socket, and struck by a sledge-hammer, other lengths of pipe being added and driven down in a similar manner until moist ground is reached. This done, the conductor is threaded through the projecting piece of the cast-iron top, and dropped to the bottom of the tube, which is then filled up completely with granulated charcoal or carbon. The top piece can then be lowered, and the electrical connection made in the same way as the joint of a water or gas main, by molten lead and caulking. With the cap which marks its position in place, the earth is then complete, but in order to render it permanent a ¾in. or ¾in. gas-pipe is led from one of the holes in the top piece to the



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nearest rain-water pipe. Where there is no rain-water pipe handy, the earth can be kept damp by occasionally lifting the cap and pouring water down the tube that way. It is claimed that the conductivity of this earth is perfect and constant, while the first cost is less than for the plate earth, which latter has, moreover, to be tested periodically. It remains to add that the device has been used at a large number of public buildings and elsewhere. The licensed makers are the Carboid Company, 1, Emery-hill-street, Ashley-gardens, Westminster, and the General Electric Company, Limited, of whom further particulars may be obtained.

Crypto Electrical Specialities.

The accompanying illustration, Fig. 1, shows a "Crypto" induction motor, which is "special" in that the starting is

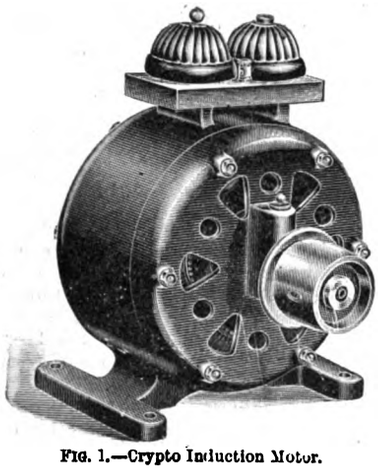

FIG. 1.—Crypto Induction Motor.

accomplished by simply closing the switch and pressing the button mounted on the top of the machine, the usual starting switch and resistance being dispensed with. Fig. 2 illustrates a "Crypto" motor-generator set designed to meet the requirements of those who, although supplied from alternating-current mains, wish to have a supply of continuous current for charging

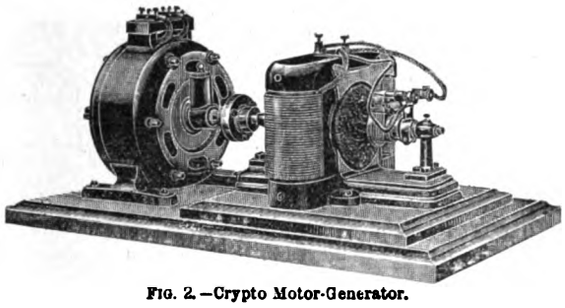

FIG. 2.—Crypto Motor-Generator.

accumulators, etc. For further particulars of these useful specialities we must refer the reader to a new list just issued by the Crypto Electrical Company, 3, Tyer's-gateway, Bermondsey-street, London, S.E.

Catalogues, etc., Received.

CROMPTON MOTORS.—In their new catalogue of continuous-current motors, Messrs. Crompton and Co., Limited, have, they inform us, endeavoured to give as much information as possible regarding the machines offered. They have fully standardised these motors, and are manufacturing them in very large quantities. Driving conditions, however, vary so largely that they often introduce considerable modifications in the mechanical parts. In the past English makers have been in the habit of carrying out these alterations either free or at a comparatively small extra charge. But this has been possible only by manufacturing the machines in small quantities, or by charging such a price for the standard machines that it will cover to a certain extent the cost of these alterations. Foreign competitors have adhered more rigidly to their standard designs, and refused definitely to make any modifications. Messrs. Crompton and Co. have endeavoured in their new list to take a middle course. They have reduced the prices of their standard motors to the very lowest figure, and if a customer requires some special modification introduced, they are prepared to make the same, in this case charging him with the full cost. The above is the system on which Messrs. Crompton and Co. have prepared their list. They have taken a plain motor as their basis, and have quoted separately for each variety of driving gear, from the ordinary belt to a geared motor. In geared motors, we notice, they have standardised three different speed ratios for each machine. The questions of "variable speed," "totally enclosed," and "reversible crane motors" are dealt with briefly in the list under notice, while the over-all dimensions, net and gross weights, and shipping measurements of the motors, particulars of the firm's standard pulleys, flywheels, couplings, foundation bolts, etc., are given. Some space is also devoted to starters, about which a considerable amount of information is given in a very handy form. To facilitate reference, the starters have been divided into three different types, each type representing a different rating in the resistance—viz., light-load starters, half-load starters, and full-load starters. These starters are listed with no-volt and overload releases, separate quotations being made for the various extras required for each type. The system here outlined, which has been adopted by Messrs. Crompton and Co., and so carefully elaborated by them, should commend itself to their customers.

ARC LAMPS.—From the British Thomson-Houston Company, Limited, Rugby, we have a copy of their pamphlet No. 176, describing the three forms of continuous-current series-multiple arc lamps which they manufacture. The first, with entirely self-contained line and substitutional resistances inside the lamp; the second, with self-contained substitutional and external line resistances; the third, with a self-contained line resistance only. The first and second forms are adapted to operate two in series on 200-250-volt circuits, and five in series on 500-600 volt circuits. The third form is suitable for operation two in series on 200-250-volt circuits only. It should be mentioned that this publication supersedes the firm's pamphlet No. 156 in part. An index to British Thomson-Houston current literature is also to hand.

DYNAMOS AND MOTORS, ETC.—The Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., have recently issued a new list of their dynamos and motors for continuous current. This list is in three sections. The first (Section A) fully describes the special features of the machines, which are of a type designed to meet the growing demand for dynamos and motors of light weight, occupying small space, and possessing a large overload capacity, the brushes being fixed independently of the load. Section B is made up of tabulated data—mainly electrical—relating to the different standard sizes, which, it may be mentioned, cover a wide range, while Section C is comprised of line drawings and tables of dimensions. From the same firm we have three leaflets giving particulars of continuous-current and three-phase small motors for special purposes, such as driving dentists' machinery, massage apparatus, polishing discs, emery wheels, sewing machines, etc. We have also a reference list of dynamos and motors supplied by the Electrical Company, Limited and a leaflet illustrating their contact clock, which can be used in combination with any type or make of direct or alternate current watt-hour meter to form a two-rate or double-tariff system.

MOTOR STARTERS.—Messrs. Johnson and Phillips have recently issued a separate list of their motor starters dealing with standard sizes, from ¼ h.p. to 50 h.p. The design of these starters combines several special features. For instance, although fitted with the usual no-voltage and overload coils these starters have a special mechanism whereby they cannot be operated against an overload.

THE SCHULER MOTOR.—Some interesting particulars of the Schuler motor are contained in List No. 27, recently issued by the Lahmeyer Electrical Company, Limited, Bank-buildings, 109-111, New Oxford-street, London, W.C. It is pointed out that this motor is especially suitable for lift and crane work on single-phase circuits, due to its very large starting torque.

WESTINGHOUSE MOTORS.—The British Westinghouse Electric and Manufacturing Company, Limited, have lately published a revised circular dealing with their type "S.B." direct-current motors, ranging in size from ¾ h.p. to 100 h.p. The special features of these machines are fully described and illustrated, while the circular also includes many pages of tabulated data.

New Books Received.—"Einleitung in die Theorelische Elektrizitätslehre," by Dr. Ignaz Wallentin, K. K. Regierungsrath and inspector of State schools at Vienna. Illustrated with 81 diagrams. B. G. Teubner, Leipzig. 12s. This is vol. XV. of Teubner's collection of text-books for mathematical science and its application "Elements of the Mathematical Theory of Electricity and Magnetism," by J. J. Thomson, M.A., D.Sc., LL.D., Ph.D., F.R.S. Cambridge University Press. The most important of the alterations made in this third edition consists of a new chapter on the properties of moving electrified bodies. The author says many of these properties may be found in a simple way, and the important part played by moving charges in modern physics seems to warrant a discussion of their properties in even an elementary treatise.

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CHELTENHAM ELECTRICAL UNDERTAKING.

The following is the full text of the report presented by Mr. James Swinburne (of the firm of Swinburne, Cooper, and Baillie) to the Corporation of Cheltenham. It is dated Oct. 22, 1904, and was considered by the Council last week.

Introduction.

Gentlemen,—The position is that in 1893 the Council decided to put down a central station for supplying Cheltenham with electric light and power. This has been carried out, and has resulted in an excess of expenditure over revenue, which is a disappointment to many, and I have been instructed to investigate the working of the electrical undertaking, and to report both as to its business and engineering management. Such cases as Cheltenham are by no means uncommon, and a great many local authorities are finding out that electrical generation and distribution are not necessarily as profitable as originally expected, owing to the difficulty in exactly appreciating the conditions necessary for success.

The town of Cheltenham is peculiar in many ways. It is essentially residential, and is spread over a large area in proportion to its population. The private houses of the most well-to-do residents are generally in their own grounds, so that the customers otherwise most profitable are spread over a large area. It is not a manufacturing town to any important extent, so there is but little sale of energy to private consumers for power purposes. The public street-lighting is carried out with arc lamps in a more elaborate way than usual, and many of the important streets are especially difficult to light well, owing to the foliage. The electrical tramways are worked by a private company supplied with energy in bulk from the Council's works. Cheltenham depends largely on its reputation as a health resort and as an attractive residentia l town; and in such cases it is usual for local authorities to sink money in public works which, though in the first instance coming on the rates, attract more visitors and residents, so that, the total rate being spread over a larger number, the rate of each individual is reduced rather than increased by an expenditure which has no direct return. Public works which make a town more attractive also increase the incomes of business and professional men, and the increase of rates in such cases may be more than covered by increase of income. A large proportion of the residents of Cheltenham, however, are not dependent on local prosperity. They have independent incomes, generally fixed, and are interested in keeping the rates down. Unless, therefore, non-paying public works increase the town so that their own rates actually decrease, they get no benefit from them in that way.

In making this investigation I have had every assistance and the frankest information from the officers of the Corporation, and I am especially indebted to Mr. Kilgour for the great trouble he has taken in giving me quantities of detailed information, and to Mr. Seacome. I have also been greatly assisted by the speakers at the representation on the 13th, especially Messrs. Ansell and Ley-Wood, and Major-General Babbage. A great many points they brought forward are not specially dealt with in the report, either because they did not prove to be valid criticism, or because they do not involve any important financial results, or else because they are involved in matters treated in full. I prefer to deal broadly with the whole question, and not to go into more detail than necessary to give a clear idea of my view of the position.

Accounts.

As the determination of profits depends very largely on the accounts, and as a great deal of what I have to say turns on what is a fair allowance for depreciation and antiquation, I will deal with the accounts first. The statutory method of keeping the accounts of a municipal electric undertaking is not adapted to the purpose, as it was apparently conceived without any idea of municipal trading. If a sewage works is put down a loan is raised, and the theory apparently is that the costs of working are made up out of the rates, and enough is also raised annually to pay off the loan in a certain period. This would be simplicity itself if the sewage works lasted exactly the term of the loan, and no longer. If at the end of the term it is as good as ever, and fit for another 25 years' work, it is clear that capital has been accumulated out of the rates. On the other hand, if it had to be superseded in 10 years, there is a loan left and no plant, and the question is complicated, more especially as the plant is not really the security for the loan. Whether municipal trading is good or bad is not to the point; municipal trading is fully recognised by Parliament, and electric lighting and tramways are recognised municipal trading, having come into the scope of local authorities because they involve interference with the streets. The accounts should therefore be suitable for a trading department; but they are not. An electric department might be comparable with a company in which the ratepayers are the shareholders and the council are the elected directors. If we follow this out, we have a company which is not allowed to have any subscribed capital. When capital is needed it issues debentures redeemable gradually over many years, and such debentures are not allowed except for buying plant. The plant is not security for the loan, but if it wears out before the loan is repaid, the company will be forbidden to issue any more debentures for new plant to replace it. The real security is the liability of the shareholders, or ratepayers. They hold no stock, but they take any profits, and find any losses. Their liability is unlimited as long as they stay, but it ceases if they go away. But they then generally become compulsory shareholders in other undertakings. No working capital is permitted. An industrial concern provides capital for running at a loss during the first few years; but in our analogous municipal company the shareholders pay rates or negative dividends to make up the trading losses.

Under such circumstances it is difficult to get out satisfactory accounts. The mere matter of dealing with debentures instead of capital would in itself give little trouble, but a great difficulty arises in estimating depreciation apart from sinking fund, and as the repayment and depreciation are the most serious items, there is a great uncertainty as to the real state of a concern. For instance, if money is borrowed for 20 years and an electric lighting station put up, and that installation just lasts 20 years without any repairs and then becomes valueless when the loan is paid off, there would have been an exact balance; but if the installation is as good as ever it is clear it must have been paid for out of profits, for as there is an installation to the good, and no loan against it, and no capital account, it must have come out of the revenue account. But suppose the installation needs repairs from time to time, small at first, and greater towards the end, so that it is as good as ever at the end of 20 years. Again we have a station to the good, and as there is no capital and no loan it must have come out of revenue. But suppose, on the other hand, in spite of frequent repairs, it becomes useless in 10 years, then we have a loan running, and no installation, so too little has been taken out of revenue. A private commercial concern would estimate how much it would cost on the average to keep the station in thorough order, or to build up a plant to replace the capital when the station had to be rebuilt. This would be the depreciation. The private undertaking will allow interest on the capital invested, and depreciation, including maintenance, to keep the machinery up to the full value of the capital. If the municipality charges the same interest and depreciation as the private concern, it has at the end of 20 years paid interest and depreciation, but has, in addition, paid off the loan or capital, so that it has taken too much out of revenue to the extent of the repayment. We thus find that depreciation should be charged in the municipal case, but, other things being equal, it should be less than the private concern's depreciation by the amount of the repayment. This is not a recognised principle; it is a personal opinion. The whole subject is much debated by leading authorities, and I have had to come to a decision to act upon here, so I give my reasons.

But in practice the case is much more complicated. Suppose, say, £10,000 is borrowed, and, say, a steam set put down, and the loan to be paid off in 20 years. Suppose ample maintenance allowed, so that the plant is in perfect order at the end of 10 years. It is then proposed to extend by borrowing another £10,000. Suppose the old plant is in perfect order—as good as when new, in fact—but the new plant to be put in is so much more efficient that it will pay better to scrap the old plant and put in two new sets. If application is made to the Local Government Board to borrow £20,000 and replace one set, they will refuse on the ground that that leaves a loan without its corresponding plant, and will cut the loan down to £15,000—that is to say, a deduction is made for the outstanding portion of the first loan. The result is that it is impossible to replace any machinery that becomes obsolete before its loan is repaid, except by improper methods, such as borrowing money for a total of three sets, and then discovering, after the money is obtained, that two will do the work if they are both new. This obliges local authorities to be irregular as regards loans, and this one element makes great confusion. Thus in the case taken, putting down the second £10,000 plant may be clearly a good investment; but replacing the first by a new and more economical plant is a different question altogether. The whole profits of the second set are to the good, but in the first set the investment of the £10,000 to replace it is only good if the difference of profit from the old and new sets will repay the investment of £10,000. The obvious way of keeping the matter straight would be to pay off the first loan. Thus, supposing there is £5,000 of the loan still owing, and the set is worth £2,000 as scrap, £13,000 is borrowed and the old loan paid off. In putting in the new set the council then considers whether it will pay at £10,000, but the replacing set must pay on £13,000 or it should not be put in. But this is not done, so the capital accounts become a tangle of loans, redeemable at different dates, borrowed at different times, at all sorts of rates of interest, and having no traceable relation to the plant actually in existence. The only way I can treat this is to regard the total loans as the capital of the concern, and to deduct the repayments from what would fairly be allowed as depreciation in a commercial under-

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taking. It is a serious question, however, what rate of depreciation should be charged on plant that does not exist. In the hypothetical case of the £10,000 set, assume the £10,000 is borrowed, and the first set sold for £2,000 while there is still £5,000 owed on it, when is the £3,000 to be paid off? It may be wiped out in a year or two, or spread over the remaining term of the loan. The latter is the most convenient course, but it makes the accounts look better than they are in the meantime. On the other hand, depreciation is not chargeable on £30,000 when the two sets are running, and the old one gone, as there is only £20,000 of plant depreciating, but the repayment must be calculated on £30,000. At Cheltenham plant has been discarded; the result is that the sinking fund is partly to pay off loans whose corresponding plant is not there. The real state is thus worse than the accounts alone can show, but only to a small extent. In the question of depreciation and antiquation even commercial electric supply concerns are rather apt to underestimate the necessary allowance.

I would suggest as to the accounts: (1) That the interest and sinking fund should be charged as usual. (2) That a depreciation and antiquation fund on the present value of the plant, etc., be charged at a percentage rate that would be charged in private concerns, less the percentage rate for the sinking fund. Repairs and other maintenance charges to come out of this fund. (3) That a rent should be charged for the works, such as the Council would have obtained had they let the ground. (4) Properly speaking, the works should be charged with the same rates as they would have paid had they been a private concern, as the town would have received these rates had the concern been a company. This is advisable for the sake of accurate knowledge.

The Station.

In dealing with the matter before me, the first question is whether the Council was originally well advised in starting the electric light works in Cheltenham. Ten years ago it was the accepted opinion among engineering and financial authorities that electric lighting would pay well in such a town as Cheltenham. The Council, as a safeguard, took the opinion of authorities of highest repute in the profession. Their reports must be read in close connection with the particular scheme that was before them at the time, and not as dealing with the undertaking as now developed. Under the circumstances the Council were perfectly justified in going into electric lighting—in fact, they might have been open to censure if they had not.

The next question is whether alternating or direct current should have been employed, and where the station should have been. The station was put where it is to be near the destructor, which was expected to supply steam for some 70 h.p. At that time the idea of getting steam from destructors was very prevalent, but though in some towns the destructor helps, this depends on the type of destructor and on the type of town refuse. This varies from place to place. Cheltenham being a scattered town, the road refuse may be large in proportion to the combustible house refuse. In my opinion it would have been an error to put the station where it is for the sake of the destructor alone, especially as the steam pressure was 80lb. on the square inch. It is, however, an advantage, especially important in a place like Cheltenham, to put the station out of the way, as there is sentimental objection to its being in the middle of the town. But this means cost of high-pressure mains, and sub-station transformers. The long high-tension mains mean money in capital, for themselves, for the transformers, and for the buildings, and cost in revenue also. It would, I consider, have been better to have had the station more central, distributing by low-pressure alternating currents in its neighbourhood and by transformers in the distant portions, or, as is more usual, by direct currents on the three-wire system, at any rate, for the important and central districts. Ten years ago, however, the system that has been adopted was the fashion, and it was very natural that it should have been selected for Cheltenham. I do not consider that the question of the position of the station is vital; it would have made some but not a great deal of difference.

Distribution.

I find the main cause of the present position of the undertaking is that it has been managed too much with a view to a rosy future than a matter-of-fact present. As an instance, the supply of energy was commenced about May, 1895, from works costing £16,880, but in July of the same year it was decided to apply for a loan of £10,000 for extension; then again in February of the following year it was resolved to apply for a further loan of £15,000 because of the delay in obtaining the sanction of the Local Government Board. It would have been more prudent to have accepted the view expressed in Mr. Hall's report until there were distinct indications that the undertaking would pay. I may mention this instance as an illustration of what I conceive to have been the general policy. If the mains are laid over a scattered area to meet the demand of a few consumers, it is clear that a little extra cost will make them large enough to meet a large number of consumers. For instance, when the first consumer in a street comes on, a main may be laid that will just supply him, but it is better to put down a larger main that will supply something like the expected future demand along it. The cost of the mains themselves is but little more, and the laying is the same. Adding more main capacity afterwards costs as much as the original mains unless an expensive draw-in system is used. The same reasoning applies to transformer sub-stations. A sub-station put down for a small local supply may soon be too small, and if the supply grows, a new sub-station will cost a great deal more than the extra expense of making the original sub-station large enough. It is, therefore, sound business to put down distributing mains and accessories capable of coping with a much larger demand than is guaranteed or expected immediately. But, though it may be impossible to go slowly in each street, it is not impossible to go cautiously in a whole town. The sound method would have been to carry out the intention of Mr. Hall's report and to have secured the greatest number of consumers with the smallest capital expenditure. This could have been done by wiring that portion of the town where the demand was likely to be the most dense. It could then have been nursed up until the consumption was heavy in proportion to the mains. The most promising streets in the optional area could have been cabled afterwards, and so on. This may sound slow, but it is safer. Instead of this, mains have been extended in a way which points to a complete absence of consideration of their really probable revenue. When a main is put down which cannot be remunerative for some years, it must be remembered that the depreciation and interest are going on in the meantime, so that a distant revenue must be much larger to pay for immediate capital investment. In many of the streets and roads it will be long before the revenue will be sufficient. I may mention as examples of such mains, the high-tension cables along the Evesham-road—part of this is outside the municipal boundary; the high and low tension mains along Hale's-road, Battledown-approach, and Birchley-road; the high-tension main along Oakley-road; the low-tension main and transformer station in Hewlett-road; the high-tension main along Alstone-lane; the high and low tension mains along Queen's-road; the high and low tension mains along Lansdown-road and Gloucester-road; the high and low tension mains in Park-drive. I mention these to show the type of main that is generally unprofitable.

The consumers in Cheltenham are particularly difficult to supply economically, as so many of the houses are villas in their own grounds, scattered sparsely along broad roads. The length of the mains and services are thus excessive. The Council is not compelled to provide light anywhere outside the compulsory area, and need not do so unless it will pay. As a safeguard against unreasonable refusal on the part of the Council, the order authorising the lighting provides that customers can demand supply on specified terms which practically ensure safety to the Council but are rather prohibitive to the consumer. In practice it is usual for the lighting people to make special terms by which the outlying consumer pays a fair contribution towards the service, or guarantees a minimum revenue, or both. It must be borne in mind that the consumers who insist on light in a sparse district are expected to guarantee enough revenue to go towards repayment of mains; it is not only a question of services. That many consumers are willing to take the light on such terms is shown by their doing so during the last year, but before that time expensive outlying consumers appear to have obtained the light on the same terms as those in the compulsory area. This must have been a source of loss to the undertaking. The result is that the system of mains in Cheltenham is a sort of skeleton, with very little on it. All that is wanted is flesh on the bones. This growth must be a matter of time, and I have no doubt the revenue will increase in the near future without corresponding increase of capital expenditure, as the mains are there; but many of the mains will always remain a very doubtful investment. In my opinion, the extension of the mains has been too rapid, and somewhat reckless. This puts the undertaking at a great disadvantage during its early life, and though it has its advantages later, when more lights can be taken on at small extra capital cost, the policy has been carried to extremes.

Public Lighting.

In dealing with this it must be remembered the Council is both buyer and seller; it is simpler to consider the electric works as a separate concern. We have therefore to consider whether the light is what the town wants, and whether it pays a fair price for it, from the town's point of view, and whether the lighting is the best the works could do from the point of view of internal economy for a given amount of light, and whether the price paid the works is right from the works' point of view. The public lighting by arcs in Cheltenham has increased from 37 lamps in 1898 to 388 now in use. The capital allocated to public lighting appears to be £47,771, making the expenditure on each lamp about £123. The interest and sinking fund on your loans comes out about 7 per cent. per annum, so that the annual cost per lamp under this head is about £8. 12s.

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These figures allow nothing for depreciation and antiquation beyond the repayment, and in my opinion a further 2½ per cent. should be allowed to cover the difference between the depreciation and the repayment. This makes the depreciation and antiquation 9½ per cent., not 10. The cost of energy, however, includes an item for maintenance and repairs, which must be considered as depreciation. Taking this as equal to ½ per cent. on the capital, brings the depreciation and antiquation up to 10 per cent. total. These items together amount to over £11. 13s. per lamp per annum. The total energy generated in 1904 for public lighting was doubtless nearly 700,000 units, or, say, 1,770 Board of Trade units per lamp. The net cost of producing energy for public lighting depends on several unknown factors, and can only be estimated. By taking the cost excluding capital charges to be 1d. per unit, the annual cost of energy per lamp will be about £7. 8s. The cost of carbons and attendance during the year 1903 and 1904 was £1,221, or, say, £3. 3s. per lamp. On this basis the gross cost of each lamp would be £22. 4s., and the total cost would be £8,610 per annum. It is a question of policy as to whether a few streets should be lighted on so liberal a scale, but it appears to me that a town of 50,000 inhabitants can hardly afford to spend the sum of £6,698 allocated to public lighting in the accounts of 1903 and 4, to say nothing of the larger sum of £8,610 necessary to make the undertaking pay expenses, and therefore really borne directly and indirectly by the town. From the works point of view the arc system has been well installed. The system of lighting by special mains with transformers was about the best practice at the date, and from an engineering point of view the arc lighting is carried out satisfactorily.

Tramway Supply.

Evidently if the works asked too much from the tramway, the tramway would either not start at all or it would generate its own power. The cost of generating its own power is, therefore, the upper limit of the price to be asked. The lower limit is the lowest price at which it will pay the works. In estimating what price will pay the works the tramway price should take no account of the capital in town mains, or in anything but the part of the station that works it, and the mains from it. The price charged is, in my opinion, low. It might be raised without approaching too nearly the cost of generating by the tramway people themselves. If the tramways company generated their own power, it is probable that they would have to sink about £14,000 for the generating station and site. The sum to be set aside annually for the payment of interest and depreciation would depend in a measure on the prosperity of the company, but might be put at 12 per cent. per annum. I have taken 12 per cent. instead of 10 per cent. because an investor in a private company, having no security, expects higher interest. A local authority borrows at a low rate, because the security of the rates is behind it. I do not mean that a local authority is at an advantage because it can borrow money at a lower rate. That is not so, because the ratepayers are saddled with the risk as well as the interest. All the same, the extra 2 per cent. should come in in this way in the estimate. The annual charge on this basis would be £1,680. The tramways use about 250,000 Board of Trade units per annum, and the net cost at which they could generate themselves would under the circumstances probably be not less than 1¼d. per unit, excluding capital charges and maintenance. The total cost of energy on this basis would be, say, £3,000 per annum, or 2·88 per unit. The sum obtained from the tramways company in the year 1903 and 1904 was £1,786, or 1·7, leaving a margin of 1·18. The amount of capital allocated to traction by the Corporation is about £12,000, and taking interest, repayment, depreciation, and antiquation on a basis of 10 per cent. per annum, as little or nothing can have been paid for maintenance or repairs yet, the capital charge should be £1,200. The price of energy, making allowance for load factor, and including a proper proportion of management charges, would seem to me to be about 1d. per unit exclusive of capital charges. The total cost must, therefore, be about 2·15 per unit. To permit a profit, I think the tramways company might reasonably be charged a flat rate of 2½d. per unit instead of 1·7d. now charged. I must point out that municipalities often supply themselves, or even private companies, at 1½d. per unit—in fact, 1½d. has somehow come to be regarded as the right price. I have, therefore, given my reasons fully for holding that the price should be so much higher.

The Engineering of the Undertaking.

Apart from the questions of policy in the rapid extension of mains and the installation of sub-stations to deal with a much larger future consumption, and of policy in putting down so many arcs, the engineering has, in my opinion, been carried out well and without extravagance. The station is designed on economical principles, without the somewhat usual extravagance in building design. The total capacity of plant installed at one time and another appears to have been 2,166 kw. Of this a certain quantity of plant has been discarded for adequate reasons. This is not a material point, except that it emphasises my view that a sum should be provided out of revenue for depreciation and antiquation in addition to maintenance and repayment. It is not possible to find out whether the cost of generation is low without making tests of the plant and putting the Council to further expense, which is unadvisable. Comparisons with other undertakings are very misleading because the conditions vary widely. Cheltenham ought to be low, because the tramway and the large public lighting load improve the load factor; but this, on the other hand, suffers from the character of the private lighting, which is largely shops. What is wanted is more private house supply. The main difficulty arises from the heavy load of the capital sunk, which weighs upon the undertaking. This cannot be reduced, and though reducing the working cost to the lowest possible limit is of great importance, the chief thing is to increase the sales so as to spread out the load of capital.

The Future.

The reference does not specifically ask me to make suggestions as to improvements beyond what are implied in the report, but it may be as well to do what I can. The main crux of the position is that the undertaking is heavily handicapped with excessive capital spent on the one hand; while the revenue which would justify the expenditure has not yet come into existence. The capital sunk in the distribution system is largely premature. What is wanted is to render it useful by getting more customers. I suggest that a system of energetic house-to-house canvassing for customers be put in hand. Customers will be especially shy just now, as through the discussions about the lighting they may have got a wholly wrong idea that the supply is in itself bad or doubtful, and they had better not take it. The great aim should be to obtain customers in the streets which already have mains, so as to increase the revenue without a corresponding increase in the capital. Private house consumers are specially wanted; and the canvasser should point out that the best way of reducing the rates is to take the light. A good deal of the town proper has no mains. Even though the unwired districts may not be opulent, they may pay very well if the consumers are close together. New streets into which mains can easily be led should, therefore, be canvassed, but the mains should not be put down until there is ample promise of immediate support.

Many customers are afraid of maximum demand systems of charging; they do not understand them, and think there is something unfair, whereas they really favour the consumer. It may, therefore, be advisable to give the option of a flat rate—that is, payment by energy used, apart from rate at which it is used, or payment corresponding to that for gas. Prepayment meters also bring in considerable revenues in the less flourishing districts of many towns, and are worthy of consideration. On the Continent the "Abonnement," or payment per lamp per annum, system is much liked by consumers, and it might be considered in Cheltenham. Free wiring would no doubt increase the consumption; but it involves further capital outlay if undertaken by the Council. I do not think it would be sound policy to raise the price for private supply. It would tend to discourage consumers. It may be better to encourage them to come on and take advantage of the low rates, increasing the revenue, especially if more of the existing plant is made available by a change in the public lighting.

The capital sunk in the arcs for street-lighting is sunk, and cannot be recovered; the only question is how to reduce the current expenses. I consider in a great many of the streets the public would be well enough satisfied with much less light. I would recommend that Nernst lamps be put into the arc standards, beginning in the less public streets, to feel the way. This would reduce the light, of course, but not so much as to lead to complaint, and it would reduce the cost of power very seriously, depending on the size of lamp used. The Nernst lamps would go into the present standards. The capital cost involved is small, and might be almost met by the sale of the arc lamps. There are other solutions, such as small arcs, especially enclosed arcs, but I mention the Nernst, as I know it well, for I have been connected with the introduction, and it seems the best solution. By reducing the power it allows the plant at the works to be available for taking on more private lighting, and less of the station is then allocated to the arcs, so that the capital charge is also reduced, but not in anything like the same proportion. This change would not show in the electric so much as in the general accounts. It would result in a large saving to the ratepayers in the item of street-lighting, but as the electric department sunk capital in arcs before the Nernst existed, the town should still pay for this capital sunk. The real saving would be that the town would pay less for energy, and the station would have more plant available, and would sell this energy to private consumers without further capital outlay. The price of the power for traction should be raised to something like 2½d.

The question of how the deficit should now be dealt with is hardly in my province as an engineer. I certainly consider it ought to have been charged to the rates each year. 7 (1) (c) of the Electric Lighting (Clauses) Act, 1899, runs: "Any deficiency

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of income in any year when not answered out of the reserve fund shall be charged upon and payable out of the local rate." Whether it should now be liquidated by charging it to the rates, or by a loan, makes no difference in the sense that the ratepayers must pay it in either case in the long run. The deficit has been caused by the present ratepayers through their elected representatives, and it is hard to make the next generation of ratepayers bear the burden.

In conclusion, I would strongly urge the Council to keep the most jealous watch on their capital expenditure. Unless a proposed expenditure shows an immediate revenue such that the profit on the revenue amounts to at least 10 per cent. on capital expenditure the investment is unsound. If the revenue is prospective only, and may only come in some years' time, the capital should be taken as increased at compound interest for the idle years. Neglect of this precaution is very common, and leads to many financial disasters. The Council is alone really responsible for expenditure of capital, and should themselves clearly see the probable profits estimated in money of every expenditure of capital. (Signed) JAMES SWINBURNE.

LEGAL INTELLIGENCE.

RIGHT OF WAY.

In the Chancery Division on Tuesday the action of Ord and Maddison, Limited *v.* the Corporation of Darlington and the Right Hon. John Lloyd Wharton came before Mr. Justice Buckley.

Mr. Buckmaster, K.C., and Mr. Boothwick appeared for the plaintiffs; Mr. Astbury, K.C., and Mr. Gates for the Darlington Corporation; Mr. Danckwerts, K.C., and Mr. Dunham for Mr. Wharton.

The plaintiffs claimed as assignees of John Robt. Ord and Wm. Henry Forster Maddison, and in their own right, an injunction restraining the defendants, their servants, or agents, from excavating, building upon, or enclosing the site known as Freeman-street, Darlington, or from otherwise obstructing or interfering with the plaintiffs' right of way over the street. They also asked that the defendants be ordered to remove the obstruction and restore the surface of the street to its original level, and claimed damages for obstructing and interfering with the plaintiffs' right of way, and for breach of a covenant implied or expressed in a conveyance from Mr. Wharton to them.

The plaintiffs alleged that the obstruction of the part of Freeman-street by the Corporation caused serious damage to them, and if it was allowed to continue the width of the street would be reduced from 40ft. to 28ft., and plaintiffs would not only be deprived of their right of way, but would be precluded from utilising their land adjoining the street for building upon it dwelling-houses of two storeys in height fronting on the street, and their land would thereby be a great deal reduced in value.

The defence denied the rights of the plaintiffs under the conveyances, and said that about April, 1903, the Corporation, in pursuance of statutory powers, commenced to erect on the land buildings for the purpose of the electric tramways used in their tramcar system for the borough of Darlington. The buildings in question were of great public importance to the proper conduct of the borough system of light railways, which were of great benefit to thousands of working-men and others. The piece of land as to which plaintiffs complained was essential to the use of the buildings, and if the Corporation were compelled to remove the buildings they would suffer great pecuniary loss and inflict discomfort and inconvenience on the public. The buildings had been erected at a cost of £8,000.

TRAMCAR OBSTRUCTION.

In the Aberdeen Police Court, on Tuesday, George Henderson Duncan, cab driver, was charged with having wilfully obstructed an electric car by driving a horse and cab slowly in the way of the car. He was further charged with assaulting the motorman.

Alexander Urquhart, motorman, stated that he was driving a car westwards along Union-street, and when near Market-street he made up on a cab driven by accused. Accused drove straight on to the rails in front of the car, and continued to drive up the street slowly on the rails. Witness rang his gong, but accused paid no heed. There was no traffic to prevent the cab from proceeding along the street without going on the rails. The car was delayed two or three minutes. Accused left the car rails and passed three carts before Belmont-street was reached, and then returned to the rails. At this time a collision was narrowly averted. Accused then drove off the rails, and the car passed the cab. At Belmont-street witness left the car with the object of ascertaining the number of the cab. He asked accused to stop, but accused whipped the horse and continued. Witness then took hold of the horse's head to stop the cab, and accused struck him on the face with the whip.

A **Passenger** gave evidence to the effect that the ringing of the gong going up Union-street attracted his attention. He looked out, and saw a cab being driven slowly in front of the car. There was no traffic, so far as he could see, that would have prevented the cab being driven on the side of the street.

Rev. John Meany stated that he was a passenger inside the car. He noticed as the car left Market-street that a cab was on the lines in front of the car. The motorman rang his gong violently, and continued ringing it all the way to Belmont-street. Near Belmont-street there was almost a collision, as the cabdriver had driven off the rails and then returned to the rails. Witness thought credit was due to the motorman for having so smartly averted a collision. He saw no obstruction to prevent the cab from proceeding without running on the rails.

Several other passengers gave corroborative evidence.

Mr. Alexander Duncan, father of the accused, stated that he was on the box of the cab with his son at the time of the alleged offence. He considered it was impossible to get off the rails, as there were a number of carts passing.

Accused stated that he had no idea of obstructing the car whatever. He was in a hurry at the time, and was driving at a rate of about six miles an hour. He denied having struck the driver of the car with his whip.

The **Magistrate** stated there was no doubt from the evidence that accused had obstructed the car, and he thought credit was due to the motorman for having averted what might have been a serious accident. He did not think, however, that the charge of assault had been proved, and he found accused not guilty of that charge. Accused would have to pay a fine of 10s., the alternative being five days' imprisonment.

Arthur Farnfield was summoned before Mr. Lane, K.C., for obstructing an electric tramcar in Goldhawk-road, Shepherd's Bush. The evidence showed that the defendant deliberately put his cart broadside against the car on the lines and refused to move. When requested by a point boy to move he used bad language, and struck him across the face with his whip.—The magistrate imposed a fine of 78s., with 2s. costs.

William Bell, giving an address at Wood Green, was summoned for obstructing an electric car in Chiswick High-road. He was said to have driven a large van deliberately at a very slow pace in front of the car for three-quarters of a mile, causing the car to be delayed for 15 minutes.—He was fined 13s., with 2s. costs.

TRAMCAR COLLISION.

Plaintiffs, the British Electric Traction Company, the lessees of the Croydon tramways, claimed £4. 2s. from Messrs. Grant Bros., High-street, Croydon, for damage to two tramcars, which they alleged was due to the negligence of defendants' driver. There was also a counter-claim.

Mr. Newnham, for the plaintiffs, said the accident out of which the action arose occurred in the main Brighton road. Defendants' two-wheel covered cart came out of Bartlett-street into Brighton-road as two tramcars were approaching from opposite directions. Between the down tramcar and the pavement was a cart, the driver of which, unfortunately, was now dead, and the defendants' cart, instead of turning down on its near side, as, he submitted, it ought to have done, dashed out into the car which was coming towards Croydon, and was thrown back on to the down car. Both cars were considerably damaged.

Corroborative evidence was given by the drivers of the two cars.

The driver of the cart said he came out of Bartlett-street at the rate of about three miles an hour. One car was then standing, and the other car came up, caught the step of his cart, and threw the cart against the other car. There was plenty of room for him to get through, and he heard no bell or other signal. The up car was 50 yards away when he started to come out of Bartlett-street, and it came that distance while he was going 20ft. If the motorman had slowed down he could have got clear of the car.

A witness said the cart came out of Bartlett-street at almost a walking pace. The car from Purley came up from behind and dashed into the cart.

Another witness said the car coming up the road ran into the cart because the driver of the car had not proper control over it.

Police-constable Bradford, who was 100 yards away at the time of the accident, said the cart came out of Bartlett-street at a slow trot.

A boy in the service of Messrs. Grant, who was in the cart, said that as they pulled out of Bartlett-street he could not see anything coming and he heard no bell rung.

Mr. Easton, for the defence, submitted that the evidence conclusively proved that defendants' driver was not guilty of any negligence whatever.

The **Judge** said he was quite satisfied that the defendants' driver was to blame for the accident. He had always understood it to be a principle in the decision of these cases that it was incumbent on drivers entering a main road from a side street to take a good look and slow up. The driver in this case came out before one tramcar and came into collision with another one. He was satisfied that the driver was trying to dash between the two cars. Judgment for the plaintiffs on the claim and counterclaim.

FARE QUESTION.

Mr. W. T. Williams, commercial traveller, was charged at the Nottingham Summons Court last week with refusing to pay the fare when travelling on the tramways.

On the Sherwood route of the city tramways the cars start from Station-street and travel to Shakespeare-street in the first 1d. stage. The second stage commences at Market-street and extends to Hucknall-road. The defendant boarded a car in Wheeler-gate and rode to Babbington-street. The conductor took the fare for the first stage before the car reached Market-street, and when he asked the defendant for a second penny to carry him over the second stage, he refused to pay.

Evidence was given by the conductor in support of the opening statement.

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Defendant contended that a passenger who entered a car at any point in the Market-place was entitled to ride over a 1d. stage from the Market-place. In the present instance he submitted that he had a right to ride from Friar-lane to Babbington-street for 1d.

The Bench agreed that a technical offence had been committed, and ordered defendant to pay 2s. 6d. costs.

STREETS THROUGH FACTORIES.

Mr. J. H. Heathman, the ladder and fire-escape maker at Parsons Green, has been, we are informed, for nearly five years troubled by the London County Council respecting his works at Parsons Green. We gather that originally a piece of ground was bought for the purposes of his factory, and that this is now entirely covered by buildings. The land is freehold, but the London County Council wish to get a decision to the effect that there is a street through this area. The magistrate who heard the case has decided for Mr. Heathman with costs, but the London County Council have appealed, and further trouble and expense will have to be incurred. We await the decision with considerable interest.

COMPANIES' MEETINGS AND REPORTS

TYPEWRITING TELEGRAPH CORPORATION.

The fifth ordinary general meeting of the Typewriting Telegraph Corporation, Limited, was held on Monday at Winchester House, Mr. A. J. Parker presiding. There was a loss on the year of £2,434.

The **Chairman**, in moving the adoption of the report, which was accepted, stated that the directors had not sold any of the foreign patents, nor had they been successful in securing any really large orders. They had at last been successful in inducing the War Office authorities to see the instrument at work. The War Office had bought two sets, which were now being tested at Chatham, and the Company anticipated a favourable report, and might expect to receive orders. Referring to the negotiations with foreign governments, he said that Russia had some of the instruments at present in the Far East, and the directors believed they would secure a very considerable order from St. Petersburg. If this hope were realised they would have a good chance of clearing out the present stock. The prospects of success with the military world were distinctly good, and the present machine was not likely to be endangered. In the field of the Post Office the position was not quite so promising with the old instrument, but with the new standard teletyper they believed they would have the very best instrument. In regard to the financial position, they wanted time to realise the assets, exploit the new instrument, and carry on operations for a couple of years. If success did not come within that time, there would be nothing left but to liquidate.

An extraordinary general meeting followed, when the chairman's proposal that further capital to the extent of £3,000 should be raised by 10 per cent. debentures was adopted.

INDUSTRIAL STORAGE BATTERY SYNDICATE.

An extraordinary general meeting of the Industrial Storage Battery Syndicate, Limited, was held on Monday at Winchester House, Mr. C. Temperley presiding.

The object of the meeting was to confirm a resolution passed by the shareholders making an addition to the articles of association, thereby giving the Company power to subdivide its shares into shares of a smaller amount.

Mr. O. W. Powers seconded the resolution, which was carried unanimously.

Resolutions were then submitted authorising the directors to divide the shares not yet issued into two shares of 10s. each, and to reduce the capital of the Company from £100,000, divided into 81,007 shares of £1 each, and 37,986 shares of 10s. each, to £59,496, divided into 118,992 shares of 10s. each, and that such reduction be effected by cancelling capital which had been lost or unrepresented by available assets to the extent of 10s. per share upon each of the 81,007 shares issued.

The **Chairman** stated that the directors had considered several schemes for getting further capital, and the meeting had been called in order to pass such resolutions, and to see to what extent the shareholders would support the scheme.

A **Shareholder** asked whether any further progress had been made with the working of the patent?

The **Chairman** said the experiments had been very satisfactory, and several orders were on hand.

Mr. Powers seconded the resolutions, and impressed upon the shareholders the necessity of providing additional capital.

The resolutions were carried.

NEW COMPANIES REGISTERED.

Crawshay-Williams, Limited. — Capital, £6,000. Object: to carry on the business of motorcar, vehicle, and cycle manufacturers, electricians, engineers, suppliers of electricity, etc. Registered office: 98, Gresham-street, E.C.

Electric Power Development Company, Limited.—Capital, £25,000. Object: to carry on the business of suppliers of electrical power, proprietors of electric light, telephonic, telegraphic, and other works, generators, storers and transmitters of electricity for all purposes, mechanical and electrical engineers, manufacturers of rolling-stock, etc.

I. V. O. Kill-All Chemical Company, Limited. — Capital, £2,000. Objects: to acquire as a going concern the business of the I. V. O. Kill-All Chemical Company, now carried on at Burmantofts, Leeds, to carry on the business of manufacturing chemists and manufacturers of electrical, scientific, and other apparatus and materials, etc. Registered office: 2, Argyle-road, Burmantofts, Leeds.

Hastings and District Electric Tramways Company, Limited.—Capital, £500,000. Objects: to adopt agreements (1) with M. S. Myers and C. Mendel, (2) with the Hastings Tramways Company, and (3) with Dick, Kerr, and Co., Limited; to construct, purchase, lease, or otherwise acquire light or other railways and tramways in Hastings and Bexhill or elsewhere; to obtain any orders or Acts of Parliament in connection with the same; and to carry on the business of tramway and railway proprietors and workers, electricians, mechanical engineers, contractors for public and other works, etc.

Liens Registered.

Burnand Transformer Company, Limited, Manchester.—Lien registered Nov. 3, for £1,000 second debentures; no trustees; charged on all the property, present and future, including the uncalled capital for the time being, subject to debentures for £1,000.

Northampton Electric Light and Power Company, Limited.—Lien registered Nov. 7 for £400 4 per cent. debentures, part of a series not to exceed two-thirds of the subscribed and paid-up capital. Amount previously issued, £32,220. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being.

South Staffordshire Tramways (Lessee) Company, Limited, Strand, W.C.—Trust deed registered Nov. 3 for £54,700 debenture stock, with power to issue further stock ranking *pari passu*, so that the total amount does not exceed £100,000. Trustee: Law Guarantee and Trust Society, Limited. Charged on leasehold interests in the South Staffordshire Tramways, plant, machinery, etc., certain shares of the company, and the undertaking and assets, present and future.

Underground Electric Tramways Company of London, Limited, London, E.C.—Trust deed and instrument of charge under the Land Transfer Acts, registered Nov. 9, for securing £850,000 debentures. Trustees and mortgagees: J. Trotter, 2, Princes-street, E.C.; H. Cookburn, 61, Threadneedle-street, E.C.; and J. A. Dawes, 9, Angel-court, E.C. Charged on the company's generating station, plant, and machinery at Lots-road, Chelsea, together with cables and ducts therefrom to Earl's Court, all rights and interests in certain contracts for the supply of electricity, etc., and all loose plant, machinery, and chattels in or upon the said station.

PERSONAL.

Prof. Henry Adams, M.I.C.E., has recently retired from the City of London College, where for 35 years he has been head of the engineering department. He is, however, still continuing his practice as a consulting engineer at 60, Queen Victoria-street, E.C., where he has had offices for the last 25 years.

The Horsham District Council have decided to increase the salary of Mr. Morgan, their electrical engineer, from £175 to £225 per annum. Since his appointment the output at the works has considerably increased, and with it the engineer's duties.

The Erith Town Council have appointed Mr. Grainge assistant electrical engineer at the electric light station.

On Tuesday last week Mr. E. G. Love, superintendent of mains and overhead tramway equipment, was presented by the staff and employés of the Halifax Corporation electricity works with a handsome marble clock, suitably inscribed, as a mark of esteem on his recent marriage. Mr. W. M. Rogerson, borough electrical engineer, made the presentation in the presence of a large gathering, representing all the departments of the works.

Mr. Robinson, assistant electrical engineer at Worksop, has resigned.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Porto Alegro (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Banza (Spain).—The Municipality require tenders for the electric lighting for five years. Particulars from the Alcalde, Banza (Jaen).

Pola de Siero.—The Municipality require tenders for the electric lighting for 10 years. Tenders by Nov. 30 to the Alcalde, Pola de Siero, Spain.

Madrid.—The General Telegraph Office require tenders for installation and working telephones in the town of Talavera. Tenders to above by Dec. 7.

Guirgia (Roumania).—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Ibros.—The Municipality require tenders for the electric lighting of the town for 15 years. Tenders by Nov. 22 to the Alcalde, Ibros, Province of Jaen, Spain.

Salamanca.—The Municipality require tenders for public electric lighting of the town. Tenders by Dec. 12 to above or to Direccion-General de Administracion, Madrid.

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Swansea.—The Corporation invite tenders for a 12 months' supply and delivery of motors and starting switches. Tenders by Dec. 1 to Mr. Jno. Thomas, town clerk. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply, delivery, and erection of one 15-ton and two 5-ton electric overhead travelling cranes. Tenders by Nov. 22. See advertisement.

Caen (France).—The Prefect requires tenders for concession of a tramway from Eyes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Llandilo (Wales).—The Urban District Council invite tenders for testing and calibrating the electricity meters installed in the town (70 in number). Tenders to Mr. R. Shipley Lewis, clerk, Llandilo, before Dec. 6.

Newport (Mon.).—The Electricity and Tramways Committee invite tenders for various machine tools. Particulars may be obtained from the Borough Electrical Engineer, Town Hall, Newport, Mon. Tenders to the Town Clerk by first post on Nov. 21.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Rotherham.—The Corporation invite tenders for wiring the new isolation hospital buildings in Badsley Moor-lane. Specification and forms of tender at the office of the Borough Electrical Engineer, Rawmarsh-road. Tenders to be sent to Mr. W. J. Board, town clerk, Town Hall, Rotherham, by Nov. 21.

Glasgow.—The Governors of the Glasgow and West of Scotland Technical College invite tenders for a complete wiring installation and switchboards for the electric lighting of their new buildings. Specification may be obtained from Mr. H. F. Stockdale, secretary and director, 38, Bath-street, Glasgow, to whom tenders must be delivered by Nov. 26.

Brussels.—Tenders are invited for the construction of an electric generating station and other works in connection with the establishment of a goods station at Brussels. The estimated cost of the work is about £24,367. A deposit of about £280 is required to qualify any tender. Specifications (price 1s. 10d.) and further particulars may be obtained from M. De Rudder, Administrateur des Voies et Travaux, 11, Rue de Louvain, Brussels.

Perth (Australia).—Tenders are invited by the Duputy-Postmaster-General for the supply of the following telephone material; 19½ miles 26-pair lead-covered cable, dry core, to standard specification No. 7; 5,000 paper sleeves, 3in. long by ⅛in. diameter; 350 yards paper strips, 2in. wide. Conditions, etc., may be obtained at the General Post Offices at Perth, Adelaide, Melbourne, Sydney, Brisbane, and Hobart. Tenders by Dec. 28.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Peck and Co., 63, Leadenhall-street, London, E.C. Tenders by March 31.

Sydney.—Tenders will be received at the office of the Acting Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 28, for the supply and delivery at the Departmental Stores, Sydney, of telegraph, telephone, and electric light material. Specifications and general conditions may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth. Samples may also be seen at Sydney, Melbourne, Brisbane, and Adelaide.

Bromsgrove (Worcs.).—The Visiting Committee invite tenders for the supply and erection at their new lunatic asylum of the following plant: (Section A) engines, dynamos, booster, and steam services; (B) storage battery and accessories; (C) main switchboard, ring main, feeders, distribution boards, wiring, lamps, and accessories. Specification, etc., may be obtained from Mr. Robert J. Oliver, clerk of the Visiting Committee, Shirehall, Worcester, on payment of £5 for each section of the work as above, which will be returned on receipt of a bona fide tender.

Belfast.—The Town Council invite tenders for the following tramway works, equivalent to about 70 miles of single track: (1) permanent way, road-bed, paving, and bonding; (2) overhead electrical equipment; (3) underground feeders, telephone and test wires, spare conduits, etc.; (4) steam dynamos, switchboard, also three-phase plant, condensing plant, overhead traveller, station lighting, etc.; (5) boilers, superheaters, mechanical stokers, economisers, coal and ash conveying plant, steam exhaust and feed pipes, pumps, etc.; (6) double-deck electric tramcars. Tenders must reach the Town Clerk's Office by 18th inst., at noon.

Leith.—The Corporation invite tenders for the supply of the following tramway cars, delivered free at Leith: Passenger cars—double-deck, single-truck cars with reversed staircases, equipped with motors, controllers, brakes, lifeguards, lights, etc., complete; number, 30. Alternative tender for the same car with ordinary staircase. Double-deck, single-truck cars with reversed staircases and covered top, equipped complete as above; number, 7. Alternative tender for same covered-top car with ordinary staircase. Sprinkler car—sprinkler car with water-tank, sprinklers, grooved watering pipes, revolving brooms, snow-plough, with motors and all other necessary electrical equipment and brakes complete; number, 1. Conditions, etc., may be obtained from Mr. T. B. Laing, town clerk, Council-chambers, Leith, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide offer. Tenders by Nov. 26.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegragh Office Yard, Thursday Island of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Plymouth.—The Hart Accumulator Company have secured the contract from the War Office for the supply of 67 of their standard lighting-type cells, having a capacity of 600 ampere-hours.

Fulham.—The Council have accepted the tender of the British Thomson-Houston Company, at £492, for the supply and erection of a 3,000-volt main generator switchboard at their generating station.

Electric Lighting.—Messrs. Woods, Slacke, and Co., Blackburn, report the following contracts: Salford—complete electric lighting, including switchboards, arc lamps, etc., for half a mile of transit sheds for the Manchester Ship Canal Company; Newcastle-upon-Tyne—complete electric lighting, including switchboards, etc., at the new hospital, union workhouse; Rochdale—electric lighting of car-shed, including telephones, bells, etc.; Crewe—electric lighting of post office; York—electric light installation for city cattle market, and complete electric lighting, about 1,700 lights, including boilers, feed pumps, steam and exhaust piping, three engines and dynamos, main switchboards, motors, etc., at the York City Asylum.

APPOINTMENTS VACANT.

Junior Assistant for a firm of consulting engineers. See advertisement.

Assistant Electrical Engineer, Worksop Urban District Council. Salary, £150 per annum.

Mains Superintendent, Poplar electricity works. Salary, £120 per annum. Applications by Nov. 18. See advertisement.

Mains Assistant, Blackburn electricity works. Commencing salary, £130 per annum. Applications by Nov. 18. See advertisement.

Demonstrator in Engineering, London County Council Paddington Technical Institute. Applications by Nov. 23. See advertisement.

BUSINESS NOTES.

TRACTION.

Nottingham.—The Corporation have published the statutory notice of their intention to apply for parliamentary powers to construct several extensions of the tramways.

Shanghai.—The Municipality are again inviting tenders for the construction and working of 24 miles of electric tramways on the trolley system, double or single.

Colwyn Bay.—Good progress is being made with the line to Llandudno, which it is hoped to complete by March 1 next. The system will be about 8½ miles in length.

Accrington.—The Corporation have published a statutory notice of their intention to apply for parliamentary powers for a number of works, including electric tramways and lighting.

Derby.—An extension of the tramways from St. Peter's-street to Market-square has been decided upon at a cost of £3,470. The work will be carried out by J. G. White and Co., Limited.

Liverpool-Bolton.—This journey can be made by street car. The distance is 30 miles, and the journey extends over some eight systems. The fares total 1s. 9d., and the time occupied rather under four hours.

Margam (Glamorgan).—At a meeting of the Margam Council, the Chairman stated that a syndicate had been formed to obtain a provisional order for the construction of an electric tramway from Briton Ferry to Taibach.

Hindley.—At the meeting of the District Council it was reported that negotiations are proceeding between the Wigan Corporation and the South Lancashire Tramways Company with regard to the proposed Wigan-road route.

Aberdare.—The District Council have decided to apply for power to construct an electric tramway, to execute street widenings, and to erect a dust destructor, the total expenditure involved being between £93,000 and £94,000.

Monorail Construction Co.—A meeting of the Monorail Construction Company, Limited, has been called for the 22nd inst. to consider a resolution to increase the capital to £70,000 by the creation of 1,000 new shares of £10 each.

Exeter.—The first section of the electric tramways from St. David's Station to Liverydole will be completed by the first week in December,

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and the St. Sidwell's section shortly afterwards, though they may not be open for traffic until the New Year.

Beckenham.—At the meeting of the Electric Lighting and Tramways Committee last week, the clerk produced the bond and agreement duly sealed by the British Electric Traction Company and the Electric and General Investment Company, Limited.

Darlington.—The working expenses of the trams from the commencement of running to Sept. 30 amounted to £2,595. 8s. 9d., and the receipts were £3,698. 0s. 11d. The number of passengers carried was 908,664, and the receipts per car mile were 7·249d.

Aston.—The Tramways Committee have decided, in reference to the Steelhouse-lane to Aston line, that covered cars should be ordered for the ordinary traffic of the line. One covered car has been running on the section for some time, and this has proved entirely successful.

Bradford.—A proposal to grant the tramway employés under the Corporation a week's holiday annually was on Monday considered by a sub committee, but no decision was arrived at. The question would affect about 1,000 men, and would involve about £1,500 increased expenditure.

Sunderland.—The receipts of the Corporation trams for the half-year amount to £35,223, an increase of £721 upon the same period last year. For October the passengers carried were 1,262,552, and the receipts £5,289, an increase on October last year of 59,954 passengers and £253 in receipts.

Dundalk.—The promoters of the tramway scheme have applied for a further extension of their order for 12 months. Having received an assurance that the promoters are proceeding with the financial part of the scheme, the Urban District Council unanimously resolved to consent to the extensions.

Calcutta.—The new line along Harrison-road is on the verge of completion. It is expected to be of great service, and extensive patronage is probable. It is reported as not unlikely that eventually the Harrison-road line will be extended westwards over the Howrah floating bridge to join on with the system of tramways to be undertaken on the further side of the river.

Ashton.—The Tramway Sub-Committee having had a satisfactory conference with the Stalybridge, etc., Tramway and Electricity Board relative to inter-running and the construction of the Scotland-street and Old-street line, the borough surveyor and electrical engineer have been instructed to prepare the necessary plans and specifications for the construction and equipment of the route.

Bishop Auckland.—The Durham County Council have received notice that the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, has transferred the Bishop Auckland, Shildon, and Spennymoor tramway to the Public Undertakings Limited. The Council have assented to a 12 months' extension for the completion of the Houghton-le-Spring tramways.

Aston.—Another section of the tramways was opened on Tuesday. The new section extends from Aston Cross to Gravelly Hill. The cars are of the single-deck type, so as to pass under the railway bridge at Aston Station. With the commencement of this service the whole of the steam cars which formerly belonged to the Birmingham and Aston Tramway Company have been taken off the track.

Torquay.—The chairman of the Dolter Company (Mr. Hugh Lubbock) and Mr. W. C. Hawtayne had an interview with the Electric Lighting Committee the other day, and provided that current is available a definite promise was given on behalf of the company that the electric trams should commence running by June next. The company will be in a position to begin the work of laying the lines immediately after Christmas.

New York Underground Railway.—The *Glasgow Herald* says "The new high-speed electric locomotive was tested at Schenectady on Saturday, and more than fulfilled the expectations of the company's officials. The engine attained a speed of 72 miles an hour, and it is estimated will be able to travel at 60 miles an hour with a 500-ton load. Mr. Wilgus, vice-president of the railroad, declared that the engine solved for all time the problem of electric traction at high speed."

Proposed Electric Railway.—A scheme is reported to be on foot for a railway from Pontefract to Immingham. A survey has been made, and the surrounding landowners are understood to be favourably disposed. According to the plans the proposed route is practically a straight one, extending over a distance of 49¼ miles. The South Yorkshire coal collieries are expected to provide a substantial revenue. It has not yet been decided whether electric or steam power should be employed.

Snowdon, etc., Light Railway.—At an extraordinary meeting of the North Wales Narrow-Gauge Railways Company, approval was given to an agreement between the Portmadoc, Beddgelert, and South Snowdon Railway Company, the North Wales Power and Traction Company, Limited, and the North Wales Narrow-Gauge Railways Company containing the basis of working arrangements between the companies.

The Underground.—The District Railway Company are notifying their season-ticket holders that they cannot renew beyond Dec. 31. After that the zone system comes into operation. A few electric trains will possibly be running on New Year's Day; but for some weeks or months steam will continue in a lessening quantity. The zone (single) fares will be: 2d. any station between Aldgate and Hammersmith, and Hammersmith and Ealing, 3d. between Aldgate and Ealing and between Hammersmith and Whitechapel, and 4d. between Whitechapel and Ealing.

Huddersfield.—The traffic receipts from Nov. 1, 1903, to Sept. 30, 1904, amount to £60,801. 4s. 5d., being an increase of £4,937. 6s. 8½d. over the corresponding period. The total is made up as follows: receipts from passengers, £60,084. 12s. 10d.; parcels, £619. 10s. 7d.; miscellaneous, £97. 1s.—making a total of £60,801. 4s. 5d. The mileage run during this period amounts to 1,522,919 miles, an increase over the corresponding period of 112,141 miles. The number of passengers carried was 11,464,033, an increase of 1,110,320 over the corresponding period.

Cheltenham.—The Town Council have adopted a recommendation of the Highways Committee that the Council should agree to bear the cost of raising or lowering the levels of the road along which the extensions of the light railway are being laid where such is required by the Council, for the purpose of improving the gradient of the road, but that the company be required to bear the cost of raising or lowering the level of the road to coincide with the level of the railway track fixed by the borough surveyor, where such alteration of level is in the opinion of the surveyor necessary in order to make a satisfactory track. There are a good many undulations, and the object is to secure a level road.

Weymouth.—At the meeting of the Dorset County Council, the Works Committee reported an intimation from the Weymouth Corporation of the latter's intention to formulate a scheme of tramways leading to the village of Wyke Regis, and thence to Portland on the one hand, and on the other through the village of Broadwey to the bottom of Ridgeway Hill, and they asked the Council to consent. The Corporation had not yet formulated a definite scheme, and pending this the committee could not recommend the Council to entertain the question of giving any consent under the House of Commons Standing Orders, but they suggested that the Council should invite the Corporation to submit full particulars.

London United Tramways Co.—The Board of Trade have confirmed the order made by the Light Railway Commissioners, authorising the construction of light railways in the county of Middlesex between Hounslow and Cranford and between Heston, Hounslow, Hanworth, Twickenham, and Sunbury Cross, being extensions of the existing and authorised undertaking of the London United Tramways (1901), Limited. The Hammersmith Borough Council have received a communication from the town clerk of Ealing asking whether the Council will join the committee of local authorities which it is proposed to appoint for the purpose of dealing with the tramway noise, and, if so, whether they will contribute towards the costs of any proceedings that may be decided upon. The Parliamentary Committee of the Borough Council express their sympathy with the movement, but do not recommend any financial assistance at present.

Newport.—The accident on the Stow-hill section was referred to at a meeting of the Town Council by Mr. W. H. Brown, chairman of the Electricity and Tramways Committee, who deprecated the sensational way in which a Newport newspaper had reported the occurrence. He read a report from the borough electrical engineer, explaining that the accident was caused by the greasy state of the rails, consequent upon a drizzling rain and falling leaves, and through a piece of wood choking the sanding apparatus on the car. The danger of a recurrence of such an accident would be removed by stationing a man on Stow-hill to spread sand on the rails whenever necessary. He added that the sum of £31. 11s. 9d. had been taken in the three days since the section had been opened. Several members expressed the opinion that the accident was distinctly alarming, and that it was necessary to reassure the public that such steps would be taken as would prevent such another accident occurring.

Manchester.—Plans are in preparation, and will be deposited before the end of the month, for an underground railway through Manchester. The scheme has not yet secured the approval of the Corporation, although in view of the present congested condition of the traffic through the main streets of the city this will probably be obtained. The author of the scheme is Mr. W. A. Jackson, architect and engineer, who contends that the railway would not only be a commercial success, but a great public benefit. Instead of a circular route he begins with a cross route, with subsidiary lines, getting in touch with the tramlines at eight places. By through routes from one district to another, Mr. Jackson thinks it will only require three minutes for a journey that at present occupies 20 minutes. The system, he contends, will obviate the necessity of spending large sums of money for the widening of main thoroughfares. The total length of tunnelling would be 2½ miles, and the estimated cost is three quarters of a million for the single-deck cars.—*Financial Times.*

Hastings.—The Hastings and District Electric Tramways Company yesterday opened their subscription list, which will close on or before Monday next. The system will comprise nearly 20 miles of track, and besides running along the front of Hastings and St. Leonards, there will be a line to their rapidly-rising neighbour, Bexhill, thus supplying a valuable means of communication between these popular resorts. Besides this, there will be a circular route passing through Baldslow and Ore, affording a delightful country trip. According to the census of 1901, the normal population of the municipal borough of Hastings was over 65,000, and that of Bexhill more than 12,000, besides which there are, of course, hosts of visitors, who will doubtless appreciate the new facilities for seeing the surrounding country. The consulting engineers, Messrs. Kincaid, Waller, Manville, and Dawson, estimate that, upon a conservative calculation, the system will show an annual net profit of £30,000, with the possibility of a considerably larger surplus. The contractors are Messrs. Dick, Kerr, and Co.

Erith.—It was reported at the meeting of the Urban Council that as the result of information obtained by the recent inspection of the tramways at Leicester, Derby, Sheffield, Manchester, and Preston, and the several engineering works which they visited, the Tramways Committee have made several suggestions to the consulting engineers relative to the construction, fitting, and equipment of the tramcars for the Council's tramways. The committee have gone through the draft specification for the tramcars with Mr. Hawtayne, and recommend that the specification be approved and an advertisement for tenders issued. The consulting engineers reported that Messrs.

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Blackwell and Co., the contractors, had started the work under contracts Nos. 1 and 2, in Bexley-road, Northumberland Heath, and in Abbey-road, Abbey Wood, and that material was on the site sufficient to allow good progress being made. They also reported the progress made by the contractors for the Lower-road bridge. The concrete foundations for the abutments and wing walls had been satisfactorily completed. The committee have instructed the clerk to make application to the Bexley Urban District Council for permission to make a visit of inspection of the Bexley tramways.

Cardiff.—A chartered accountant deals in the *Western Mail* with the tramway finances, which have caused a good deal of discussion. On the question of depreciation, he remarks that there is not only depreciation through continued use, but also the risk of obsolescence to be considered. The capital charges debited against the revenue account for the year ending March 31, 1904, were: loans fund account (1902) instalments, £11,593. 8s. 3d.; and loan repayment, Public Works Loan Board, £2,490. 9s. 2d.—total, £14,083. 17s. 5d. In the evidence given before the Joint Select Committee on Municipal Trading it transpired that the Glasgow Corporation tramways revenue account was charged with both the repayment instalments and full depreciation; but the Glasgow tramways accounts showed enormous profits, and this partly owing to the fact that some items of expenditure properly chargeable against the tramways appeared to have been debited to other accounts. Basing his calculations on the amount of the capital outlay at March 31, 1903, the writer considers £24,315 a fair annual amount to allow for depreciation and renewals. He allows 1½ per cent. for new buildings, 2 per cent. for the old depôts, 10 per cent. for plant and machinery, 2½ per cent. for conduits and cables, 5 per cent. for engineering charges, 2½ per cent. for overhead equipment, 7½ per cent. for cars and rolling-stock, etc. On this basis the undertaking would show for the year ending March 31 last a deficit of £4,913. 4s. 5d., instead of the surplus of £5,317. 18s. 2d. shown by the accounts.

Snowdon-Bettws-y-Coed.—Sir Herbert Jekyll, on behalf of the Board of Trade, heard objections to the confirmation of the order passed by the Light Railway Commissioners for a light railway from Snowdon to Bettws-y-Coed, a distance of 13 miles, in what was described as the loveliest part of North Wales. The scheme was opposed by the National Trust for Places of Historic Interest or Natural Beauty, the Co-operative Holiday Association, the Alpine Club, and several others. The objectors' contention was that the beauty of the Snowdon district was so exceptional and its attraction for a large number of visitors so great as to deserve protection from a railway. This district was attractive on account of natural qualities, which the proposed railway would entirely destroy. Mr. Honoratus Lloyd, for the promoters, said they had done everything to avoid interfering with the natural beauties of the neighbourhood, and the whole of the landowners affected were in favour of the scheme. Mr. Banks contended that the workers of the country were entitled to have some places left in which they could have a quiet holiday undisturbed by the noise of gongs and tramcars, which would bring in their train the cheap trippers. Mr. Lloyd said the railway already not only carried people to Snowdon but up the mountain itself, and the beauty of the scenery would not be affected by a little narrow-gauge electric railway. The Board of Trade will give a decision shortly. The question was raised by the Urban District Council of Bettws-y-Coed as to the running of trains on Sundays. Sir Herbert Jekyll said the Board had never put in a clause against the running of trains on Sundays, and although he should reserve his decision, it was not likely that the Board would make an exception in this case.

Colchester.—At the meeting of the Town Council the Finance Committee reported having accepted an offer from the Ecclesiastical Commission to advance £50,000 (part of the loan for tramways) at £4 per cent., the payment of interest and repayment of principal to be made by 48 half-yearly payments of principal and interest combined. A sad fatality—the first since the opening of the system—occurred on the Corporation tramways, the victim being a little girl about six years of age, named Emily May Secrett. The child crossed the road immediately in front of an oncoming car, which had slowed down somewhat to pass the points. The driver sounded his gong and shouted to the child, and applied the brake instantly, but it was too late to save her. The front of the car struck her and knocked her down, and the lifeguard descended, but, instead of picking the unfortunate child up, the apparatus was caught and jammed by a portion of her clothing, with the result that the body was forced along for a foot or two, and then crushed by the lifeguard, which was forced over her body and then fell again. A jack was hastily sent for, but proved too large to be used effectively to raise the car, and a foreman of the car depôt ran for another. Meantime, however, a plank was secured, and the jack, being laid on its side, was used as a prise, the car being by this means lifted and the body of the child taken from underneath it. When taken out, the child was breathing, but unconscious, and death ensued in a few moments, the base of the skull being badly fractured, while the right arm and left leg were broken, and the body had sustained other terrible injuries. The pilot board of the tramcar was broken—probably by the force and suddenness with which the driver applied the brake, the car being brought to a standstill with such suddenness as to almost throw the conductor from his feet. At the inquest the jury returned a verdict of "Accidental death," and attributed no blame whatever to the driver, who they considered did everything possible to avert the fatality. With regard to the suitability of the lifeguard, they suggested that two springs should be fitted to keep it down, and the foreman added that it was a remarkable thing that the body of a small child should be able to press up the present apparatus. The jury also suggested to the Tramways Committee the provision of jacks on every car. At a special meeting of the Town Council on Tuesday it was proposed that powers should be applied for to authorise an extension of the tramways for about half a mile. It was stated that the new section would serve a populous neighbourhood. As, however, owing to various causes, less than two-thirds of the Council were present, the matter had to be deferred.

London County Council.—At its meeting on Tuesday the Council considered the recommendation of the Highways Committee that powers be sought to carry the tramways over Blackfriars Bridge and along the Embankment so as to effect junctions with other lines, and after some discussion the proposal was agreed to unanimously. On the same day the Streets Committee of the City Corporation discussed the proposals of the County Council in regard to this scheme. Representatives attended from the County Council and from the Bridge House Estates Committee, the latter being apparently adverse to the project. Several members of the Streets Committee favoured the scheme, and in the end the committee decided to hold another meeting shortly, when a definite recommendation to the Court of Common Council will be decided upon. The Highways Committee recommend that an agreement be entered into with the North Metropolitan Tramways Company for the working by the latter of the authorised tramway in Rosebery-avenue. It is proposed that the company shall pay as rent a certain proportion of the cost of construction. The estimated cost of construction is £10,285 for the temporary horse system, and £26,000 for the conduit electrical system. In connection with the tramways taken over from the London, Deptford, and Greenwich Tramways Company, it is proposed to discontinue the routes from St. James's Church to Tower Bridge-road and from Raymouth-road to the canal bridge, Old Kent-road, as these are not much used. In regard to the remainder of this tramway, the Highways Committee have under consideration the question of improving the service by electrification or otherwise. Apart from this undertaking, the Council's system has produced £394,518 from April 1 to the 5th inst., as against £318,593 last year. The Council have replied to the Bostall Estate Protection Association that the Council have under consideration the question of proceeding forthwith with the street widenings required in connection with the authorised tramways between Beresford-square, Woolwich, and the county boundary, Abbey Wood. So soon as these shall have been completed, the construction of the line will be commenced. A public meeting at Blackheath the other day entered a protest against the proposal of the Council to construct a tramway from Deptford across Blackheath to Shooter's Hill, and passed a resolution in support of an alternative route from the existing tramway in Woolwich-road up Westcombe-hill, and thence by the Old Dover-road and Shooter's Hill-road to Shooter's Hill. It was decided to send copies of the resolution to the Council and to the Lewisham Borough Council.

Lowestoft.—In presenting a report and accounts for the 14 months' trading of the tramways undertaking to the Council last week, the Chairman and General Manager explained that the accounts were made up from the opening of the system on July 22, 1903, to Sept. 30, 1904, so as to bring the tramways department accounts into line with other accounts of the Corporation, which close on the latter date. The revenue account, after paying the total working expenses, show a gross profit of £4,801. 11s. 2d., to which must be added the borough fund grant £145, giving a total of £4,946. 11s. 2d. Interest on capital and income tax amounts to £3 331. 14s. 7d., sinking fund charges £875. 3s. 9d.; and the committee recommended that the balance be divided as follows—viz.: to the credit of reserve or renewal account, £350; repay grant from borough fund, £145; carry forward to next year's account, £244. 12s. 10d. The revenue account showed traffic receipts £14,086. 12s. 4d., and advertisements £425. 4s. 7d.—total, £14 511. 16s. 11d. Traffic expenses totalled £4,050. 6s. 10d. (including £3,231. 1s. 5d. wages of inspectors, motormen, conductors, etc.), general expenses £1,250. 11s. 11d., general repairs and maintenance £969. 16s. 1d., power expenses £3,439. 10s. 11d.—total, £9,710. 5s. 9d.; balance carried to net revenue account £4,801. 11s. 2d.—total, £14,511. 16s. 11d. The revenue profit was dealt with as follows: interest on capital £3,254. 7s. 3d., income tax £77. 7s. 2d., balance to appropriation account £1,614. 16s. 7d. The last-named amount was appropriated in the following manner: first instalment of contribution to sinking fund £875. 3s. 9d., reserve or renewal fund £350, balance carried forward to next account £389. 12s. 10d. The capital account totals £75 894. 4s., and the Electric Lighting Committee pay interest and sinking fund charges on £10,000. The balance-sheet showed liabilities £78 897. 13s. 11d., and the following items appeared under the heading of property, assets, and outlay: cost of existing works—viz., permanent way, £36,280. 14s. 6d.; mains and electric equipment, £6,939. 8s. 5d.; generating plant, machinery, and tools, £9,678. 10s. 11d.; rolling-stock, £11,407. 16s. 11d.; buildings, £7,034. 2s. 9d.; office furniture, etc., £28. 4s. 10d.; sundry equipment, £326. 6s 6d.; preliminary expenses, £786. 18s. 7d.; engineers' fees, £3,343. 14s.—total, £75 815. 17s. 5d. By investment: on account of sinking fund, £875. 3s. 9d.; stores in hand, £217. 4s. 5d.; sundry debtors, £340. 13s. 6d.; unexpired licenses insurance, and rates and taxes, £216. 15s. 10d.; cash at bank £1,401. 12s. 1d.; cash in hand, £30. 6s. 11d.—total, £78,897 13s. 11d. The accounts were audited by Mr. Joseph E. Tubbs, F.C.A., of London, who in his report stated that in addition to the sum of £875. 3s. 9d. appropriated to the sinking fund, £350 had been transferred to reserve or renewals account. The report continued: "No special provision has been made in these accounts for depreciation beyond the above-named sums, but this should be considered and dealt with in the future." The net balance after 14 months' working is £389. 12s. 10d. The following statistics were also presented: car miles, 359,435; passengers carried, 3,128,867; total number of units used, 366,885; number of units per car mile, 1·02; average traffic revenue per car mile, 9·40d.; average total, 9·68d.; average car miles per car per day, 75·78; average working expenses per car mile, excluding power cost, 4·18d.; average working expenses per car mile, including power cost, 6·48d.; average fare paid per passenger, 1·08d.; average number of passengers per car mile, 8·70; passengers at 2d., 249,278; passengers at 1d., 2,871,062; passenger workmen at 1d.,

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8,257; private hire of cars, £11. 0s. 3d. The matter of the construction of the East Anglian light railways from Lowestoft to Kessingland had been considered by the Tramways Committee, and further deferred. The report was adopted. The accounts show an excellent result for the initial year's working.

LIGHTING AND GENERAL.

Electrical Trades Union.—A branch of this union is to be formed at Hull.

Spalding.—An application for a provisional order for electric lighting is now being made by the Urban District Council.

Southport.—Electric light is being fixed on one of the Corporation's bowling green, so that play may be continued after dark.

Gosport.—The proposed provisional order of the Gosport Electric Lighting Company has been approved by the Urban District Council.

Church Stretton.—The electricity works, which have been erected at a cost of between £5,000 to £6,000, are completed, and the plant is being tested.

West India and Panama Telegraph Co.—The directors recommend a dividend of 7s. per share on account of arrears of dividend on the first preference shares.

Govan.—The Secretary for Scotland has consented to the borrowing of £47,000 for electric lighting, making a total sum for the electric lighting scheme of £127,000.

Brentford.—The Board will next week consider the advisability of adopting a system of electric lighting throughout the workhouse, and, if expedient, the whole of the institutions of the Guardians.

Lowestoft.—There are now connected to the mains 554 consumers, representing 27,653 8-c.p. lamps. During the month eight new consumers have been connected, representing 305 8-c.p. lamps.

Central Electric Supply Co.—The transfer books of the 4 per cent. guaranteed debenture stock will be closed from Nov. 17 to Nov. 30 inclusive, preparatory to the payment of interest due Dec. 1.

Preesall.—At a recent meeting of the Urban Council a letter was read from Mr. O. Hanson, electrical engineer, Fleetwood, intimating that a company was about to be formed to supply electricity in Over Wyre district.

Lytham.—A committee of the Council have had a conference with the St. Annes authority to consider the latter's proposal to supply Lytham with electricity in bulk. The matter is now under the consideration of the Council.

Inverness.—Mr. E. J. Williams, resident engineer for the North of Scotland Electric Light and Power Company, Limited, has submitted to the Town Council specification of the plant, etc., for the town electric installation.

British Trade with South America.—Senor Pedro A. Costa, of Buenos Ayres, is issuing for the Buenos Ayres and South American Agency, Mansion House-chambers, Queen Victoria-street, a series of notes and comments on the above subject.

Bideford.—The Town Council have received several notices of intention to apply for a provisional order to supply Bideford with electricity, and asking for the Council's consent, and they have replied that the Council themselves intended applying for an order.

Perth.—The Town Council have decided to call for offers for the erection of additional electrical plant, suggested by Mr. Lambert, and also to apply to the Secretary for Scotland for authority to borrow to the extent of £6,000 to meet the cost of said plant.

Wednesbury.—The Town Council have agreed to the extension of the electricity main at a cost of £85. Since the last meeting of the Council 500 additional lamps have been applied for. There are now altogether some 1,600 lamps connected to the mains.

Tredegar.—The District Council have accepted the offer of Mr. Tallis, Tredegar Company, to fix an installation of electric light at Pochin for £35, on the understanding that the light be turned on for the convenience of the men going to work in the morning.

Clewer.—The Windsor Electrical Installation Company, Limited, intend to apply for a provisional order to authorise them to supply electrical energy for public and private purposes within the parishes of Clewer Without and Old Windsor in the rural district of Windsor.

Shrewsbury.—The number of units of electric current sold during the last quarter shows an increase of 8,764 units, compared with the corresponding quarter last year. Extensions will be required to the electricity works, both with regard to buildings and machinery, and a report is being prepared.

Great Western Railway.—The Howard Conduit Company, Limited, Trafford Park, Manchester, report an order, through Messrs. Siemens Bros., for the troughing required in connection with Messrs. Kennedy and Jenkin's specification for the Great Western Railway electrification.

Cheltenham.—The report of Mr. Swinburne, noted in our last and dealt with in another column of the present issue, will come before the Council on the 23rd inst. In the meantime, Mr. Ley Wood has replaced Mr. Norman as chairman of the Electricity Committee, and it is anticipated that quieter counsels will prevail.

Swansea Telephones.—The rentals due for the 12 months ending Nov. 5, 1904, were £3,979. 0s. 9d. Of that amount £3,135. 9s. 11d. has been actually collected, leaving £845. 10s. 10d. to be collected. Included in the last-named figure is £89. 17s. 4d. for police private telephones, which only became due on Nov. 5.

Beckenham.—At the last meeting the following subjects were brought forward and adjourned till the next meeting: supply of current for Penge tramways; purchase of Crystal Palace Electric Lighting Company's rights of supplying Beckenham; and the extension of lease of the electric lighting undertaking.

Life-Saving Apparatus.—It is reported that an effort is being made to induce the United States Government to stretch an electric light wire along the whole extent of the Cape Cod coast and maintain power through it, so that life-savers, upon any emergency of a wreck, could apply an electric searchlight to facilitate life-saving operations.

Shildon.—The Urban District Council are urging the Northern Counties Electric Supply Company to sign an agreement to complete their scheme by January. The Council are prepared, in case of the work being delayed by wet weather, to grant a reasonable extension for the completion of the scheme. The company have already expended £6,000.

London County Council.—The Council are establishing a residential home for mentally defective boys at Brixton, and have entered into an agreement with the South London Electric Supply Company, who will supply current at 4d. per unit. A number of applications to lay mains, etc., in various parts of the Metropolis were agreed to on Tuesday.

Epsom.—The Lighting Committee have informed the owners of the Alexandra Park Estate that the Council would proceed in due course to light by electricity the portion of the Alexandra-road on which the estate abuts, and would consider the question of lighting Ashdown and Kingston roads on the terms previously discussed with the estate agents and contractors.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Telephone Company of Egypt, Limited, £60,000 4½ per cent. debenture stock, and to allow the Montreal Light, Heat, and Power Company's 7,500,000dol. 4½ per cent. bonds to be quoted in the official list.

New Barnet.—At a recent meeting of the New Barnet Tradesmen's Association a letter was read stating that the Council had resolved not to proceed at present with the National Construction Company's scheme, and, further, that before the Council completed any arrangements with any electric lighting company they would convene a meeting and place the details before the ratepayers.

Chester-le-Street.—The Rural District Council will at their next meeting discuss an application of the County of Durham Electrical Power Distribution Company, Limited, to support their application at the Board of Trade for a provisional order under the Electric Lighting Acts, 1882, 1888, 1889, to supply electricity within the area of the Council's jurisdiction. The Durham Rural District Council have consented to a similar application for an order for their area.

Durham.—At the last County Council's meeting the Clerk read a communication from the Local Government Board in reference to the proposed county electric supply, stating that the Board was not aware of any statutory authority whereby the county could carry out a scheme of electric supply. The letter was ordered to be entered in the minutes, and the report of the Electricity Supply Committee was, in the circumstances, referred back for further consideration.

Ashton.—The Town Council have resolved to adopt the following scale—viz: (1) for power, the present rate of 1½d. per unit; (2) to consumers satisfying the committee or electrical engineer as to the continuous running of their motors, whose consumption exceeds 500 units per quarter, but does not exceed 1,000 units per quarter, the rate of 1½d. per unit; (3) to consumers complying with Clause 2, and whose consumption exceeds 1,000 units per quarter, 1d. per unit.

Grangemouth.—The Town Council have for some time had under consideration the propriety of lighting the burgh with electricity, and at the ordinary meeting on 15th inst. they resolved, on the recommendation of the Lighting Committee, to postpone making application to Parliament for a provisional order until next session, and meantime to procure information as to the position of other burghs, and the terms likely to be granted them by the Scottish Central Electric Power Company.

Burslem.—The Local Government Board have expressed their willingness to sanction the loan for electric lighting and dust destructor purposes. Providing that the Tunstall Urban District Council agree, their provisional order will be revoked and a new provisional order obtained by Burslem on the same conditions as the Burslem Extension Order, 1899. A special meeting of the Council is to be held on Nov. 30 for the purpose of passing the required resolutions.

Colchester.—At the last meeting of the Electric Light and Power Committee, it was reported that as the result of a canvass 130 new consumers had been obtained, and that the premises of 63 thereof had been already connected. The following statistics are taken from the report of the electrical engineer: output of electricity in units during September, 1904, 75,700 (1903, 28,705); number of consumers at end of September, 551 (374); total number of 8 c.p. lamps connected, 27,159 (23,427).

New Issues.—The Llandudno and Colwyn Bay Electric Traction Company, with an authorised capital of £150,000 and an authorised debenture issue of £60,000, offer for sale 1,000 5 per cent. debentures of £50 each and 49,440 ordinary shares of £1 each. Of the balance of the share capital 10,500 shares have been issued for cash, and 90,000 are reserved for future issue. The route of the light railway to be constructed is from near Colwyn Bay Station to the West-parade, Llandudno, a length of 8½ miles.

London Gazette.—Applications have been made for electric lighting provisional orders by the following: Kingsbury Urban District Council; Andover Corporation; Conway Corporation; Litherland Urban District Council; and Penmaenmawr Urban District Council. A petition confirming a special resolution reducing the capital of the Nernst Electric Light Limited and Reduced Company from £320,000 to £90,000 will be heard before Mr. Justice Swinfen Eady, at the Royal Courts of Justice, on Nov. 29, 1904.

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Cardiff.—At the last Council meeting Alderman Carey said that next year they would have to make provision for 45,000 extra candle-power lamps, including 16,000 candle-power lamps for Cathays Park. In the year 1900 the Corporation had generated something like half a million units of electricity, but their returns up to March, 1904, showed that they had generated about 3,000,000 units, so that in less than four years they had been called upon to supply six times the original demand.

Hammersmith.—The last report shows that the premises of 11 additional consumers, representing a maximum of 245 8-c.p. lamps, have been connected to the mains, that three consumers have been disconnected, and that the present number of consumers taking current from the mains is 1,519. The Borough Council have allowed the Post-master-General to place an underground telegraphic line along the south side of Uxbridge-road, and an overground telegraphic line along South-street and Waterloo-street.

Dundee.—The motive power in Messrs. James Prain and Sons' jute works, which are made up of two sections, one on each side of the street, consists of two steam-engines, developing about 400 h.p. The load on the engines was rather unequally distributed, and electric power is being installed, which will be conducive to more economical working. A generator of 80 kw. will be actuated by one of the existing engines, and the current will be conveyed across the street by an underground cable to a 100-h.p. motor. The drive will be taken up by a system of wheel gearing, and the entire factory will be actuated by its agency. The contract for the electric plant has been obtained by Messrs. D. W. Ritchie and Co., electrical engineers, Ward-road.

Newport (Mon.).—An enquiry has been held into the application of the Corporation for sanction to borrow £17,825 for purposes of electric lighting extensions and power supply. Mr. A. A. Newman, town clerk, and Mr. H. Collins Bishop, borough electrical engineer, gave evidence for the Corporation, the latter stating that they estimated the profits of the electrical undertaking for the current year at between £1,000 and £2,000. The lamp connections had increased from 7,278 at the end of the first year (1896) to 65,000 at the end of September, 1904. The Llanarth-street works were not to be superseded. It was proposed to erect a sub-station on Stow-hill, and automatic feeders would be placed in various parts of the town.

Poland.—The French Consul-General at Warsaw, in his report for 1903, states that there is a good opening in Poland for all kinds of electrical apparatus, such as motors, batteries, dynamos, accumulators, electric lighting materials, ornamental fittings, incandescent lamps, arc lamps, electric toys and bells, telephone material, etc. These goods are now imported mainly from Berlin and Vienna. The trade in electrical apparatus is not very large at present, but it is bound to extend, owing to the recent foundation of a central generating station. Despite the extension of the contract with a Dessau company for lighting the streets of Warsaw by gas, the use of electric light is becoming general in private houses and business establishments.

King's Lynn.—The electrical engineer reported at the October meeting that since the last meeting applications had been received for a supply to 282 additional lamps of 8 c.p., or equivalent, making a total of 19,968 from private consumers, and that there are now 485 private connections to the mains, being an increase of five. The applications included two additional motors. The engineer submitted the following statement—viz.: units generated, September, 1904, 36,575 (1903, 31,263); total units sold to private consumers (light and power), 26,449 (16,556); units sold at power rates, 12,518 (5,230); cost of fuel, stores, repairs, and wages at station, £113. 19s. 3d. (£97. 13s. 9d.); cost per unit generated, 0·7478d. (0·7499d.); wages of lamplighters and outside staff, £20. 11s. 4d. (£18. 10s. 1d.).

Pollokshaws.—It is reported that the Pollokshaws and the Glasgow Councils have now come to terms for the supply of electricity to the burgh. The agreement is to the effect that (1) if the Town Council obtain a provisional order from the Board of Trade to supply electricity, with a clause authorising them to transfer their powers to the Corporation, the latter will pay the expenses of the Town Council up to £400; (2) that if the Town Council obtain an order, but without authority to transfer it to the Corporation, their expenses will be paid by the Corporation only to the extent of £200; and (3) that if the Town Council obtain an order, but carry out the work themselves or transfer their authority to a body other than the Corporation, no contribution will be made by the Corporation towards their expenses.

Ayr.—The monthly report by the burgh electrical engineer, Mr. Roland Marshall, contains the following figures: Number of consumers, as per last report, 320; number of consumers connected during the month, 4—total, 324. Number of lamps connected, as per last report, 34,591; number of lamps connected during month, 115—total, 34,706. Units generated, as per last report, 378,344; units generated during month, 123,298—total, 501,642. Units generated for corresponding period last year, 455,378—increase, 46,264. The above figures show satisfactory progress for the first six months of the year, especially in the number of lamps connected, which show an increase of 6,405, or 21 per cent. in excess of the number connected for the same period last year, while the number of units generated show an increase of 46,264.

German Atlantic Telegraphy.—The German Atlantic Telegraph Company, which is now taking over the Borkum-Vigo cable undertaking of the German Marine Telegraph Company, is making a fresh issue of shares to the extent of £200,000 for this purpose. It appears, says the *Financial Times*, that the subsidy receivable from the German Government for the use of the two Atlantic cables will amount to £81,000 in 1905, £82,500 in 1906, and £84,000 in 1907. The directors state that the receipts for the first 10 months of the present year show an increase of £14,500 over the corresponding period of 1903, and this must be attributed to the bringing of the second cable into operation. The company, which has a combined share and bond capital of £2,200,000, paid a dividend of 5½ per cent. for 1903, as against 5 per cent. in 1902, and 4½ per cent. in 1901.

Chelsea.—At the last meeting of the Guardians the General Committee reported that having regard to an admitted breach of contract by the contractor for the electric wiring at the infirmary, the committee recommended that, to avoid a disturbance of the infirmary patients by the rewiring of the wards, Mr. Mickleburgh be called upon to pay £25 for supervision of the work still to be completed and for a further inspection of the finished work; that at his own cost certain portions of the wire be taken out and be submitted to an independent firm of cablemakers to be tested; that if the cable be found satisfactory, the remainder of the wiring, including any to be replaced, be carried out in strict accordance with the specification, the whole work being approved by the architects; and that Mr. Mickleburgh be required to extend his guarantee to six years and to leave £100 in the hands of the Guardians for two years, to be used by them in case of his failure to rectify any defects which may arise during the two years. The recommendation was adopted.

Macclesfield.—In reply to a letter from the Board of Trade asking what steps had been taken by the Corporation to carry out their obligations under the provisional order, the Council have informed the Board that they had carefully considered different schemes which had been submitted to them, but that they had not been able at present to adopt either of them, being of opinion, with a view of the large financial undertaking and responsibilities of the Corporation, that the present was not an opportune time for the undertaking by the Council of a large electrical installation for the borough. An amendment "That the British Westinghouse Company, Limited, Messrs. Crompton and Co., Limited, and the Industrial Engineering Company, Limited, be asked to tender for the installation of an electricity supply both with and without gas producers on the lines laid down in Messrs. Crompton and Co.'s scheme," was discussed at the last meeting and negatived. The Council also declined Messrs. Foote and Milne's proposals as to the financial part of the scheme.

Huddersfield.—The annual statement of the electricity department for the year ending Dec. 31, 1903, shows a surplus balance of £3,915. This amount carried to the depreciation and contingencies account makes the latter £11,853. The average cost of production was lower, and the number of lamps connected was larger than in any previous year, no less than 18,661 additional 8-c.p. lamps having been connected. During the year the committee reduced the charges for meter rents by one-half, which will represent a loss of revenue of approximately £800 per annum, and they have reduced the initial charges for energy for motive power purposes by 20 per cent. This should still further encourage the use of electricity for motive power. During the present year the mains have been considerably extended. The Corporation have, after several years' negotiations, secured provisional orders for the supply of electricity to the area of the Lunthwaite and the Golcar Urban District Councils, the main object in obtaining these orders being to interconnect the districts of Crosland Moor and Longwood, which these areas dissected. Mains have already been laid from Crosland Moor to Milnsbridge, and it is anticipated during the present year will be carried forward to interconnect the existing mains.

India and Burma.—Major Joly de Lotbiniére's report on the utilisation of the Periyar water power to supply electricity to Madras has been considered by the Madras Government, and is now before the Government of India for orders. *Indian Engineering* says: "We are assured that there is no doubt now that Government will approve of the Mussoorie electrical scheme, since Major Joly de Lotbiniére has sent in a favourable report regarding it. However, it is more to the purpose to learn that Government will advertise for tenders shortly. Messrs. Johnson and Phillips, through Messrs. Balmer, Lawrie, and Co., of Calcutta, have supplied the transmission plant for mining work at the Ruby Mines in Burma. Briefly, the plant may be described as 'two-phase, two miles transmission, 170 h.p., 2,000 volts, 60 periods.' The approximate price per horse-power of the plant delivered is £17, and there are four such plants now running. They have worked without a hitch from the commencement, and the installation furnishes a striking example of how, by the adoption of electricity, an undertaking which could not previously pay dividends was made a great success. Before installing the electric transmission plant, it cost £6,000 per annum at the Ruby Mines for fuel and lighting, and the chairman of the company went so far as to say in public that if worked in the old-fashioned way the concern would never have been placed on a paying footing."

Dover.—An enquiry has been held into an application for sanction to borrow £24,475 for the electricity undertaking extension. The Town Clerk said the Corporation had borrowed £150,000 for the purchase of the works. The loan now asked for consisted of an item of £7,715. Mr. Woodman gave the following particulars: under the head of plant—80 per cent. of the cost of new 400-kw. Ferranti engine set, £2,680; condenser valves, £135; steel tubes, £29; inspection fee, £15. 15s.; cast-iron pipes and work in connection with Ferranti set, £114; sundry invoices, £26. 12s. 6d.; salaries and wages, £200. 10s.; sundry stores, £13. 5s.—total, £3,214. 2s. 6d.; mains, including cost of laying, £2,878. 1s. 7d.; meters and indicators, £355. 15s. 11d.; electrical instruments, including a high-tension switchboard, £675. 6s. 10d.; transformers, £12. 7s. 2d.; street lamps, £26. 14s. 11d.; accumulators, £1. 13s. 4d. This accounted for a total of £7,714. 17s. of the £7,715 to be borrowed. The next item of the loan was £11,260, capital expenditure January, 1904, to March 31, 1905; buildings, £2,010; machinery, £5,240; the remaining 10 per cent. on the Ferranti set, £335; additional transformers, £100; concentric cable for reserve, £25; and cable for Prince of Wales's Pier, bridge, etc., £450. The other items were: £2,000 cost of mortgage (the bill for which was being taxed at the Local Government Board's request); £1,500 for free wiring; and £2,000 for meters; accounting in all for a total of £24,508 expenditure in respect of the loan of £24,475.

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Felixstowe.—The Urban District Council have completed the purchase of the Suffolk Electricity Supply Company's works at Felixstowe. The company will still carry on the undertaking, under the Council, for the next 25 years, when the Council will take over the entire control without payment to the company. In the meantime the company are to receive all the profits and pay the Council 6 per cent. for all capital moneys advanced. This is in payment of interest and sinking fund on the loans borrowed by the Council for the purpose of the purchase, and all additional new works. The purchase price is £8,000, of which £5,000 was paid on Friday. The remaining £3,000 is retained until the company can show that the undertaking is paying 6 per cent. The price of the current is to be reduced from 8d. to 6½d. per unit, but this will be increased to 8d. per unit during the three summer months, when it is reckoned the visitors will defray the extra cost. The Council are thus relieved of all responsibility in the working of the plant, and the company become lessees of the works, and pay to the Council in the nature of rent 6 per cent. of the capital expenditure, which will pay both the interest on the purchase money and the sinking fund, so that in 25 years the Council will take over the works practically free of cost, without any payment for goodwill or compensation for loss of future profits. The purchase was completed at the Felixstowe Town Hall on Friday morning, between Mr. J. Manning Prentice, the solicitor to the company, and Mr. F. B. Jennings, clerk to the Council. A move was afterwards made to the electric light works, where the undertaking was formally handed over to the Council by Mr. P. C. N. Peddar, the chairman of the company, nailing a brass plate, bearing the Council's name, to the entrance to the works. The engineer to the company (Mr. Napier Prentice), the Council's engineer (Mr. R. P. Wilson), and Mr. C. F. Fisk (chairman of the Lighting Committee) were amongst those present.

PROVISIONAL PATENTS, 1904.

Nov. 7.

23991. Improvements in magnetic suspensions for the moving parts of measuring instruments. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 6, 1903, being date of application in Germany.) (Complete specification.)

24030. An improved electric time switch or contactor. Frederick William Edmund Jones, 17, Claremont-road, Leamington.

24065. Improvements in electric switches. Louis Thurnauer and Alexandre D'Oreli, 4, South-street, Finsbury, London.

24078. Manufacture of single or multiple electric conductors. Société Industrielle des Téléphones, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 11, 1904, being date of application in France.) (Complete specification.)

24089. Improvements in or relating to electric motors and controlling devices for use in the electrical propulsion of vehicles. John Smith Raworth, 46, Lincoln's-inn-fields, London.

24093. An improved receiver for use in wireless telegraphy. John Greeme Balsillie, Clun House, Surrey-street, Strand, London.

Nov. 8.

24101. Improvements in automatic machinery for winding wires, cords, electric cables, and the like. Alexander Douglas Barty, Moss Works, Prescot, Lancs.

24102. Improvements in mountings and connections for electrical conductors, especially applicable to the supports for collecting brushes of dynamo-electric machines. The Phœnix Dynamo Manufacturing Company, Limited, Wilhelm Oelschläger, and Fredrick Haddock, 322, High Holborn, London. (Complete specification.)

24142. Improvement in electric interrupters for high-frequency currents. George Ephraim Johnson, 65, Chancery-lane, London. (Complete specification.)

24145. An improved thermometer to be used with electricity and in conjunction with various apparatus. Benjamin Foster Wickens, 10, Cranbrook-park, Ilford, Essex.

24166. Improvements relating to electric accumulators. Francois Mouterde, 7, Southampton-buildings, Chancery-lane, London.

24177. Improvements in thermo-electric batteries. James Yate Johnson, 47, Lincoln's-inn-fields, London. (A. Wolf, jun., and Co., Germany.)

24178. Improvements in the manufacture of thermo-electric batteries. James Yate Johnson, 47, Lincoln's-inn-fields, London. (A. Wolf, jun., and Co., Germany.)

24180. Improvements in and relating to protective devices for electric transmission systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24181. Improvements in systems of electric distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24190. Improvements in alternating-current motors, also relating to generators and direct-current machines. Valere Alfred Fynn, 70, Chancery-lane, London.

24192. Improvements relating to electric telegraphy. Sidney George Brown, 7, Southampton-buildings, Chancery-lane, London.

24200. Improvements in electric switches. Percy Lemon Clark, 18, Buckingham-street, Strand, London. (Complete specification.)

Nov. 9.

24225. Improvements in wheel guards and obstruction removers for electric tramcars or other electrically-driven vehicles. Eric Nicholson, Canal Bank, Carlisle.

24276. Improvements in alternating-current motors. Valere Alfred Fynn, 70, Chancery-lane, London.

Nov. 10.

24310. Improvements in lighting by means of Nernst electric lamps or the like. George Wilkinson, Beech Mount, Otley-road, Harrogate.

24316. Improvements in electric arc lamps. August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

24323. Improvements in and relating to electric traction. Joseph Birkbeck, Sunbridge-chambers, Bradford.

24341. Improvements in electric switches. Owen David Lucas, 39, Victoria-street, Westminster, London.

24342. An improvement in carbons for electric arc lamps. Frederick James Green, 96, Brookbank-road, Lewisham, London.

24343. Improvements in electric signs. Julius Heinemann, 55, Chancery-lane, London. (Complete specification.)

24351. Improvements relating to dynamos and other rotary electric machines. Miles Walker, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

24358. Improvements in carbon-feeding mechanism for electric arc lamps. Gregory Douglas Mantle, 9, Regent-street, London.

24369. Improved arrangement of electric emergency lamps in theatres and like buildings. Fritz Brandt, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24379. Improved means for use in connection with electric motors and centrifugal separators or other apparatus driven by such motors. William Harding Scott and Robert Williamson, 47, Lincoln's-inn-fields, London.

24384. A combined mouth gag and electric light. John Sides Davies MacCormac and the Dental Manufacturing Company, Limited, 322, High Holborn, London.

24388. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24389. Improvements in controlling devices for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24390. Improvements in insulators for the live rails of electric railways, tramways, and the like. Oswald Erlands, 18, Buckingham-street, Strand, London.

24394. Improvements in means for connecting electric circuits, especially applicable for the lamps of motorcars. Dominique Couverchel, 1, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Dec. 19, 1903, being date of application in France). (Complete specification.)

Nov. 11.

24399. Improvements in electric tools. Paul Schiemann, 37, West Nile-street, Glasgow. (Complete specification.)

24423. Improvements in electricity meters. Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 4, New Bartholomew-street, Birmingham.

24429. Improvements in telephone systems. William Aitken, Milton-road, Edge-lane, Liverpool.

24432. Improvements in or relating to electro-mechanical synchronisation apparatus. Bahne Bannikaen, 18, Hertford-street, Coventry.

24443. An improved multiple-filament incandescent lamp. Joseph Klopfenstein, 11, Southampton-buildings, Chancery-lane, London.

24464. Improvements in and connected with the field windings of series-wound dynamo-electric machinery. Arnold Frank Hills, David Urquhart, and Alfred Edward Honey, 4, South-street, Finsbury, London.

24466. Improvements in electrical conductors. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

24470. Improvements relating to electric, gas, or vapour apparatus. Peter Cooper Hewitt, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 24, 1903, being date of application in United States.) (Complete specification.)

24477. Improvements in or connected with electric arc lamps. Frank Michael Lewis, George William Lewis Case, and the Beason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

24485. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 12.

24538. Improvements in electrical fuses. Bertram Thomas and Gustave Thomas, Worsley-street, Hulme, Manchester.

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24539. Improvements in automatic electric switches or circuit breakers. Bertram Thomas and Gustave Thomas, Worsley-street, Hulme, Manchester.

24560. Electric testing clip. Harry Frankel, 321, High Holborn, London. (Date applied for under Patents Act, 1901, Dec. 2, 1903, being date of application in United States.) (Complete specification.)

24569. Improvements relating to the supply of current to electric vehicles. Oscar Howard Baldwin, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

24572. Improvements in connection with electric igniters for internal-combustion engines The Marquis Albert de Dion and Georges Bouton, 47, Lincoln's inn-fields, London. (Date applied for under Patents Act, 1901, Aug. 16, 1904, being date of application in France.) (Complete specification.)

24573. Improvements in dynamo-electric machines Asa Fred Batchelder, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 12, 1903, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED

To be published Dec. 1, 1904.

1903.

23853. Mercury electrolytic apparatus, specially applicable to electric meters and electric switches. Du Bois and Reason Manufacturing Company, Limited.

24063. Electrical apparatus used in propelling autocars and other vehicles, launches, and the like. Rees.

24235. Electric arc lamps. Davy.

24701. Multiplication of electric force, applicable to machinery of all kinds requiring power. Howell.

25322. Electrical resistances Matthews and Hoghton.

26856. Electric circuit-breaker mechanism. Crompton and Co., Limited, and Harris.

26954. Mechanical device applied to the cars or cages of electrically-driven lifts and belt-driven lifts. Moffatt.

27069. Means or apparatus for operating points on electric tramways, light electric railways, and the like. Cardell.

28607. Electrical fuse holders, fuse boxes, and the like. Baily.

1904.

319. Electric cables. Field.

330. Electric fuses. Lackie and Callerwood.

351. Safety device for use on vehicles propelled by electric traction on the stud contact system. Griffiths and Bedell.

1006. Spark-extinguishing apparatus for use in connection with electrical high-frequency circuits. D'Arsonval.

2347. Composition for electrical conduits. Starke.

2512. Electrical joint-boxes. Groves.

4062. Electric arc lamp. Scialpi.

14523. Telephone systems. Fairweather. (American Electric Telephone Company.)

15869. Installations for electrically operating railway points. Siemens Bros. and Co., Limited. (Siemens und Halske Act.-Ges.)

16871. Receiving telegraph instrument. Underhill.

17166. Chain for suspending electroliers. Clements.

18919. Terminal or coupling for electric cables. Middleton and Middleton.

18991. Systems of electrical distribution. Thomas. (Date applied for under International Convention, Sept. 4, 1903.)

19265. Electrical fire-alarms. Hoenicke.

20001. Systems of electrical distribution. Lincoln. (Date applied for under International Convention, Sept. 30, 1903.)

20165. Electrical signalling apparatus for fire calls and the like. Pinching and Walton.

20864. Wireless telegraphy systems. Thompson. (Gesellschaft für Drahtlose Telegraphie m. b. H.)

21648. Trolley heads employed in electrical traction. James and West.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
	£		£
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	15/32-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	3¼-3⅜
—— 4 per cent. Mortgage Debenture Stock	100	–	89-91
Brush Electrical Engineering, Ordinary, Nos. 1-105,731 ..	2	–	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock.....	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	69-73
Callender's Cable, Debentures	100	–	104-106
—— Ordinary	5	–	9¼-10
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	5	–	14-14½
—— 5 per cent. Debentures.....	100	–	90 95
Edison and Swan United, "A" Shares, 1-99,261	5	–	¼-⅜
"A" Shares, 01-017,139	5	–	1-1¼
—— 5 per cent. Debentures.....	100	–	78-84
—— 4 per cent. Deb. Stock, Red.	100	–	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼-1½
—— 7 per cent. Cumulative Pref.	2	–	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10¾-11¼
—— 4½ per cent. Preference	5	–	5¼-5⅜
—— 4½ per cent. Debentures	100	–	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	20-20¼
—— 4 per cent. Debentures.....	100	–	99-102
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance.....	12	–	37-39
—— 5 per cent. Bonds	100	–	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock. Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	100-103
Brompton and Kensington, Ordinary.....	5	–	10¼-11
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 ..	5	–	7⅜-8 xd
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	105-109
Charing Cross and Strand, Nos. 1-70,000	5	–	8¼-9
—— 70,001-80,000.....	5	..	8-8½
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4¾-5
—— 40,001-80,000.....	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	103-105
Chelsea Electricity Supply	5	–	6¼-6⅜
—— 4½ per cent. Debentures	100	–	109-111
City of London, Ordinary.....	10	–	10¼-11
—— 6 per cent. Cumulative Pref.....	10	–	13¼-14
—— 5 per cent. Debenture Stock	100	–	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	104-106
County of London Electric Supply, Ordinary	10	–	9¼-9⅜
—— 6 per cent. Cum. Pref.	10	–	12-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	100-103
—— 4½ per cent. 2nd Debentures Prov. Certs.....	100	..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	–	6¼-6¼
—— 4½ per cent. First Mort. Deb.....	100	–	106-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.....	100	–	101-104
Havana Electricity, Limited, 1-15,000	10	–	9¼-10⅛
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7⅛ 8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	99-101
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	5/16-7/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-91,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10¼
London Electric, Ordinary	5	–	2-2¼
—— 6 per cent. Pref.....	5	–	5⅜-5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	97-99
Metropolitan Ordinary.....	10	–	16-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb..	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	.	14¼-15
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) ..	100		101-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510.....	5	–	6-6¼
—— 4 per cent. Debenture Stock	100	–	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2⅜-3¼
—— 4 per cent. Debenture Stock	100	–	83-87
South London, Ordinary		–	4¼-4½
South Metropolitan Electric Light and Power Co., Ord...	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	107-110
—— Ditto, June, 1904			
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	14¼-14⅜
—— 7 per cent. Pref.	5	–	8¼-9
—— 3½ per cent. Deb.	100	–	99-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4¼-5
Westminster, Ordinary	5	–	12¾-13½
—— 5 per cent. Cum. Pref., 110,101-138,251.....	5	–	6¼-6⅜
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅜-5¼
—— Ord.	5	..	6¼-7¼
—— Permanent 6 per cent. Debenture Stock, 1888 ..	100	–	141-144
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	105¼-106½
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..	1	..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000.....	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103 xd
—— Ord Pref.	100	..	102-105
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	–	102-104 p ol
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	11¼-11⅜
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	..	96-97

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Name.	Amount paid.	Last price.
	£	£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	3 15/16-4 1/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	106-108
—— Prov. Cert., all paid	100	102-105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	96-99
Calcutta Tramways, Limited, 1-102,268	5	7⅛-7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	106-108
Cape Electric Tramways, Nos. 1-480,000	1	1 9/16-1⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¾-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	9¼-10
—— 5 per cent. Cum. Pref.	10	11-12
—— 4 per cent. Debentures	100	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4½ per cent. Deb Stock	100	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000	5	3¾-4¼
—— 4 per cent. Debenture Stock	100	90-93
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	10⅜-10⅞
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	103-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	103-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	¾-⅞
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	102-104
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-1¼

Name.	Amount paid.	Last price
	£	£
Oldham, Aston, and Hyde Tramway, Ordinary	10	2-2¼
—— 5 per cent. Cum. Pref.	10	9⅜-9⅝
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary 20,001-40,000	10	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-8¾
—— 4½ per cent. Debenture Stock	100	99-102 xd
South Lancashire Electric Traction and Power Company —— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	p.c.

Electric Railways.—

Central London, Ordinary	100	91-94
—— 4 per cent. Pref.	100	100-102
—— ,, ,, deferred	100	85-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	108-110
City and South London, Consolidated Ordinary	100	46-47
—— 4 per cent. Debenture Stock	100	104-107
—— 5 per cent. Pref. Stock '91	100	122-125
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	114-117
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-99¼
Waterloo and City, Ordinary	100	88-90

Telephones.—

National Telephone, Preferred	100	106½-107½
—— Deferred Stock	100	97-98
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5⅝
—— 5½ per cent. Deb. Stock, Red.	100	97½-98½
—— 4 per cent. Deb. Stock, Red.	100	104½-105½
—— 4 per cent. Prov. Cert.	—	67½-68½
Oriental Telephone and Electric Company	1	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	1¼-1⅜

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 29	1,152	1,227	— 74	— h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	Nov. 12	185	181	+ 4	+ 490	8	8	,, 15	14,160	3,201,586	316,049	1·03	10·11	1,770	5·04
Barking Corporation	,, 12	50	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 13	976	1,004	— 28	— 427	23·53	23½	March 31	56,073	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Corporation	,, 12	331	—	—	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 12	5,584	5,221	+ 363	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 11	846	750	+ 76	+ 3,173	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·59
Blackpool Corporation	,, 10	337	299	+ 33	+ 5,850	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 12	185	222	— 37	+ 372	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	,, 6	1,614	1,687	+ 7	+ 374	38	38	March 31	94,151	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 9	827	796	+ 31	—	10·15	10¼	—	—	—	—	—	—	—	—
Bradford Corporation	,, 5	3,926	3,506	+ 420	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 13	837	844	+ 13	+ 3,278h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 4	4,659	4,521	+ 138	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 12	1,003	791	+ 212	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 13	316	329	— 13	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 12	1,903	1,865	+ 37	+ 1,664	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 12	192	189	+ 3	+ 200	—	—	Dec. 31g	9,987	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 12	7,002	6,936	+ 6	— 272a	6	6	,, 31	362,471	44,933,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 13	2,841	2,894	— 53	— 1,817h	6¼	6¼	,, 31	165,003a	19,069,519a	—	—	—	—	—
Colchester Corporation	,, 9	181	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 3	457	461	— 6	— 2 539	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 11	225	210	+ 15	—	7·23	7·23	March 31a	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 15	181	165	+ 16	— 261	4½	4½	,, 31	11,255	2,871,332	280,901	0·91	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 4	111	94	+ 17	— h	7	6½	Dec. 31g	6,234	688,905	107,164	3·88	14·09	932	7·39
Dublin U. T., electric cars	,, 11	3,750	3,725	+ 25	—	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 11	795	776	+ 19											
Dundee City Tramways	,, 9	826	799	+ 27	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 12	618	612	+ 6	+ 1,495	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 12	14,314	13,723	+ 591	— h	145	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 9	229	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 2	2,628	2,546	+ 82	+ 3,598	33	30½	March 31	68,289	16,322,054	1,387,885	1·00	11·79	2,089	8·77
Huddersfield Corporation	,, 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 12	2,154	1,895	+ 258	+ 9,411	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 12	370	343	+ 27	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 10	121	106	+ 15	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 9	204	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 12	5,402	5,106	+ 296	+11,721	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 12	1,785	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 5	10,143	9,900	+ 243	+13,241	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 13	1,409	1,646	— 237	— 1,612h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 5	12,382	10,010	+2,372	+75,926	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Oct. 25	160	175	— 15	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 27	126	125	+ 1	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	Nov. 12	11,788	11,315	+ 473	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 11	1,752	1,130	+ 621	+ 9,861h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 12	115	88	+ 27	+ 1,221	2¼	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 12	3,576	3,574	+ 2	—	45	38½	,, 25	185,027	39,715,120	4,059,907	1·1	10·94	4,111b	7·19
Newport (Mon.) Corporation	,, 12	545	448	+ 97	+ 303	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 12	1,554	1,395	+ 159	+ 5,532	29	29	,, 31	91,448	18,204,426	1,828,193	1·15	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 10	497	398	+ 99	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 5	81	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 13	4,573	4,450	+ 123	+ 3,042	34¼	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 10	899	906	— 7	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Oct. 19	272	243	+ 29	+ 1,292	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	Nov. 11	456	334	+ 122	+ 7,598	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 6	1,117	1,094	+ 23	+ 720	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	,, 9	160	—	—	—	3¾	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 12	658	596	+ 62	+ 1,589	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 10	1,047	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 9	717	424	+ 293	—	7¼	—	,, 31g	20,878	4,263,066	417,335	—	12·006	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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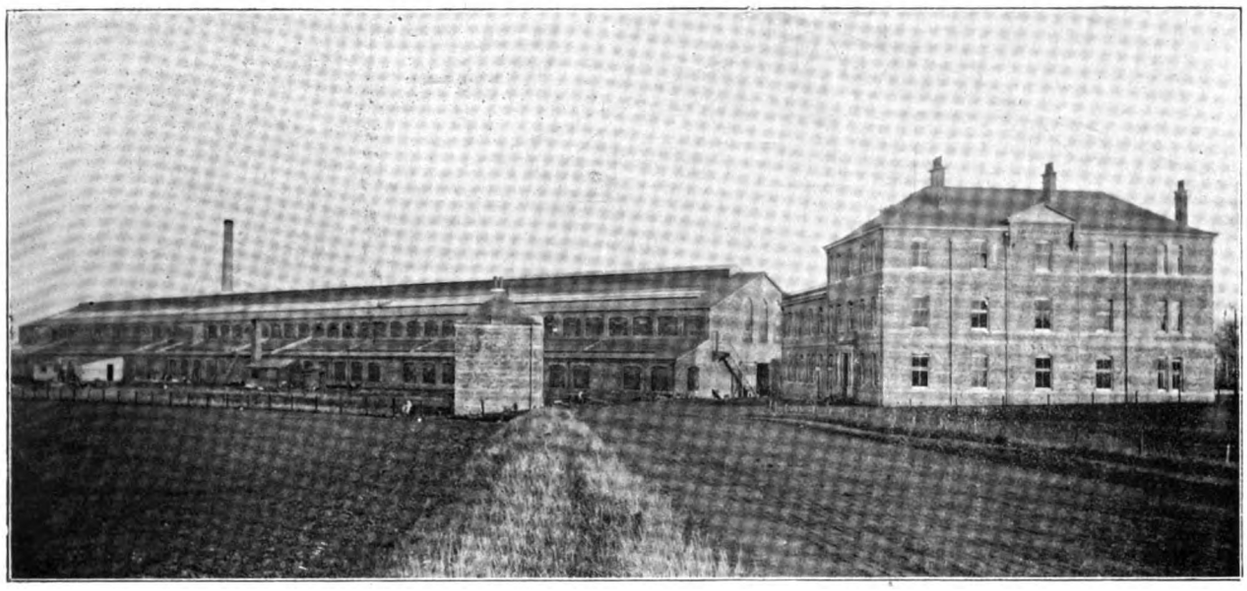
MESSRS. BRUCE PEEBLES AND CO.'S NEW WORKS AT EAST PILTON, EDINBURGH.

The firm of Messrs. Bruce Peebles and Co. have been well known in engineering circles for a very long time, and they have had a reputation for good work from the first.



Messrs. Bruce Peebles and Co.'s New Works and Offices at East Pilton, Edinburgh.

When the firm decided to launch out into the electrical side of engineering they secured the services of Mr. Roland S. Portheim and Mr. M. T. Pickstone, which accounts for the three P's in their trade mark. This departure was made only eight years ago, but owing to the excellent design and the consequent good performance of the generators and motors manufactured by the firm, the growth of the business has been exceedingly rapid. The electrical business soon outstripped the other departments of the firm, and the old Tay Works became too small to cope with the orders obtained. It speaks well for the heads of the firm that this rapid growth of business has been concurrent with a time of very severe competition, first from American and Continental firms, and latterly from other manufacturers within the United Kingdom. In 1903 the business was found to have altogether outgrown the capacity of the Tay Works at Leith, and, in consequence, the works we are now about to describe were erected. It might be well at the outset to give a general idea of the type of work which the firm are now undertaking, and hence the following reference to contracts in hand will be of service. The volume of work comprised in these and other contracts is such that already the manufacturing facilities of the East Pilton works are severely strained, and extensions are contemplated as indicated in the block plan (Fig. 1).

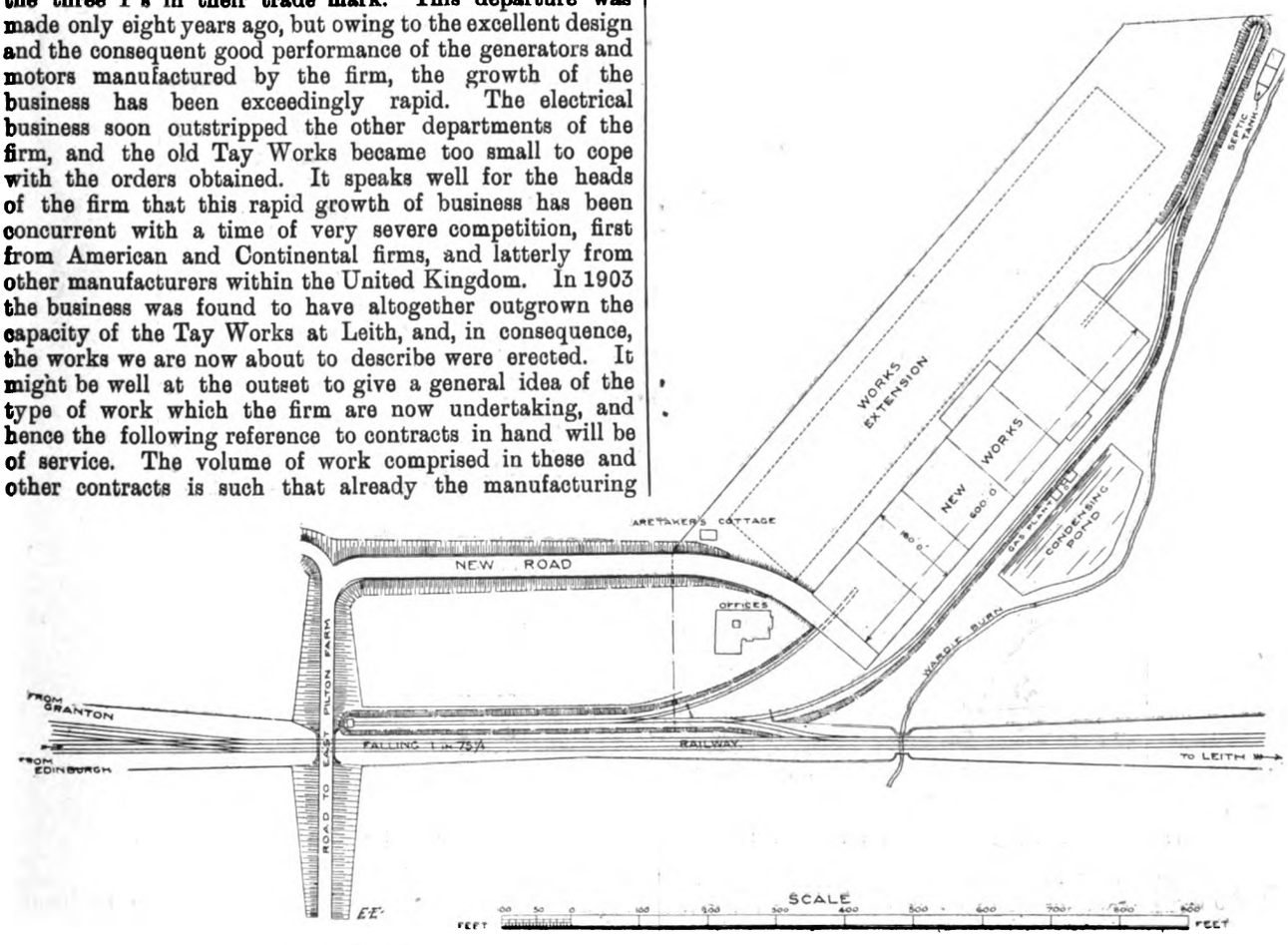


FIG. 1.—Block Plan of Messrs. Bruce Peebles and Co.'s New Works at East Pilton, Edinburgh.

On going through the shops one is struck by the exceedingly large number of machines, varying in output from 1,500 kw. to 500 kw., in hand for contracts of every description. Standing opposite one of the boring machines, we noticed a stator of one of four 1,500-kw. machines at 10,000 volts being machined. These were for the North Wales Electric Power Company. This company is now just completing a hydro-electric power station at Portmadoc with a capacity of some 10,000 h.p. to the joint designs of Sir Douglas Fox and Messrs. Harper Bros, the consulting engineers. The water supply is drawn from Loch Llydaw, on the lower summit of Snowdon, with 1,200ft. head. Turbines of the Pelton type drive the Peebles alternators now going through the shops in 1,500-kw. units, giving 10,000 volts, three-phase. The current is utilised for two turbines, one for driving a three-phase electric railway 18 miles in length, parts of

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the locomotives of which, at 250 h.p. capacity, are now being manufactured at East Pilton. Owing to the narrow gauge of the line, and the high power of the motors, these are placed with vertical axles, and drive by bevel gearing. This electric railway will be three-phase throughout, and as the railway feeders supply the quarries on the line of route, the advantage of one system for both purposes is obvious.

a commutator at the other, the construction being exceedingly simple and efficacious.

In the left bay in the motor assembling room we saw over 100 Peebles tramway motors in various stages of construction, some 60 of these being required for the Sunderland and District Power Company, the whole contract for the electrical machinery of which has been manufactured by

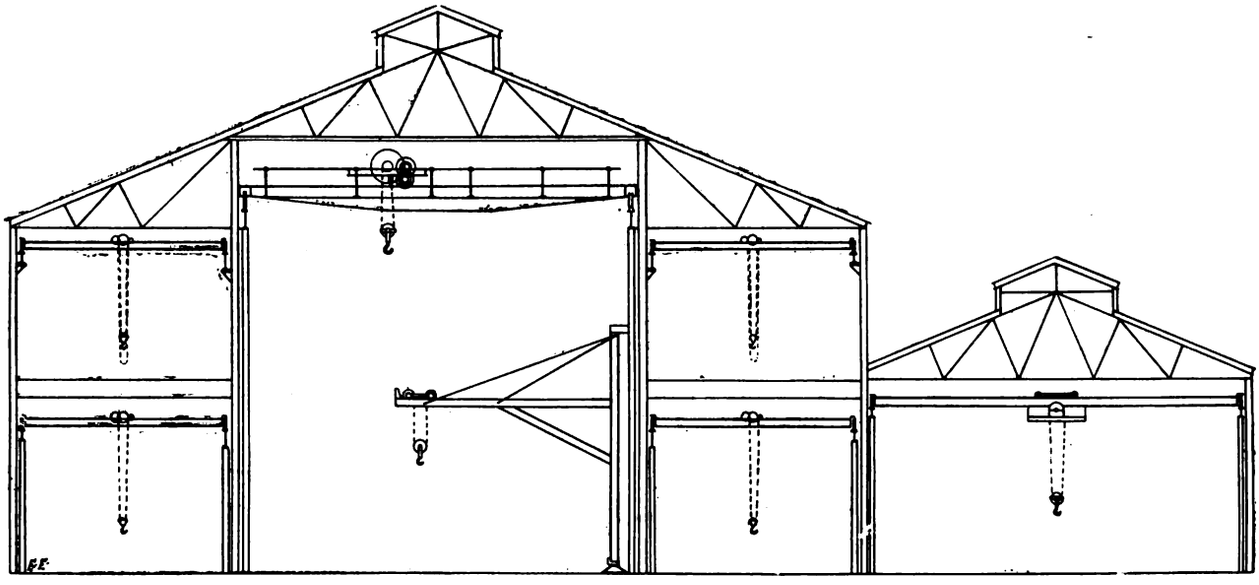

FIG. 2.—Section of the Works, showing Cranes and Lighting facilities.

A little further on we came to two 500-h.p. three-phase generators which were being built by Messrs. Bruce Peebles and Co. for the Canadian Electric Traction Company. This three-phase railway scheme involves some 30 miles of track, commencing at the city of London in the Province of Ontario, Canado, running from there to Port Stanley on Lake Erie. The initial power-house, which is being

Bruce Peebles and Co., Limited, including 1,000-h.p. gas-driven generating station. Amongst some of the other larger machines were two 600 h.p. three-phase alternators for the Fife electric power station, being the first portion of a 2,500-h.p. generating plant contract, the whole of which, including boilers, switchboards, etc., is in the hands of Bruce Peebles and Co.

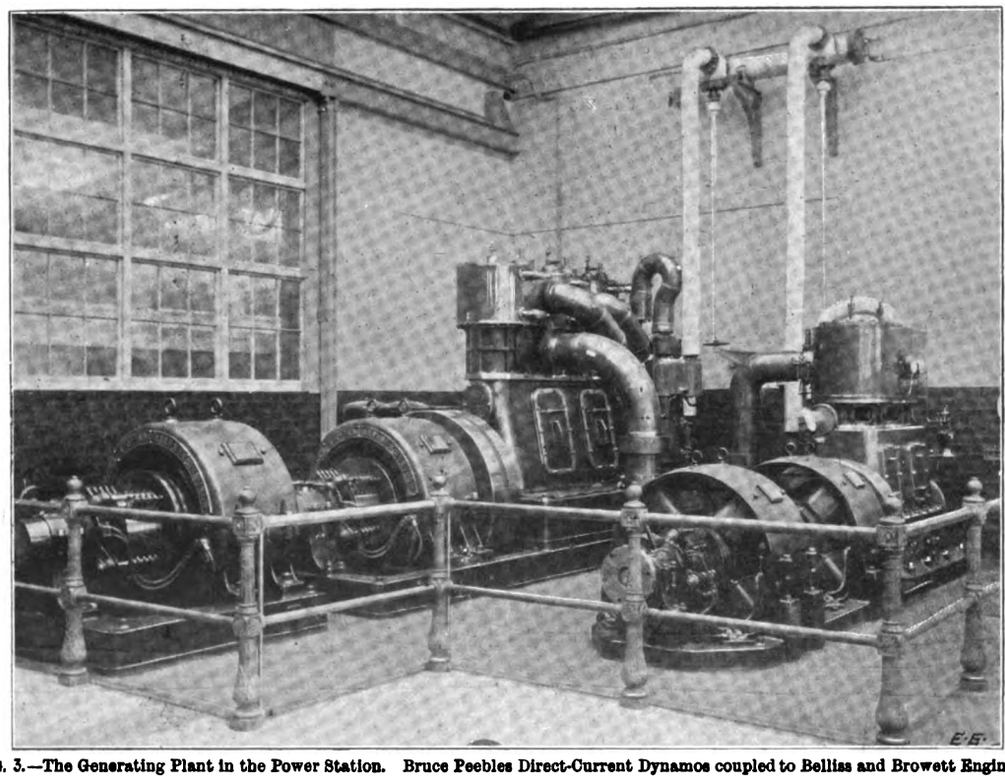

FIG. 3.—The Generating Plant in the Power Station. Bruce Peebles Direct-Current Dynamos coupled to Bellias and Browett Engines.

constructed by Messrs. Bruce Peebles and Co. in Canada, is of 1,000 h p. capacity, and the motors of the firm's manufacture are of an exceedingly interesting design, being combined continuous current and three-phase, so that the same motor when running between the towns and the open country runs as a 1,000-volt three-phase motor, and when running through the towns on the existing 500-volt continuous-current system runs as an ordinary series traction motor, the rotor having slip-rings at one end and

Parts of similar machinery for a similar installation—the Scottish Central Power Company—were also in hand. This latter power station is about to supply power to the Falkirk and District Tramways Company, the contract for the whole of same, including permanent way, now being constructed by the firm, whose traction department, to judge by the orders on hand and orders going through, seemed full to overflowing. In the continuous-current department we saw parts of six 750-kw. direct-current

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machines for H.M. Dockyard, Chatham, in various stages of manufacture, together with a large number of motors.

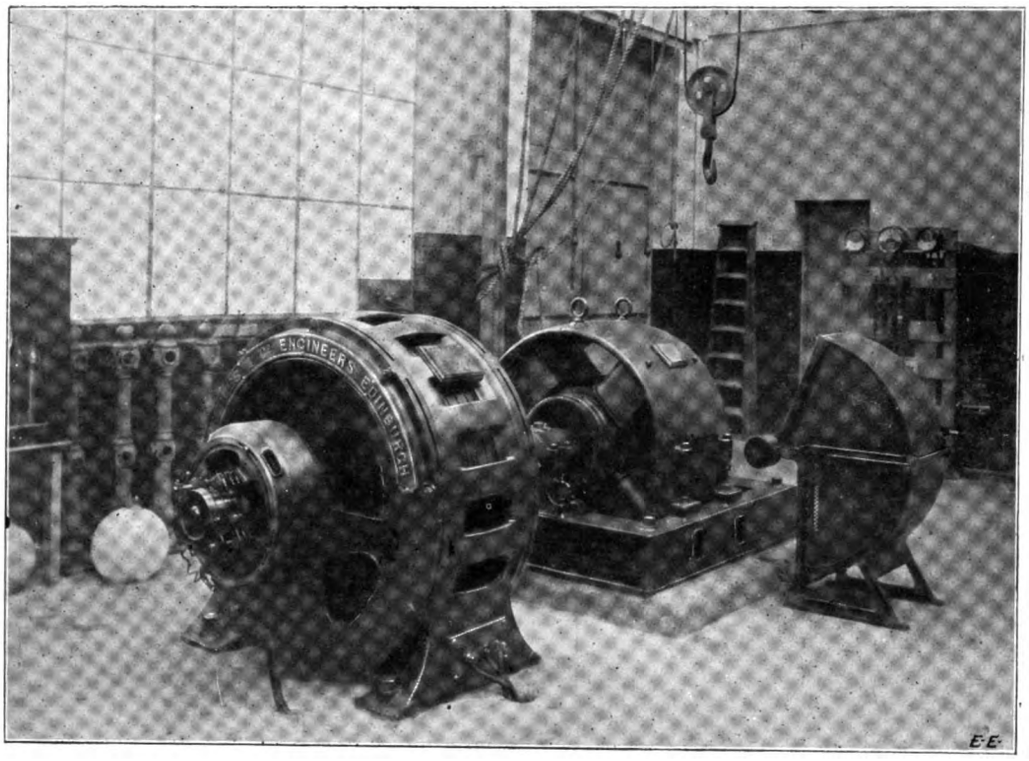

FIG. 4.—The Motor-Generators in the Power Station.

We understand that the whole of the contract for this important dockyard is in the hands of the firm.

On the heavy end of the test plate were two sets of

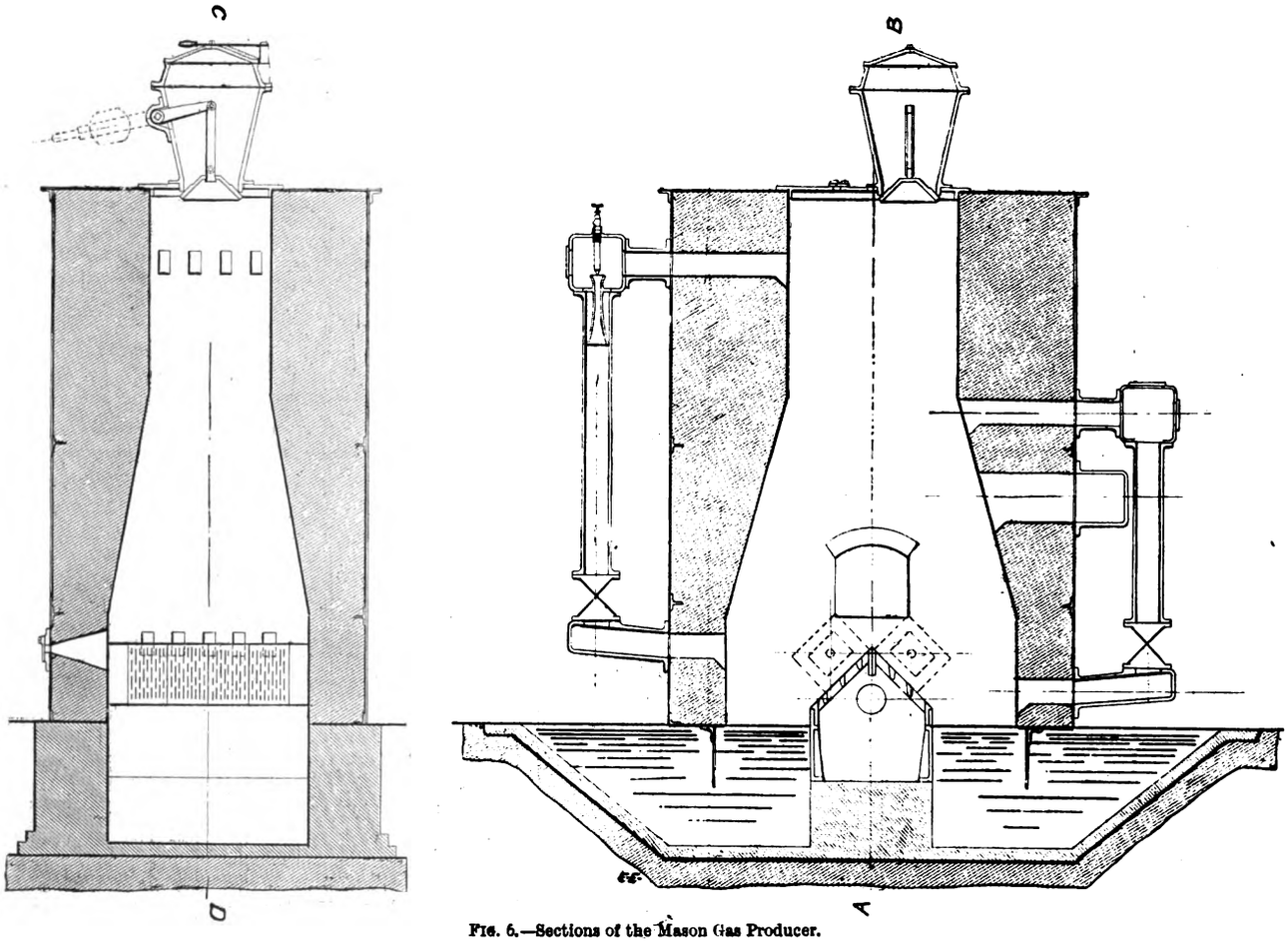

FIG. 6.—Sections of the Mason Gas Producer.

500-kw. motor-generators going through for the Poplar Corporation, being part of an order of six for this Corporation on the Peebles-La Cour system, which exceedingly interesting example of improved motor-generators we shall have to describe in detail later on. The Peebles-La Cour motor converter is really a rotary with all the advantages of a motor-generator, and the best tribute to this system is the fact that over 20,000 kw. of this particular type are now on order, including 8,000 kw. for the Great Western Railway Company. The orders which are now being placed for these motor-generators fully justifies the firm in their adoption of the system, and they are further to be congratulated in having secured the services of Mr. La

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Fig. 5.—Plan of Messrs. Bruce Peebles and Co.'s East Pilton Works, showing the arrangement of the numerous Departments.

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Cour himself as head of the electrical designing department. In the space at our disposal it is impossible to describe

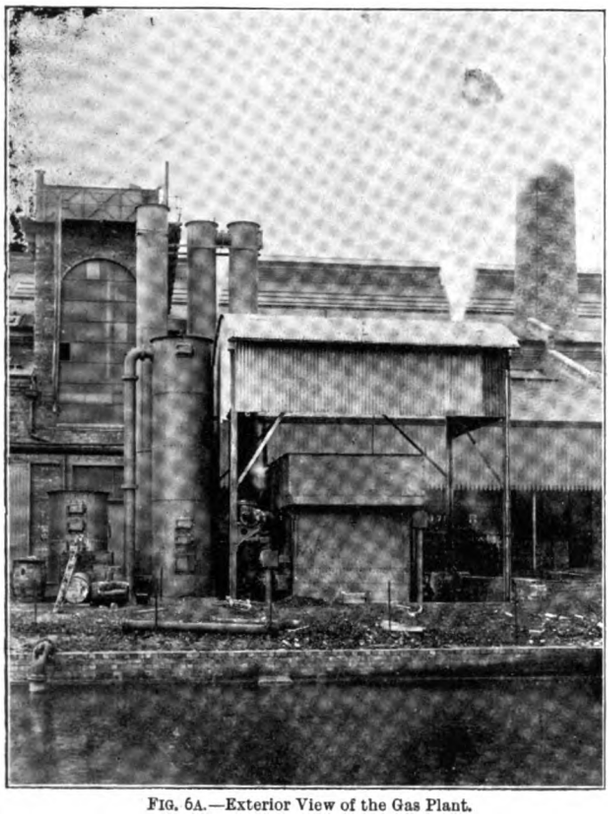

FIG. 6A.—Exterior View of the Gas Plant.

the enormous amount of shipbuilding and colliery equipment work which Bruce Peebles and Co. are doing. Suffice to say that some of the most important collieries and shipping firms appear to be customers on a very large scale, judging from the stencilled names we saw on the machines being tested and dispatched.

The East Pilton works are situated on a site overlooking the Firth of Tay and adjoining the Leith branch of the Caledonian Railway. The site is shown in the block plan (Fig. 1), on which the siding facilities are clearly drawn. This connection to the railway is a most valuable one, as it gives easy access not only to the railways of the country, but also to the docks at Glasgow and Leith. The works stand in open country in a most healthy situation, and are arranged so that they can be conveniently extended. There is much to gain from choosing a position, as Messrs. Bruce Peebles and Co. have done, outside a large town: the employés have all the advantages of the town, and the manufacturers are not a nuisance in any way to those living in their immediate vicinity, as may be the case if they were in the town itself. It will be seen from the block plan that the offices are placed in a separate building. The drawing offices are situated in the galleries of the new works. The main machine-shop is 600ft. long by 160ft. wide. It will be seen that there is railway access to either end of this long building, and, as will be explained later, the raw materials and castings are brought in at the end of the works nearest the offices, while the finished machinery is dispatched on the line leaving the works at the farther end. There is thus a constant forward movement of the parts towards the packing-room at this end. The arrangements within the works for transporting the materials and machinery are most ample, as will be gathered from the section of the works (Fig. 2). In this illustration, which is not quite a true section, there is shown no less than six travelling cranes. These do not all, however, run the full length of the factory. The following details of these travelling and other cranes will be of interest. Thus the main shop is spanned by two 15 ton travelling cranes, each with two-speed gear and three motors. The speeds of motion are as follows: heavy lift, 12ft. per minute; lift up to six tons, 24ft. per minute; travel 300ft. per minute; traverse, 80ft. per minute. The motors for

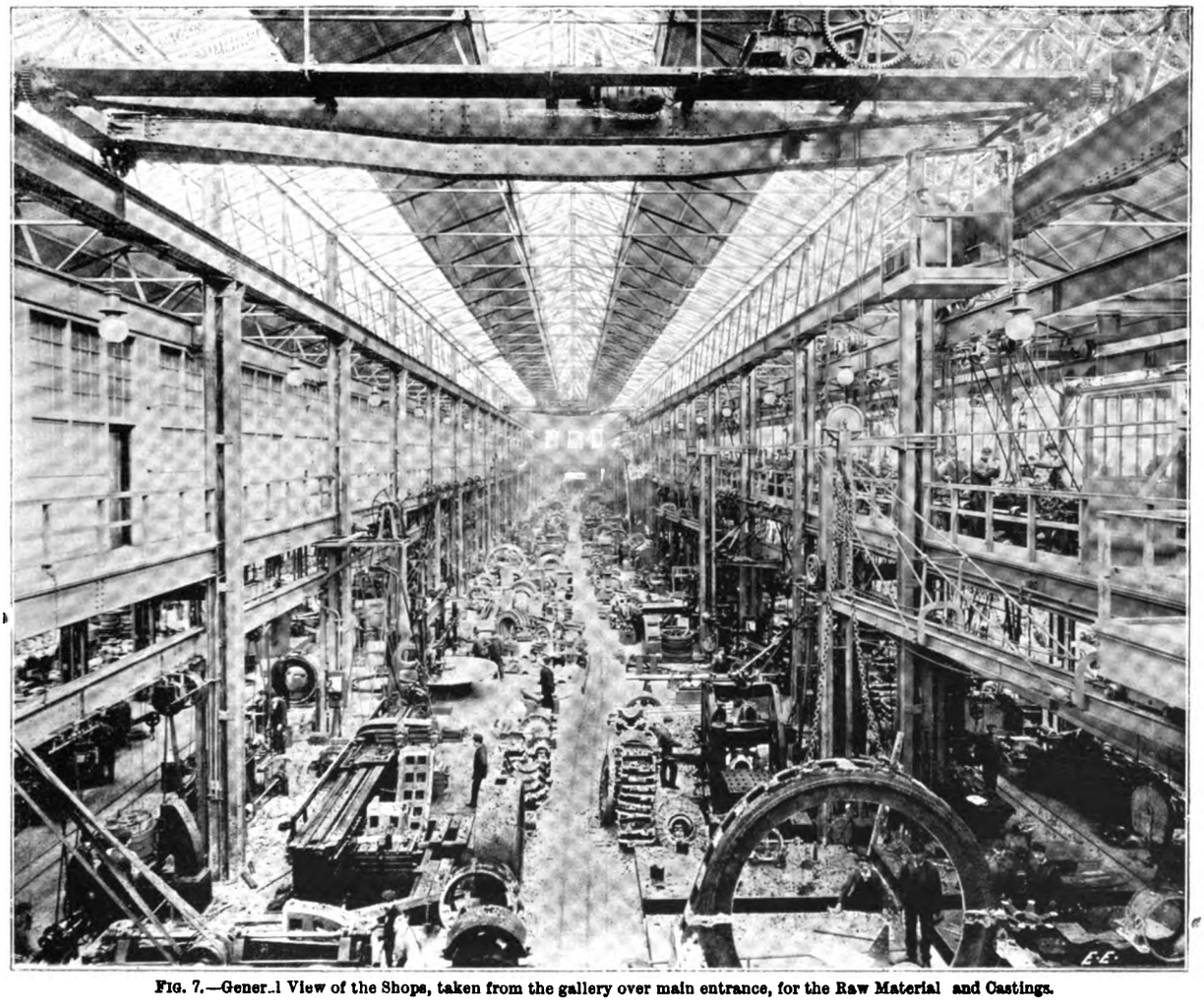

FIG. 7.—General View of the Shops, taken from the gallery over main entrance, for the Raw Material and Castings.

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the lift are of 15 b.h.p., for the travelling motion 10 b.h.p., and for the traverse 3 b h.p. In the side bays are found two six-ton cranes with similar speeds for travel and traverse, and equipped with motors of 7 h.p. and 2 h.p. for these respective motions. A lift motor of 12 h.p. is fitted in each case, and six-ton loads can be raised at 20ft. per minute and three-ton loads at 40ft. per minute. The span of these cranes is 24ft. There is also a six-ton electrical crane in the light erecting shop. This, however, differs from the other six-ton cranes in having one motor only, and being worked from the floor level instead of having an operator in a cage. One motor drives the various motions by means of belts and ordinary striking-in gear. In addition to the above, there is a five-ton two-motor crane and a large number of two-ton one-motor travelling cranes. An interesting feature of the main shop and the light erecting shop is the number of two-ton jib cranes in use, as will be seen from the general arrangement drawing. These jibs have a very wide span, and are found extremely useful for handling work being set up on the tools, etc.

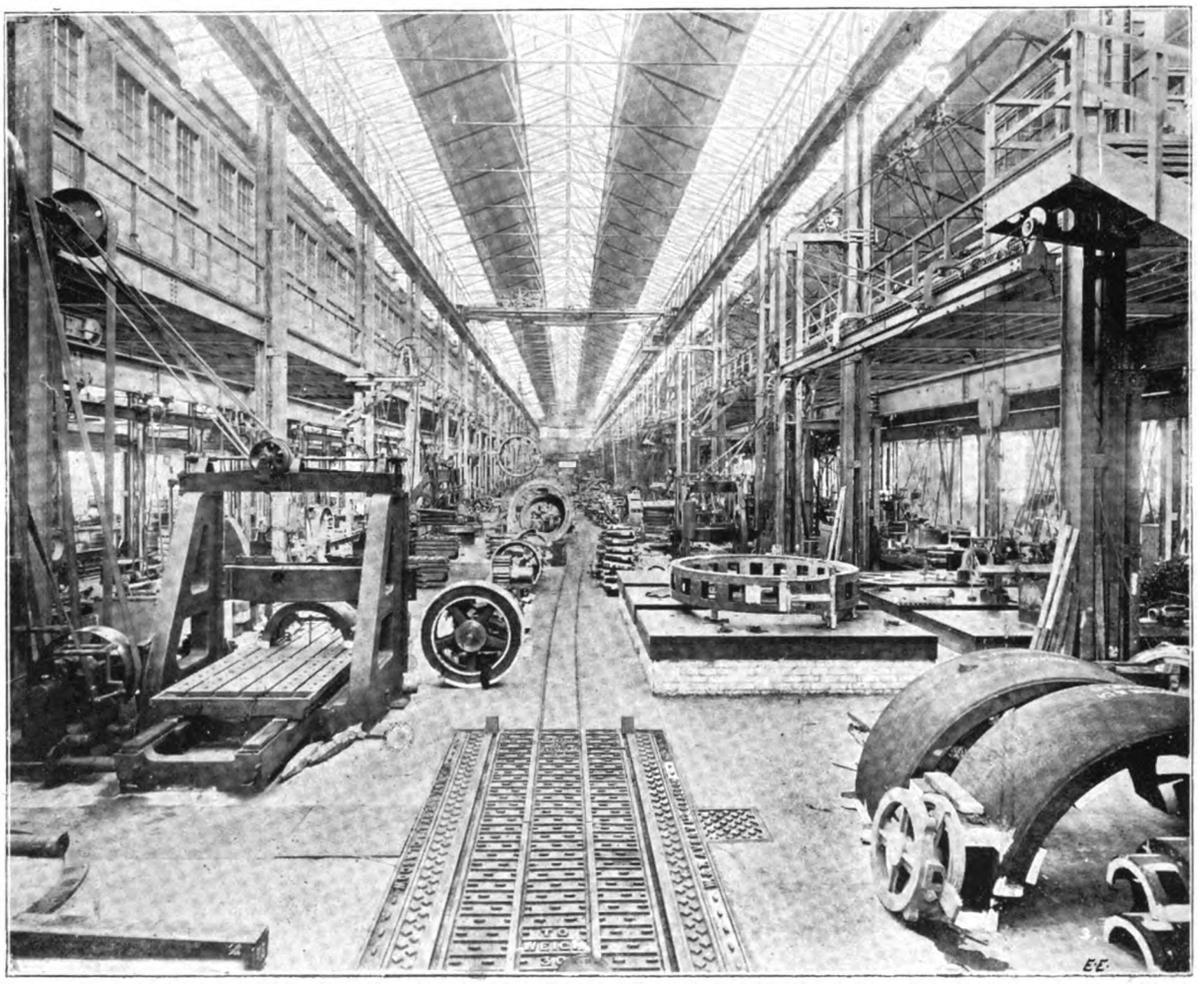

FIG. 8.—General View of the Shops from ground level at main entrance. The marking off for Surface Plants are seen on the right and the Large Planer on the left.

POWER SUPPLY.

Before proceeding with the arrangement of the various departments in the works, a few words as to the power plant will be of interest. Messrs. Bruce Peebles and Co. have naturally adopted electrical driving throughout, and they have also wisely introduced a considerable variety in the method of applying electricity. This enables them to show to their customers various systems at work, and also to demonstrate the fact that there are distinctive advantages in each of these systems. Thus in the power station they have two main generating units. The largest set (seen in Fig. 3) consists of a high-speed engine made by Messrs. Belliss and Morcom, driving two dynamos of the firm's own manufacture. Each of these is able to give 750 amperes at 250 volts. The smaller steam set seen in the right of Fig. 3 consists of a Browett and Lindley engine coupled to two Bruce Peebles dynamos, each capable of giving 320 amperes at 250 volts. These two generating sets supply the bulk of the power and light required in the factory, on the three-wire system, with 230 volts between the middle wire and either of the outer. All the lighting is done at 230 volts, and the motor supply is either at this voltage or at 460. In certain cases where speed regulation over a wide range is required, the voltage on the motor armature is altered from 230 to 460, or *vice versâ*, as may be required to give the speeds needed. This refers to the direct-current supply only, and with this system there is also a great variation in the application of the motors to the work. Thus the larger machines have each their own motor. When smaller tools have to be driven, a number are connected by belting on to a common countershaft. This countershaft is in turn driven by a single motor, either through gearing or by means of a belt. In the galleries these countershafts are placed on pedestals behind the machine tools, and hence are on the ground-level, where they are easy of access. It is thus only the special countershaft for each tool with the cones for speed changing which are overhead, and the result is remarkably good, as it leaves a clear way for the overhead traveller. There is also in the power station a motor-generator (Fig. 4) which converts electrical energy from direct current into three-phase currents at 50 frequency. The output of this machine is 120 kilovolt-amperes at 240 volts. From the three-phase side of this converter a number of induction motors are supplied. These motors are mostly used for driving the tools in the galleries, where a number of machines are grouped together under the one countershaft.

The steam for these generating sets is obtained from the boiler-room adjoining, the position of which can be seen in Fig. 5. Two boilers have been installed, one being of the Stirling water-tube type, doing 418 h.p at 220lb per square inch working pressure; the heating surface of 1,305 square feet, giving an evaporation of 8,360lb. of steam per hour. The other boiler is of the Babcock and Wilcox type, having 1,426 square feet of heating surface and giving an evapora-

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tion of 5,200lb. per hour. The condensing plant is by Messrs. Blake-Knowles of the cast-iron coil type, capable of condensing 5,000lb. per hour at a vacuum of 27in.

Adjoining the boiler-room, but quite independent from it, is the gas-producer plant, which may well be classed with the other machinery in the power department. This producer plant has been recently installed by Messrs W F. Mason, Limited, of Manchester, under the Luff and Whitfield patent. As this plant is of a novel type, we reproduce a section of the producer (Fig 6) showing its characteristics. The principal feature of this type of producer is that by the peculiar construction of the generator and grate the amount of tarry matter carried over with the gas is reduced to a minimum. The exterior casing of the generator is rectangular, and built up of steel plates stiffened with T irons, the interior being completely lined with firebrick. The bottom of the casing dips into a trough filled with water, which forms a gastight seal and serves to quench the ashes, so that these may be removed while the plant is working, and that continuous operation presents no difficulties. It will be seen that the grate is now formed of two inclined surfaces, meeting in a ridge running lengthwise of the producer. The grate is perforated with slots, through which air, forced into the interior space, rises through the fuel. Gas leaves the generator from about the centre of its height, passing up flues on each side and reuniting in the brick-lined main, at the end of which is situated the main outlet valve. Near the top of the producer on each side there are orifices connected by down pipes with similar orifices immediately beneath them on a level with the centre of the fire-grate. On the down pipes is fixed a small steam jet, pointing downwards into the neck of an expanding nozzle. These jets exhaust the tarry vapours distilled from the upper layers of the coal, and drive them, mixed with steam, back into the incandescent fuel in the lower part of the furnace. The steam is here dissociated, the oxygen combining partly with the tarry vapour and partly with the hydrogen, and then passing up through the fuel to the main outlet. Thus hydrogen and carbonic oxide are formed comparatively pure and undiluted with nitrogen. The arrangement of the coolers and the coke and sawdust scrubbers presents no unusual features. The top of the gas generator is fenced round to form a firing platform, from which the attendant feeds the furnace. Under ordinary working conditions the cooler-boiler, through which the gas passes direct from the producer, raises sufficient steam from the waste heat of the gas to supply the needs of the plant itself. The gas is used in Messrs. Bruce Peebles's works for heating the annealing oven and the drying-out oven; the latter is maintained at a temperature of about 180deg. night and day, the gas being employed to heat the floor, and not coming in contact with the machinery being dried in the oven at all. The annealing oven is constructed under the same principle, the heating being done in air only in each case. The large drying-out oven, which is shown next to the varnish shop on the general plan, measures 40ft. by 25ft., and is a most successful adjunct to the equipment. In the pump-house, between the boiler-room and engine-room, there are also placed the hydraulic and pneumatic pumping plants. The hydraulic plant was supplied by Messrs. Mactaggart, Scott, and Co., and is utilised for driving five hydraulic lifts and nine two-ton jib cranes. The working pressure is 1,200lb. per square inch, and the accumulator, which measures 14ft. by 8ft. with a lift of 10ft., is supplied by a set of three-throw motor-driven pumps. The pneumatic plant consists of two air-compressing engines and an air receiver, measuring 9ft. by 3ft. The plant is mainly used for supplying chippers and drills, portable hammers, etc., and also for drawing water from a well 450ft. deep to an elevated tank at the rate of 1,800 gallons per hour.

FIG. 9. - Building up the Stator Core of one of the Pumpherston Generators, to give 670 K.V.A. at 300 revolutions per minute.

We propose now to deal with the general arrangement of the plant and to give a few descriptive notes of the work, following through the same order as the various materials from the time they enter until they leave the works as finished machines. Fig. 7 is a general view looking down the main shops from a point on the gallery immediately over the main entrance. Fig. 8 is another view taken in the entrance itself, showing the weighbridge on which the siding from the Caledonian Railway terminates. On the right are seen the large surface plates, each 12ft. by 6ft., on which the castings are marked off. In order to deal with the very largest castings there are six of these surface plates, all on the same horizontal plane, with 1ft. gangways between for the men engaged in the important work of marking off. On the left, opposite these marking-out beds, is a large planing machine by Messrs. Buckton and Co., of

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Leeds. This machine will take a job 14ft. by 6ft. by 6ft., and has a return motion two and a half times as fast as the cutting stroke. The cutting speed is 29ft. per minute with a feed of $\frac{1}{16}$in. to $\frac{3}{4}$in. Two holders are fitted. This tool is driven by an individual motor of 20 h.p. On the pulley shaft is a multiple-thread worm driving a skew gear-wheel set at an angle of about 45deg. from the direction of the motion of the bed. The shaft on which this gear-wheel is mounted has a worm cut on it which drives the bed by means of rack cut on the under-surface of the latter. Next to this tool is a large side planing machine by Messrs. Richards. This machine has an 18ft. stroke and a 4 to 1 return speed, the cutting speed being 20ft. per minute. The feed is from $\frac{1}{32}$in. to

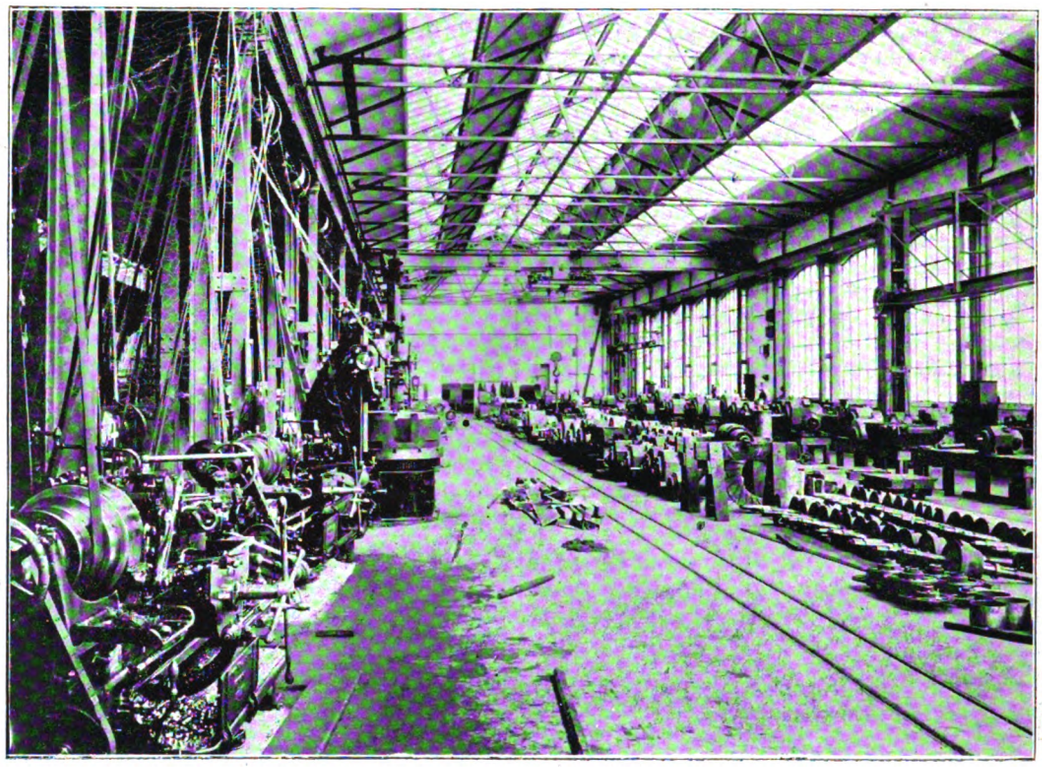

FIG. 10.—Motor-Erecting Shop, with Lathes and Boring Machines on the left.

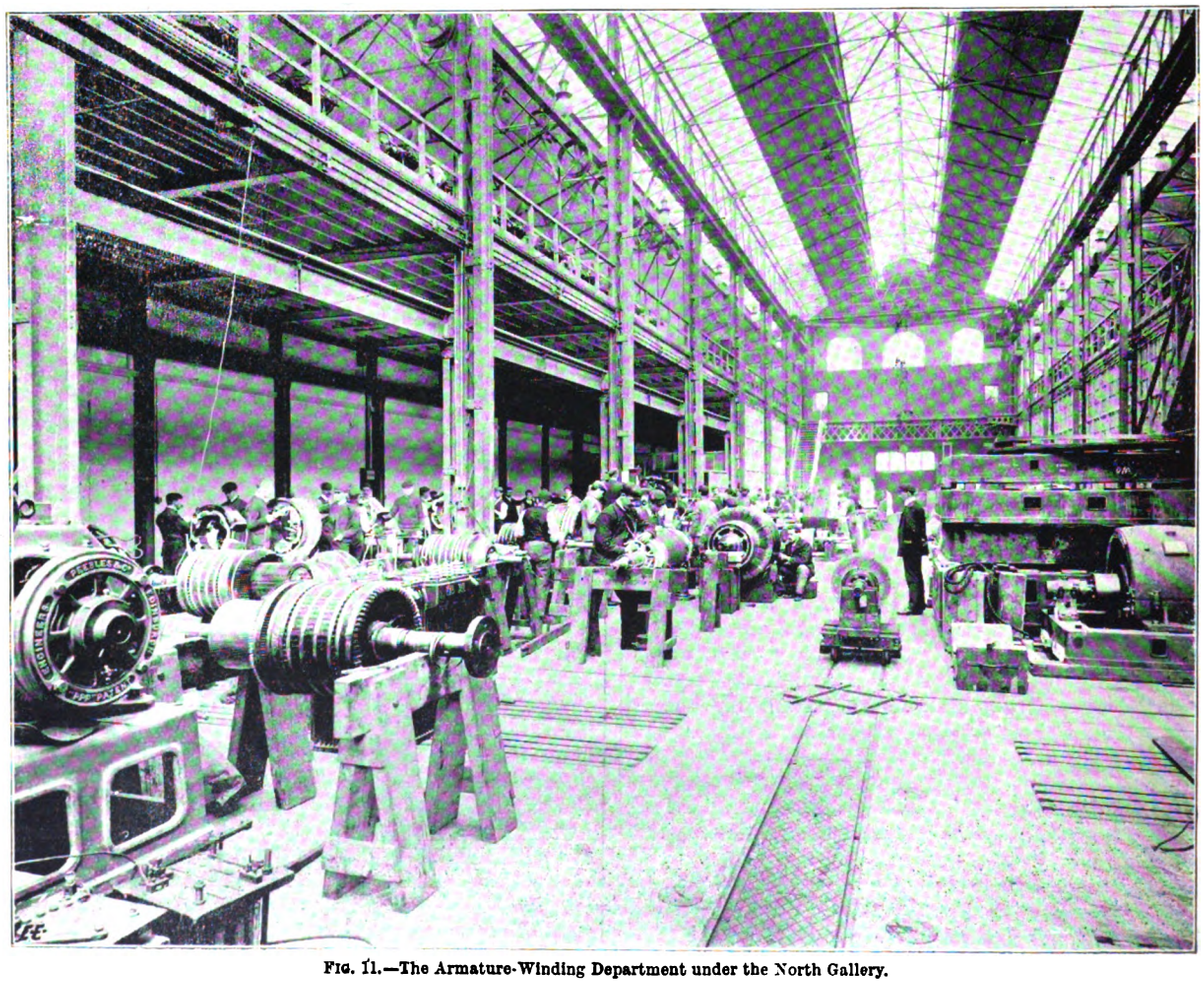

FIG. 11.—The Armature-Winding Department under the North Gallery.

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NOTES.

New Publications.—"Model Steam-Turbines" by H. H Harrison (London: Percival Marshall and Co. 6d). In the latest addition to the "Model Engineer Series," the author gives the principles on which model steam-turbines may be designed, with several examples.

Birmingham Section.—From a booklet sent us by the Birmingham Local Section, we see that the following dates have been appointed for general meetings: Dec. 14, Jan. 18, Feb. 15, March 15, April 12, and May 10 (annual general meeting). The session was opened on Wednesday, when Dr. W. E. Sumpner, the chairman, delivered his inaugural address. The meetings will be held in the physical theatre of the university. Visits to places of engineering interest have also been arranged. The membership of all grades showed an increase of 59 last session.

The McMillan Memorial Fund.—The committee appointed to receive contributions towards the above have now decided to close the fund on Dec. 1 next. The sum collected now amounts to about £1,760, and any members who intend still to contribute would greatly oblige by sending in their remittances to the secretary of the Institution before the expiration of the present month. We trust that this final reminder will induce those who have neglected to contribute to this fund until now to send in their contributions promptly, and we hope that even yet the expected sum of £2,000 may be secured.

Personal.—We have referred in our columns before to the fact that Mr. A. S. Giles, who for many years has controlled the electric lighting and tramway undertakings of Blackburn, is about to leave England in order to take up an important position in Cape Town. Last week Mr. Giles was presented with a silver tea service and tray by the tramway staff. Mr. A. Nuttall, J.P., the vice-chairman of the Electricity and Tramway Committee, made the presentation, and spoke very highly of the good feeling which existed between Mr. Giles and the entire staff. The presentation was suitably acknowledged by Mr. Giles, who said he should feel very much parting from such a number of good friends. He was wished every success as the general manager of the Cape Town tramways.

N-Rays.—The subject of N-rays took a psychical turn last week, when Dr. S. Hooker announced that, as the result of extensive investigations, he had confirmed the theory of previous experimenters that the human body emits N-rays of various hues, from which the character of the individual can be determined. This produced a considerable shower of opinions from scientists, eminent and otherwise. Some ridiculed the idea, others adopted a tolerant attitude, while the psychological fraternity declared that they had been aware of the existence of these colour characteristics for years. Sir William Ramsay stated that he had never detected the rays, but intimated that he was open to conviction. The scepticism that various critics have expressed in regard to the existence of N-rays has prompted M. Blondlot to reply at some length. He emphatically affirms that he can perceive the rays with the greatest certainty. That persons who cannot see the action of the rays on a phosphorescent screen should doubt their presence he considers quite natural, but he recommends them to lean the back and the head against a wall, and then to observe the screen by holding it at a level below that of the eyes, so that a plane through the eyes and middle of the screen makes an angle of 30deg. or more with the horizon.

Compensation Limit.—The Sheffield Corporation have decided by a large majority to withdraw the notice printed on the backs of the tramway tickets limiting liability for accidents to £25. It may be remembered that this step aroused a considerable amount of criticism, and a member of the Corporation, Councillor Muir Wilson, refused to accept a ticket when travelling on the tramways so as to test the legality of the Corporation's action. The councillor was prosecuted for being unable to produce a ticket, and the magistrate convicted, a nominal fine being imposed with a view to taking the opinion of the High Court. This case, however, scarcely went to the heart of the question. The attitude adopted by the Corporation was that as they charged less than the statutory fares, they were entitled to stipulate that their liability for accidents should be limited. If a notice to this effect constituted a contract, anybody who was unwilling to compromise his right to compensation for injuries upon the terms laid down by the tramway undertakers would be debarred from the use of a public service. The limitation seems to us *ultra vires*, and calculated to prejudice the public against the trams. We think, therefore, the Corporation have acted advisedly in not persisting with a dubious course.

Gas-Producer Plant.—Some interesting figures were recently obtained from some expert trials on a Crossley suction gas plant designed for working with common gas coke. The producer in question is to be exported for the Howrah station of the Calcutta electric supply station, where it is to be used to supply gas for one of the Crossley high-speed engines driving a dynamo. The electrical equipment has been manufactured by Messrs. Crompton and Co. The coke used on the trials was obtained from the Manchester Corporation gasworks, and when analysed was found to consist of 15·6 per cent. of ash, 1·3 per cent. of moisture, 1·8 per cent. of volatile matter, and 81·3 per cent. of fixed carbon. It has a calorific value of 12,411 British thermal units per pound. After a six hours' run at full load the following figures were obtained: total fuel consumed, 488lb.; total kilowatt-hours, 368 4; fuel per hour, 81 3lb.; kilowatts per hour, 61·4; fuel per kilowatt-hour, 1·325lb. This is equal to ·92lb. per brake horse-power hour, which is exceedingly good. It must be remembered that this type of suction gas plant can be used in places where the ordinary producer with its steam blast and gasholder could not be employed. The fact that this producer is working with gas coke is also worthy of special note.

Electric Power Costs.—Mr. W. C. Martin, in a lecture recently delivered in Dundee, made some interesting comparisons as to the cost of power supplied by electricity and steam respectively. He stated that for unlimited use the electric supply from Niagara cost to consumers near Niagara £4 per horse-power per annum, to consumers in Buffalo £4. 13s., and to consumers in Montreal (Canada) £17. 14s. In large towns at home, such as Bradford and Glasgow, where the power is charged at the rate of 1d. per unit, the cost of 1 h.p. for a working year of 2,700 hours would be £8. 8s. Mr. Martin then investigated what it costs the average manufacturer in Dundee for steam power as compared with this. He calculated that in rope works with a simple engine it cost £10 6s per horse-power used 2,700 hours per annum. The sum rose to £13. 2s. for an engineering shop, and to £37 for a small steam plant. In the mills with large modern engines and boilers the cost of steam will naturally be less, but there was the tremendous loss in transmitting by belts and shafting to the various departments. He concluded that the advantages of electric driving to works of medium size, say anything up to

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200 h.p., are all in favour of the consumer, and in some smaller works the saving was very large. He did not think the advantages were fully realised in Dundee, or there would be greater demand for electric power from the Corporation supply.

Tramcar Obstruction.—Scarcely a week passes without the time of the magistrates being occupied with cases of tramcar obstruction. Sometimes the defendants raise technical points of a more or less frivolous character; more often the obstruction is clearly deliberate. For some reason, drivers of vehicles in general experience a peculiar relish in hindering the tramcar, and especially do they revel in "sticking up" the electric tramcar. In one case we recorded last week a van driver kept his vehicle in front of a car for three-quarters of a mile, driving slowly all the time. It is not apparent whether these individuals regard such antics as capital jokes or whether they are actuated by "pure cussedness," but in either case they are a distinct public nuisance. After the number of offenders that have been fined one would have expected drivers to take heed, but week after week they cheerfully comply with the pecuniary penalties for indulging in this pastime. It is consequently a little difficult to legislate for people who thus wilfully disorganise tramcar services and cause delay to a number of passengers. In the grosser cases it could scarcely be deemed tyrannical if the delinquents were deprived of the option of the fine which they discharge with such complacency. These little pleasantries become rather expensive luxuries, however, when they cost 78s., plus costs, as occurred in the case referred above; and a few more fines of this order will probably achieve a good deal towards relieving tramway owners and the public from a long-standing annoyance.

Manchester Section Mixture.—The Manchester Section of the Institution of Electrical Engineers opened the session at the Grand Hotel last Friday with Mr. C. D. Taite's chairman's address and a smoking concert. The evening was also remarkable as giving Mr. A. S. Giles, who is just relinquishing the post of chief electrical and tramways engineer at Blackburn, an opportunity of saying farewell to his friends. His coming departure for abroad has been the cause of considerable interest in the district, partly on account of the salary that he will command (£1,800 a year, according to the Press), and partly because his destination had not been publicly made known. This was announced to be Cape Town, and it is understood that Mr. Giles will direct the operations of the local tramway company. Mr. C. D. Taite, after reading his address, which we are publishing, took the opportunity of congratulating Mr. Giles on his success in obtaining his new position, and referred to the loss he would be to the section, to which he had given considerable assistance. Later in the evening Mr. Giles very appropriately rendered "Off to Philadelphy," which took the meeting by storm, and a double chorus. The concert itself was remarkable for the number of "shop" ditties sung, Mr. P. C. Pope and Mr. B. Welbourn being the offenders with "A Dynamo Legend," "The Institution Pilgrimage," and "Ballydoneraile" respectively. Mr. F. P. Wood gave "Der Beiden Grenadiere" in German, which the waiters greeted most enthusiastically. A string and piano trio, while not up to the Gatehouse standard, were much appreciated, and Mr. Mr. J. M. Gibson also sang.

Popular Information on Telegraph Wires.—We have come across a most interesting article in a recent ssue of *Pearson's Weekly*, entitled "Tired Telegraph Wires." The information is so novel that it will take electrical engineers completely by surprise, and they will derive not only profit, but also amusement from its perusal. We have not space to reprint the whole of the column article, but the following three extracts are particularly interesting: "There is a principle of telegraphy known to all telegraph operators called the 'K. R. law,' which says that if the wire is in perfect working order, the full speed of the electric circuit will be obtained directly it is switched on. Supposing, for instance, an operator in London telegraphed the word 'Come,' letter by letter, to an operator in Brighton, the C would arrive rather more slowly than the remaining letters, if transmitted over a tired wire, for once the message has started it goes just as quickly over a tired wire as over one in full working order. The interval between the arrival of C and the next letter would be almost infinitesimal, but to a practised operator the slight delay in the arrival of the first letter would be quite noticeable, and he would report the matter to the engineer's department, where it would be at once ascertained where the earth wire was misplaced, and a couple of men dispatched to settle it. . . . Without what is known as the resistance of the electricity during its passage along the wires, it would be impossible to send messages of any length, for the circuit of electricity would be completed too quickly, and frequent breaks would then occur in a message of any length. . . . Every mile of telegraph wire costs about 5s. a day to maintain in proper condition." There is hardly need for us to comment on these paragraphs, as our readers are quite capable of drawing their own conclusions from them.

A Novel Compass.—It is reported that satisfactory results have attended the use of the electrical apparatus devised by a French inventor, M. Heit, in connection with the compass for registering automatically, minute by minute, the direction followed by the vessel. The compass card, instead of having at its centre an agate resting on a fixed steel point, is fixed on a steel pivot, which rests on a fixed agate. The latter is immersed in a small quantity of mercury, which serves to conduct the current of electricity that makes possible the registering of the movements of the compass. For this purpose the card has attached to it a small silver index, which is kept in constant electrical communication with the pivot by a fine and flexible wire. In the usual position this index does not touch the fixed basin surrounding the card, but by means of the electrical current the circuit is rapidly closed and opened, with the result that the angle of the boat with the meridian is registered. For this purpose the basin is divided into a certain number of sections, isolated from each other and corresponding in each case to a special circuit, the registration being made on a sheet of paper by means of a spark produced by a small induction coil. Certain sections of the basin also correspond to certain call bells, the commander thus being instantly informed of any abnormal deviation in the direction of the vessel. The apparatus also gives the speed of the boat by registering the revolutions of the screws, a circuit being closed and a signal sent to the receiver at each stroke of the engine. In case of accident, reference to the chart enables any alteration in the position of the vessel, and the time of such alteration, to be detected, so that responsibility can be located.

Royal Meteorological Society.—The opening meeting of the session was held on the 16th inst. at the Institution of Civil Engineers, Captain D. Wilson Barker, F.R.S.E., president, in the chair. A paper on "Meteorological Observing in the Antarctic" was read by Lieutenant C. Royds, R.N., of the "Discovery." In the South Polar regions the exploring party encountered fewer fogs than they expected. Mr. Royds's experiences brought out the peculiar difficulties under which observers labour in those high latitudes. The severest cold experienced was about

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67deg. below zero, or almost 100deg. of frost. In one of the worst blizzards the wind blew at the rate of 85 miles an hour. The party experienced, probably for the first time in man's history, 24 hours of continuous sunshine, this being in the Antarctic summer, when the sun never sets. Mr. F. J. Brodie, F.R.Met.Soc., then read a paper on "The Decrease of Fog in London during Recent Years." He had investigated the number of days of fog reported at Brixton, the London station of the Meteorological Office, for the 33 years 1871-1903, and found that the mean annual number of fog days was 55, of which 45 occurred in the winter half of the year, and only 10 in the summer half. December is the foggiest month with 9·5, the next being November with 8 5, January with 8·2, and October with 7·8. The clearest months are July with 0 4, June with 0·6, and May with 0 8. The greatest number of fog days were 86 in 1886, and 83 in 1887, and the least 13 in 1900 and 26 in 1903. Dividing the 33 years into three periods of 11 years each, the author showed that the mean for 1871-1881 was 55, for 1882-1892 it was 69, while for 1893-1903 it was only 41, there being thus a very marked decrease in the number of days with fog during the last 11 years. Mr. Brodie considered it probable that improved domestic grates and stoves, the enforcement of the law against smoke-emitting factories, the substitution of incandescent gas burners for the older forms, and of electric light for street illumination, and the adoption of many thousands of gas stoves in place of grates burning coal, had all, by bettering the combustion of fuel and the giving off of fewer solid particles, tended to the less frequent creation of fog and to its less deleterious quality.

Electrical Tool Driving.—The last issue of the *Journal* of the Franklin Institute contains an interesting discussion on the individual operation of machine tools by electric motors, which took place before the Franklin Institute this year. It was opened by Mr. Charles Day, and a number of experts joined in the discussion. The whole matter, reproduced in the *Journal*, is most interesting, and the speakers were almost unanimously in favour of having a single motor on each machine tool. Thus, from a quotation by one of the speakers, he concluded that it is to the advantage of any machine shop to put an individual motor on a 16in. lathe, provided this tool is busy throughout the shop year—that is, keeps one man busy all the time on a variety of work. It is advantageous to put an individual motor on all variable speed tools which are busy throughout the shop year, regardless of their horse-power requirements. It is also to be deduced that since no credit has been allowed for shafting, or motors allowed for group driving, it will actually pay to change existing shops to individual motor drives. The introducer of the discussion alluded to the great improvement in motor controllers for securing variable speeds which have been made during recent years. Everything depended on the proper selection of the motors and controllers, followed by intelligent installation and operation. One of the gentlemen taking part in the discussion emphasised the fact that the advantages possessed by the individual motor drive ultimately depended on the reliability of the apparatus. Another speaker, too, emphasised the fact that electrically-operated machine tools have paid well, giving the following reasons for his conclusions—*i.e.*, better placement of tools, especially the larger ones; the operation of powerful portable apparatus for use on the very largest work; better crane service due to the absence of belts; the inestimable boon of the electric crane itself; better light; less dirt; less danger to employés; lighter overhead construction necessary in new factories due to non-existence of countershaft, etc.; fuel economy in many (but not all) instances; and last, and greatest of all, abundance of power to pull a cut of the most generous proportions at the highest speed permissible with the new high-speed tool steels.

Institution of Junior Engineers.—On Friday last Mr. W. H. Lindley, M.I.C.E., delivered an interesting presidential address to the above institution on municipal engineering on the Continent. Mr. Lindley's own work in advising Continental corporations places him in an excellent position to give a *résumé* of this subject, and we are pleased to notice that so much of the work mentioned was done under the control of English engineers. Mr. Lindley divided his subject into four headings, dealing respectively with waterworks, sewage works, electric lighting, and miscellaneous work, such as the design of harbours and plans for the extension of towns, etc. It is with his remarks under the third heading that we are interested, and with the particulars he gives of the electric distribution systems at Berlin, Frankfort, and Elberfeld. He naturally referred to the great fight which raged between 1889 and 1892 as to the best system for lighting the city of Frankfort. The battle of the systems was exceedingly severe, but Mr. Lindley succeeded in inducing the Frankfort Corporation to put their money on a single-phase alternate-current system, which decision has been fully justified since. In his presidential address he referred to the details of the Frankfort system, with its small loss in the high-tension mains which supply the low-tension distribution network through transformers. These are usually placed in underground chambers. He also defended the employment of large generating units and cheap rates for the supply of motors. He then proceeded to describe the Elberfeld works, which were under his direction in 1898. Here the high-pressure voltage has been raised from 3,000 volts to 4,000 volts, and the maximum drop in the high-voltage mains limited to 2½ per cent. The low-tension network was designed for a maximum loss of only 1⅓ per cent., so that large quantities of electrical energy can be supplied at any point of the district without upsetting the voltage regulation. Mr. Lindley also gave particulars of the introduction of the Parsons turbo-generator of 1,250 kw. at Elberfeld. The economy from the use of the turbines was great, and the works cost had been reduced to 0·7d. per unit and the coal consumption to 2·65lb. per unit. In conclusion, Mr. Lindley advocated the interchange of visits of inspection between England and the Continent, so that engineers might be kept well informed of the latest practices.

Society of Arts.—The one hundred and fifty-first session of the society was opened on the 16th inst. by the vice-president, Sir William Abney, who strongly recommended that certain work performed by semi-private institutions should be undertaken by the State. He considered that the Board of Education ought to become responsible for the examinations of the Society of Arts, while the case for the assumption by the Government of some of the administrative functions at present discharged by the Royal Society was even stronger. In regard to such important institutions as the Meteorological Office and the National Physical Laboratory, it seemed to him self-evident that these should henceforth be controlled by a department of State on the advice of a scientific body. While meteorological science had been much retarded in Great Britain by want of funds, our American cousins deemed it of sufficient importance to be recognised by the State, and spent nearly a quarter of a million per annum upon work for which our Meteorological Committee expended £15,300. If weather forecasts were any good at all—and from 68 to 75 per cent. of them were successful—they ought to be made as good as possible. There

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was no doubt that kite and balloon observations, together with the use of wireless telegraphy in mid-ocean, would give a still higher percentage of successful forecasts, but the additions must remain in abeyance until the money limit which had been enforced for so many years was removed. It will be remembered that a committee reported last June in favour of the reorganisation of the Meteorological Office under the Board of Agriculture, and suggested that wireless telegraphy should be employed for recording weather in the Atlantic; but nothing has since been heard of the recommendations. With regard to the National Physical Laboratory, the term for which the Government grant was made expires in March, and Sir William declared that the Treasury will have to review the situation, as the development of the laboratory has become a public necessity. Great Britain, he concluded, had no reason to be ashamed of the work which had been accomplished, though it had of the grants. In the United States the public need was liberally catered for by a public department, as it should be. If the English Government would recognise the fact that the institutions referred to discharged essential public services, he believed that Parliament would vote the supplies in the same ungrudging spirit as the American Congress had done.

Corps of Electrical Engineers (R.V.)—A goodly assemblage of this corps attended the annual regimental dinner at the Criterion on Saturday last, Colonel Crompton, C.B., the commanding officer, presiding. The guests included Colonel R. C. Maxwell, A.A.G., R.E., Colonel W. Pitt, C.R.E., Colonel Stephenson, Prof. J. A. Ewing, F.R.S. (director of naval education), Major Dumbleton, Major Erskine, and Captain Simon, and the officers of the corps comprised Captain Dumble (of the permanent staff) and Captains O'Shaughnessy, Phillips, Edgcumbe, Biggs, and Leaf. Letters of regret for their unavoidable absence were received from Lord Kelvin, General Sir Henry Mackinnon, Sir William White, Sir Carne Rasch, and Sir John Wolfe Barry. After dinner the company had to submit to the photographer, following which came the toasts, interspersed with some delightful harmony. Following the loyal toasts, Colonel Crompton gave "Our Guests," pointing out that in a corps of this kind it was necessary to confine the invitations to those with technical knowledge. Colonel Maxwell, in responding, dwelt at length upon the services rendered by the Electrical Engineers in the South African war. He considered that this association of the engineering profession with the Royal Engineers would constitute a highly potential force, because, as civil engineers were specialists, their efficiency could be relied upon. He thought that the link might be strengthened by Volunteer officers doing a little training with the regulars. Prof. Ewing recalled the fact that the formation of the corps was suggested eight years ago by his old friend the late Dr. J. Hopkinson. After alluding to the progress that had been made, Prof. Ewing remarked that the warfare of the future would be a contest between the opposing engineers. Colonel W. Pitt, C.R.E., in proposing "The Corps," congratulated the members upon maintaining a high standard of efficiency, which, he predicted, would be further improved by the new system of company organisation The United States army had paid the corps the sincerest form of flattery by instituting a similar force. Colonel Crompton, in returning thanks on behalf of the corps, said that although progress had been made, he was not yet satisfied. Alluding to the increased scope of the corps, he remarked that at first only searchlight and mining operations were contemplated, but they soon found that there was a wider field of usefulness for them. When the corps had received visits from naval men, he had been struck by the intelligence and directness of the questions put by the visitors. On all sides they displayed indications of admirable training, and it was his ambition that the corps should emulate them by becoming the handy men of the Army. The new system of organisation would facilitate progress, and if by the end of the next twelvemonth the corps did not reach the standard he had set them, he should feel greatly disappointed. He mentioned that when in the States recently with the touring party, the Commander-in-Chief of the United States army had spoken to him of the corps in very complimentary terms. After this Colonel Crompton gave "The Permanent Staff," dwelling upon the willingness exhibited by its members. In responding, Captain Dumble (adjutant of the corps) pointed out that the relations between the permanent staff and the members of this corps might be termed unique. Although the permanent staff were in charge of the corps, they could not profess to teach its members much, seeing that the latter were experts in engineering. He joined with Prof. Ewing in appreciating the corps' mission, which was admirably crystallised in their new motto—"Ars martis comes." The organisation of the corps into regular companies would, he was confident, greatly promote efficiency, and also conduce materially towards economy. The toasts concluded with "The Press," proposed by Captain O'Shaughnessy. Admirable entertainment was provided by Messrs. T. E. Gatehouse, Chas. Corner, and S. G. Norris, and Miss Carrie Tubb.

Standard High-Voltage for Transmission.—Dr. F. A. C. Perrine in his paper before the electric power transmission section of the St. Louis Congress, dealt with American practice in high-tension line construction and operation. Speaking of standard voltages he said: "The work of the transmission engineer lies in fields so essentially dissimilar that, even in spite of this general tendency, it may be difficult at first view to ascertain what is the American practice in work of this class. On closer examination one finds, however, this work falling into natural groups dependent on the length of transmission and the voltage employed, though what has been done has been materially modified by the date of erection, since during the past 10 years modifications in the arts have been necessarily reflected in the types of construction. The general groups have been somewhat decided by the manufacturers of machinery, who have presented as preferable certain available voltages. Above 2,400 volts, where transmission proper really begins, the first voltage now commonly employed is 6,600, which figure has been established as standard by the needs of the lighting plants in the great cities, and has been adopted by the transmission companies in place of either a higher or lower voltage, mainly because it is a standard. For this voltage direct generation at high pressure is almost invariably used. The next high voltage now commonly employed, and now practically the first one for which step-up transformers are used, is 15,000. During the past few years this has taken the place of transmissions at 10,000, 12,000, and 13,000; and it is to-day the established voltage for high-tension electric railways, the general reason for its establishment as a standard being that this voltage is not more difficult to handle, as regards insulation or switching, than the three last-mentioned lower voltages, and, furthermore, that where the lower voltages have been previously established, the sphere of operation of the transmission plant has been found to be rather too much limited. There are in the Rocky Mountain region and west a great number of the older plants operating at 10,000 volts, and whenever direct high-voltage generation has been attempted, voltages of from 12,000 to 13,000 volts are used; but, at the same time, the majority of the

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plants which have used the lower pressures in the past, to-day have circuits with special transformers operating at the higher figure. The next step is to 25,000 volts, which is the highest figure reached without special study of insulators, switches, and lightning arresters. This voltage has been successfully handled without serious trouble during the past six years. A voltage of 35,000 is employed in a number of plants built about five years ago, and at this figure the special difficulties due to line capacity, insulator size, erratic lightning arrester effects, and switching begin to make themselves seriously felt. Above 33,000 volts the standard voltage is called 60,000, although in all plants that have heretofore been established to operate at this pressure there have been installed transformers arranged for connection to various voltages of from 40,000 to 60,000 volts, and the majority of these plants are to-day operating at about 50,000 volts, some of them being unable to operate at the highest pressure on account of the character of line insulators originally installed. In the choice of voltage for any transmission it is considered the best practice to establish it at the rate of 1,000 volts per mile, provided the length of transmission be not above 60 miles, since above 60,000 volts no commercial work has been regularly attempted. In the table recently presented by the Transmission Committee of the American Institute of Electrical Engineers, the highest average voltage per mile for any one class in their report is 840; but in examining this table it must be remembered that their correspondents have reported the total length of line in service, so that if a plant operated two lines 15 miles each in length at 1,500 volts, their table would indicate an operation of 500 volts per mile, although for each line the transmission was at 1,000 volts per mile."

Four-Motor Equipment with a Two-Motor Controller.—Mr. E. Taylor contributes an article on this subject to the *Street Railway Journal*. He points out that when using a two-motor controller on a four-motor equipment the motors must necessarily be arranged in two sets of two motors, each set having the armatures and fields connected in multiple, with a jumper between the positive field leads. With this arrangement a slight difference in the relative resistance of the fields in either pair will throw the fields out of balance, distorting the magnetic circuit of the weaker. Another effect is an excessive flow of current through the armature of one motor, unduly heating it and destroying the insulation. The author considers that such defects are inherent with two-motor controllers. A concrete example of the author's argument follows. The four diagrams represent respectively four-motor equipment, with two-motor controller, in series; the same in multiple; four-motor equipment, with four-motor controller, in series; and the same in multiple. The following illustration is based on the assumption that the connections shown in the diagrams are strictly followed. A General Electric type 800 motor field is ·4 ohm. If the field of motor No. 1 has a lower resistance than that of No. 3, the initial current passed through them will divide, the greater current flowing through No. 1, the lower resistance field. For instance, if a current of 200 amperes was flowing through one set of motors, say Nos. 1 and 3 (Fig. 2), and the field of No. 1 had only half the resistance of that of motor No. 3, 133 amperes would flow through field No. 1 and only 67 amperes through that of No. 3. This would excite a strong magnetic field in motor No. 1, which will build up a high counter E.M.F. in No. 1 armature. It follows that with a high counter E.M.F. the number of amperes flowing through No. 1 armature would be proportionately low; on the other hand, the magnetic field of motor No. 3 will be comparatively weak, and hence there will be a lower counter E.M.F. and a correspondingly higher number of amperes flowing through the No. 3 armature. This condition will, of course, be aggravated as speed is increased. The result is that armature No. 1 has approximately 50 amperes, while No. 3 has 150 amperes, and field No. 1 has 133 amperes, while that of mtoor No. 3 has only 67 amperes. Taking the conditions under which each motor is running separately, motor No. 1 has 50 amperes

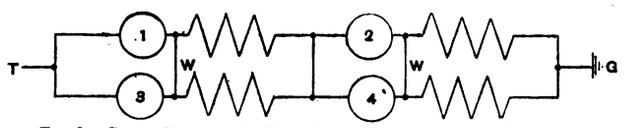

FIG. 1.—Connections for the Four-Motor Equipment, with Two-Motor Controller—in Series.

passing through its armature and 133 through its field—an abnormal condition, but not likely to produce any ill-effects. Motor No. 2 has 150 amperes passing through its armature and only 67 through its field, a condition which is radically wrong and directly in opposition to all theories of motor design or operation. The trouble occurs here, and the author explains the action of the machinery at some length. Railway motors are designed

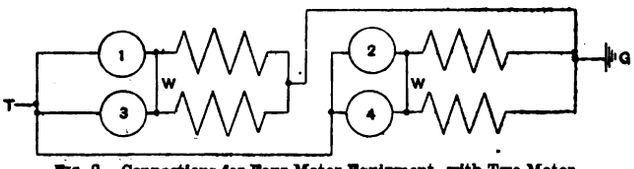

FIG. 2.—Connections for Four-Motor Equipment, with Two-Motor Controller—in Multiple.

with the intention of keeping the neutral point at a fixed location, as it is impossible to trim the brushes for the load. This works out very well when the armature and field currents are identical, as when strong currents occur in the armature there is a proportionately stronger field to overcome the increased reactance of the armature, thereby holding the neutral point fairly constant; but with 150 amperes in the armature and 67 in the field

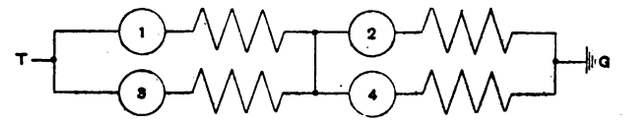

FIG. 3.—Regular Connections for Four-Motor Equipments, with the Four-Motor Controller—in Series.

there is a very strong current in the armature, reacting and setting up cross-magnetisation, which tends to shift and distort the field, with consequent change of the neutral point. The brushes being in a fixed position, and, therefore, not following the neutral points, cause pronounced sparking, as they are unable to properly commutate the heavy currents which are passed through them. The sparking tends to carbonise the brush-holder and armature,

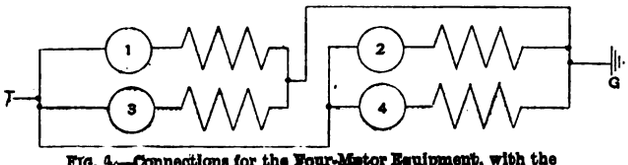

FIG. 4.—Connections for the Four-Motor Equipment, with the Four-Motor Controller—in Multiple.

and greatly overheats the commutator, so that the leads become unsoldered. Another effect is that the excessive current passing through this armature greatly heats the windings, which destroys the insulation and causes short-circuits and grounds. From Figs. 3 and 4 it will be seen that such conditions are impossible with a four-motor controller, as the current in the armature and the field is the same, thus holding the neutral point practically constant.

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THE FARADAY SOCIETY.

At the meeting of the Faraday Society on Wednesday two papers were down for discussion, of which the following notes give a general idea.

The Potential of the Hydrogen-Oxygen Cell.

BY FRANCIS JOSEPH BRISLEE, M.SC.

The potential of the galvanic cell—

Platinised platinum Charged with hydrogen | $\frac{N}{1}$ acid | Platinised platinum Charged with oxygen

has been measured by various experimenters and found to lie between 1·076 and 1·14 volts.

In these investigations two lines of work were followed: (1) the electrodes were polarised by electrolysis, the electrolysis extending over two or three days; and (2) the electrodes were freed from gases as completely as possible, and then the respective gases passed through the liquid and the potential measured from time to time until constant. By these means two potential limits were obtained, the first starting from a high potential and gradually sinking, and the second rising to a constant value. When the potentials were constant to about one to two millivolts, the effect of the addition of the various substances was tried.

A series of measurements of the hydrogen-oxygen potential employing the gases obtained by methods fully detailed in the paper gave the following result:

Source of the oxygen and hydrogen.	Potential of $^{Pt}H_2/\frac{N}{1}H_2SO_4/^{Pt}O_2$. T = 18deg. C.
Electrolytic	1·0820 volts.
Aluminium and NaOH, and permanganate	1·0830 ,,
Zinc and hydrochloric acid, Brin's oxygen	1·0818 ,,

Complete details of the apparatus used and the experiments carried out are given in the paper, while the author draws the following conclusions. In the foregoing research the influence of the addition of varying quantities of hydrogen peroxide, persulphate, and ozone upon the oxygen potential have been investigated. The results can be briefly stated as follows: (1) the addition of hydrogen peroxide reduces the oxygen potential; (2) persulphates or ozone increase the oxygen potential and diminish the rate of discharge of oxygen by an electrode supersaturated with oxygen by electrolysis; (3) by employing electrodes of extremely thin platinum deposited upon glass and platinised, the same potential was obtained independently of the method of charging the electrodes with oxygen; (4) the results obtained with the thin platinised platinum electrodes show a good agreement with the potential calculated from the Helmholtz formula.

Recent Investigations Bearing on the Theory of Electrolytic Dissociation.

BY LOUIS KAHLENBERG, PH.D., PROFESSOR OF PHYSICAL CHEMISTRY IN THE UNIVERSITY OF WISCONSIN.

In creating the theory of electrolytic dissociation, the phenomena of actual electrolysis have played a minor part. The changes of concentration of the electrolyte around the electrodes, the elevation of the temperature observed during the passage of the current, and the fact that when polarisation is prevented, electrolytes obey Ohm's law, were all explained many years before the existence of the theory of electrolytic dissociation. Indeed, the hypothesis of Clausius, which displaced the old Grotthus theory and brought conceptions of electrolysis into harmony with thermodynamic requirements, is by many chemists—and physicists still regarded as the best mechanical explanation of the electrolytic process, when all facts are fully considered.

Briefly stated, the theory of electrolytic dissociation is based upon the observation that for a goodly number of aqueous conducting solutions the so-called molecular conductivity increases with the dilution; that osmotic pressure, lowering of the freezing point, elevation of the boiling point, or lowering of the vapour tension of such solutions is abnormally great—*i.e.*, that it is greater than for non-conducting solutions, the behaviour of which, it is asserted, conforms to the requirements of the gas equation; and that the so-called degree of electrolytic dissociation may be calculated from the electrical conductivity of the solution, or from its osmotic pressure, its boiling point, freezing point, or vapour tension. Indeed, the dissociation hypothesis is vitally connected with van't Hoff's theory of solution. The latter claims that dilute solutions behave according to the equation $PV = iRT$, in which the factor i is unity for non-electrolytes. The analogy between a gas and a solution has been recognised so long that it would be difficult to state when the idea originated; but van't Hoff, by using Pfeffer's direct measurements of osmotic pressure, sought to show that dilute solutions obey the gas laws. In this he was successful, in that he had to introduce the factor i above mentioned, which varies for different solutes in the same solvent, and even for different concentrations of the same solute in a given solvent. An examination of the original tables published by Arrhenius shows that the factor i is by no means always unity for aqueous non-electrolytic solutions, nor does it always vary more from unity in the case of solutions of very considerable conductivity than in the case of non-electrolytes, but for a goodly number of excellent electrolytes i is materially greater than unity. The latter fact was utilised by Arrhenius in his endeavour to show that the factor i exceeds unity for electrolytic conductors, and increases with the dilution, as does the so-called molecular conductivity. And thus upon the assumption that free ions, part-molecules charged with electricity, exist in an electrolyte, and act like so many molecules, the general statement which van't Hoff had made for solutions was upheld—namely, that dilute solutions having the same temperature and the same osmotic pressure contain the same number of dissolved molecules.

The author contended that the facts presented by Arrhenius in his original article are not sufficient to serve as a basis for the assumption of electrolytic dissociation in solutions; and that while isolated facts may here and there be interpreted by means of the dissociation theory, the bulk of experimental evidence gathered since 1887 speaks strongly against the theory.

It is a well-known fact that the dissociation theory cannot be harmonised with the law of mass action, and that this constitutes a strong argument against the hypothesis. For solutions of weak organic acids in water, to be sure, Ostwald succeeded in computing a series of constants by means of the formula expressing his well-known dilution law, growing out of an attempt to apply the law of mass action to electrolytic dissociation. But an examination of the constants obtained for these weak acids reveals the fact that the agreement is, after all, only rough; furthermore, the attempt to apply the dilution formula to electrolytes par excellence has utterly failed, and yet the advocates of the dissociation theory continue to calculate the so-called solubility product which frequently involves the application of the law of mass action to strong electrolytes. Attempts made by Lincoln to apply the dilution formula to electrolytes in non-aqueous solutions of about the same order of conductivity as that of some of the solutions of weak organic acids in water have also proved futile. How can the formula possibly hold in cases where the molecular conductivity remains practically constant, or decreases as the dilution increases? Rudolphi and also van't Hoff have sought to amend the formula by changing the exponents so that constants would result from the observed data in special cases. While thus better "constants" were obtained in these instances, the altered formulæ proved entirely unsatisfactory in other cases; and then, too, it must be added that the alterations made the formulæ simply empirical in character, without any theoretical basis.

The difficulties met in applying the Nernst formula for calculating the E M F's of galvanic cells have been discussed in special papers, to which the reader is referred. It may be remarked here, however, that in the work on E M F's especially, many of the solutions used by advocates of the dissociation theory were far from dilute; and at best the agreement between calculated and observed values leaves much to be desired. Many colloidal solutions coagulate when treated with solutions that conduct electrolytically. Attempts have been made to ascribe this coagulative power

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to the free ions which the electrolyte is supposed to contain. It is true, however, that the power to coagulate colloidal solutions is by no means confined to electrolytic solutions; and hence anyone claiming, for example, that sodium chloride solution coagulates colloids because it is an electrolyte must assume the burden of proving his proposition.

The theory of electrolytic dissociation is unable to furnish a satisfactory explanation of the phenomena in aqueous solutions, but it is in the realm of non-aqueous solutions that the hypothesis proves especially impotent. When the theory was promulgated, but few non-aqueous solutions had been examined as to their power to conduct the current, and those few solutions in which ether, alcohol chloroform, and hydrocarbons, for instance, were the solvents employed, were found to be poor conductors. So the idea that only aqueous solutions conduct electricity to any considerable extent gained ground and held sway for a number of years with remarkable tenacity, the view being strengthened by the fact that in the solvents just mentioned molecular weights as determined by boiling-point, or, where possible, by freezing-point methods, were not "abnormally" low, as in the case of solutions of many ordinary salts in water. But now we know of non-aqueous solutions which are as good and even better conductors of electricity than aqueous solutions; and these solutions, when tested by the methods of determining molecular weights just mentioned, yield results that are generally higher than those computed from the formulæ of the solutes; only exceptionally is the reverse the case. In the course of my work on non-aqueous solutions I have pointed out numerous examples of this, and recently the splendid researches of Walden have established many more. His work on solutions in liquid sulphur dioxide especially shows that in this solvent "abormally" *high* molecular weights are generally found in the case of solutions of excellent conducting power. The field of non-aqueous solutions is a very large one, and it is here that the theory of electrolytic dissociation can really be tested. It is here that the fact that the theory is untenable becomes particularly apparent. Whetham's statement that work with non-aqueous solutions is rendered difficult by the fact that with some solvents like alcohol freezing-point work is impossible, is hardly valid, for such solutions may be readily examined by vapour tension or boiling-point methods. It is true that in operating with many non-aqueous solutions, like liquid ammonia, liquid sulphur dioxide, liquid hydrocyanic acid, special difficulties and dangers present themselves; but these are generally quite surmountable, and, indeed, often it is fully as easy to investigate a non-aqueous solution as one in which water is the solvent. It simply has not yet become generally fashionable to investigate non-aqueous electrolytic solutions. When this work is taken in hand by more investigators, the fact that the dissociation theory is useless and misleading will gain ground more rapidly.

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Nov. 22, Sir Guilford L. Molesworth, K.C.I.E., president, in the chair, the paper read was "Distribution of Electrical Energy," by John F. C. Snell, M.I.C.E. The following is an abstract of this communication:

The paper deals first with the attitude of the Legislature towards the electrical industry, and recites some of the points of the 1882 Electric Lighting Act, which retarded the progress of electrical development. It then deals with the improved clauses under the 1888 Electric Lighting Act. Reference is made to the removal of restrictions upon undertakers which would be effected by the Electricity Supply Bill, promoted by the Board of Trade in the last session of Parliament, and a hope is expressed that this will soon become law. Mention is also made of the falling in of the leases of borough tramways, and the effect of electrical traction upon the output and load factor of the generating stations. The author then describes the various systems by which electricity is at present distributed, including direct-current two and three wire distribution; direct-current high-tension generation and low-tension distribution; single-phase, two and three phase currents, high-tension generation and low-tension distribution; three-phase high-tension and low-tension direct-current distribution.

After dealing with the limits of pressure as defined by the Board of Trade, and the results of the work of the Engineering Standards Committee in settling upon standard periodicities, the systems of supply are more thoroughly criticised, and the single-phase system is set aside as being inapplicable for general supply, as is also the direct-current high-tension system. The author is of opinion that the distributing systems which are likely to be adopted in the future are: (1) direct-current, two or three wire, for small districts; (2) single-phase high-tension for railways; (3) two-phase high-tension generation and low-tension distribution (for existing single-phase systems of general supply); (4) three-phase high-tension generation and direct-current low-tension distribution (for existing direct-current systems in large districts, and for railways of short length); (5) three-phase high-tension generation and low-tension three-phase or six-phase distribution (for entirely new and large districts).

Diagrams accompanying the paper demonstrate the economical radii of supply by direct current at 500 volts for different loads transmitted and by the high-tension sub-station method, the result being that above the undermentioned distances the high-tension method is more economical—viz.:

Kilowatts.	Economical radius.
250	1·6 miles.
500	1·25 ,,
1,000	1·06 ,,

With regard to the effect of storage at sub-stations, the author believes that storage will be more largely resorted to in the future; and figures are given in support of this view. He then proceeds to discuss the economical limit of pressure for high-tension supply by underground cables, and gives curves to show that for general purposes in Great Britain 6,600 volts is approximately the economical pressure. The effect of the cost of insulation of extra high-tension cables is also discussed. The paper next deals with the cost of overhead transmission of high-tension currents, and reasons for fixing upon a pressure of 20,000 volts in this country are given. As to the cost of supply, the ideal figure given by Colonel Crompton in 1894 is stated to have been surpassed. A new ideal figure is given by the author, based upon further experience gained in the past 10 years, and he predicts the costs which are likely to be charged to various classes of consumer. Turning to transmission lines, a description is given of the practice adopted in extra high-tension underground cables, and the risks which have to be guarded against. The mechanical and electrical construction of overhead lines for extra high pressures is also dealt with.

The paper then enumerates various classes of sub-station, covering static transformers for three phase low-tension distribution; static transformers with rotary converters for direct-current distribution; and synchronous or induction motor-generators for direct-current distribution at the higher periodicity. Descriptions follow of the various sub-stations erected by the author, with curves of their outputs and particulars of their efficiencies. The various methods of distributing energy at low pressure are classed as follows: I.—Conduit or draw-in system: (1) bare copper-strip systems, strained and unstrained; (2) cables insulated by indiarubber, vulcanised bitumen, or other dielectrics drawn into stoneware casings, Callender-Webber bitumen casings, fibrous conduits, cement casings, and cast-iron or wrought-iron pipes. II.—Buried or solid system: (1) vulcanised bitumen, dialite or other insulated single cables, laid in iron, stoneware, or wooden troughing, and surrounded by molten bitumen or pitch; (2) concentric cables, paper insulated, and lead covered, laid in the same manner; (3) single-phase or concentric cables, each protected by its own sheathing of steel tapes or wires, laid direct in the ground. The relative merits of these systems are fully discussed, and a curve is given showing the respective capital costs of the systems.

The author then deals with the systems of distribution

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adopted in tramway construction, and their relative advantages and disadvantages. The question of fusing the general network and the fixing of section boxes is gone into fully; the author deciding against fuses, except in concentric networks, and strongly advocating the use of section boxes for sub-dividing the network.

The paper concludes with some particulars of the supply of electrical energy to short and long distance railways. The author believes that a modification of the present third-rail system will remain with short-distance railways, and that improved methods in the application and control of single-phase currents will be adopted for long-distance railways.

BALLYDONERAILE.

(Sung at the Manchester Section Smoker, Nov. 18, 1904.)

Ho! all you 'licthric ingineers, come listen to my tale
Of how they make th' licthric light in Ballydoneraile,
The Works is next the Morturee, the boilers they are fed
Wid annything-come-handy, and sometimes they miss the dead.

The plant was made by local men to benefit the place—
To buy from Saxon foreigners they felt was a dishgrace,
So the engines was by Mulligan, N.B.G.-type machines:
He also built the dynamos, likewise the works latrines.

The cables was by Rafferty, who had ambitious hopes;
He made them from a recipe that acted well wid ropes.
A constant insulation is the mainsman's joy, for such
Is point 00001 ohm, which never varies much.

The switchboard insulation being deal is not so high,
So they put a stove beneath it for to keep the beggar dry.
To help resuscitation from one-hundred-voltage shocks
A keg of Dunville's compound is in every jointer's box.

The engineer is honest and he deals contractors fair;
They do not need to get their dues by presents or by prayer,
For a beautiful example in persuasion has been read
To all the late chief engineers—wid dynamite and lead.

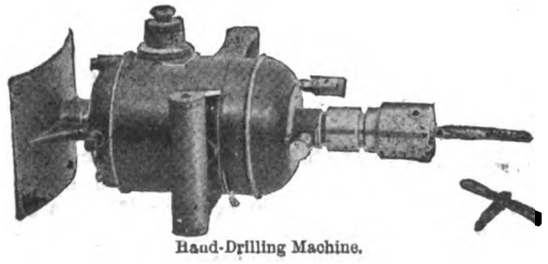
By dint of such good management, the station pays its way;
But when the Income's less than Costs the stoker gets half pay,
The meter reader sacked—and this is never known to fail—
And thus they run the 'licthric Works at Ballydoneraile.

B. C. H. J.

TRADE NOTICES AND NOVELTIES.

Portable Drilling Machine.

The accompanying illustration shows a useful type of hand drilling machine supplied by the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C. This machine is



Hand-Drilling Machine.

fitted with double-reduction gear, and combines strength of construction with lightness, the latter advantage being obtained by the use of aluminium for the non-magnetic parts of the driving motor. The double-reduction gear enables the speed of the drill to be varied, but the machine can be supplied with single-reduction gear if desired—also for working either on continuous-current, alternating-current, or three-phase circuits. Current is switched on the motor by means of a press button attached to the machine itself, whereby economy is effected in the total consumption of energy.

The "Harman" Electric Hoist.

Messrs. R. Harman and Co., 10, Westmoreland-buildings, Aldersgate-street, E.C., have, we understand, placed on the market an "electric hoist" designed to meet the requirements for a small lifting gear, more especially in connection with the building trade. Small dimensions and light weight are among the advantages claimed, a hoist to lift 8cwt. 80ft. per minute weighing only 7cwt. It is fitted with a liquid controller and a magnetic brake. The gearing is of the worm type, provided with a mild-steel worm and gunmetal wormwheel, and ball-thrust bearings, the whole enclosed in a dustproof case, and running in an oil bath.

Some G.E.C. Novelties.

Several novelties are described in the "Progress Sheet" issued by the General Electric Company, Limited, for last month. The first of these is the "Robertson Witelite" lamp, shown in Fig. 1

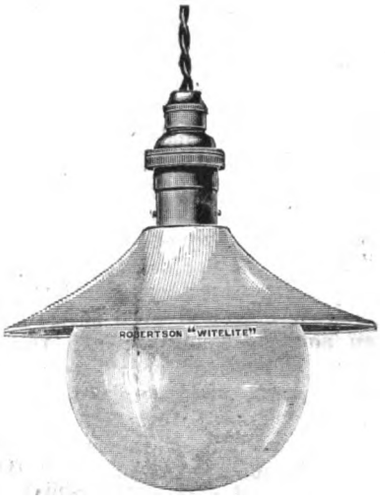


Fig. 1.—The "Robertson Witelite" Lamp.

herewith. This lamp marks a departure from the usual design of incandescent lamps, and is recommended for use in place of ordinary high candle-power lamps. It has a large spherical bulb (without the usual pip), which is frosted or obscured excepting the uppermost part. A small opal shade is provided, so shaped as to give the maximum of light without any sharp shadows. It is further claimed that this combination yields a very agreeable light of a soft white nature, and that although the increase of candle-power is very marked the consumption of current is no greater than that of an ordinary 16-c.p. lamp, while no special holder is required. From the description given it does not appear that any novelty is claimed in regard to the design or composition of the filament of this lamp, and we therefore assume that the large increase of candle-power obtained refers to the percentage of the total light emitted which is usefully employed.

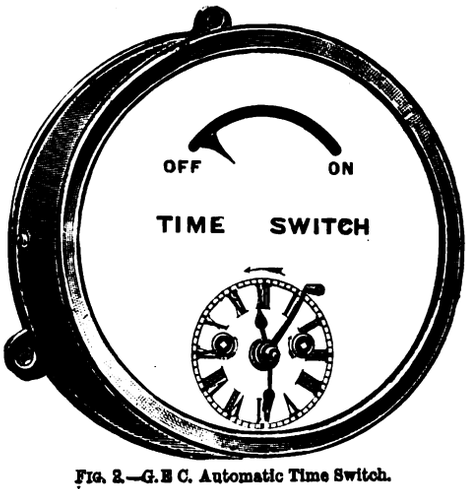


Fig. 2.—G.E.C. Automatic Time Switch.

Fig. 2 represents an automatic time switch consisting of a good quality one-day clock combined with a single-pole switch. The clock has a third hand which can be set to any time at which it is desired to open the switch, the clock face being provided with quarter-hour divisions. The mechanism for actuating the switch is somewhat similar to the ordinary alarm movement on a clock. It has a separate spring of its own, which is wound up automatically during the operation of switching the lights on. This is done by half a turn of the clock key in the right-hand hole. When the hands of the clock reach the time set for switching off, a cam releases the alarm movement, and this, running down, operates a series of links releasing the switch, at the same time moving an index pointer on the face of the clock from the word "on" to the word "off." The switch release is also fitted with

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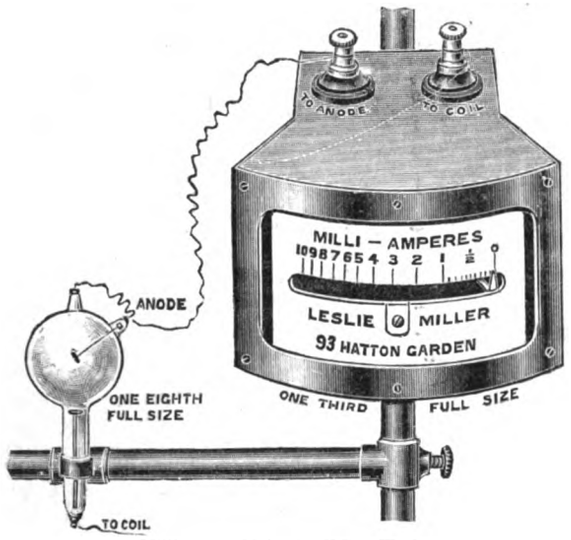
a weighted escapement, which causes a distinct sound when vibrating to and fro. The arrangement of links for operating the switch is very ingenious, it being impossible to push the switch into the "on" position by means of the index, so that if the key be taken away no unauthorised person can close the switch. The switch is intended for currents of from five to ten amperes at voltages up to 220. Among the other articles dealt with in the publication under notice are some useful forms of outside shop window reflectors.

A Milliampere Meter for Radiographers.

We illustrate herewith a meter which has been introduced by Mr. Leslie Miller, 93, Hatton-garden, London, E C., to enable radiographers to know the quantity and penetrating power of the rays given off by an X-ray tube at any moment. By means of this instrument the intermittent current passing through the tube itself can be measured, like the interrupted current, through the primary winding of the induction coil. In reality, the needle of the instrument indicates in milliamperes a mean of the rapidly dying away impulses it receives. This enables the operator to see clearly when he has reproduced certain favourable conditions, instead of judging the condition of a tube by



Milliampere Meter for X-Ray Work.

the green fluorescence or the effect on a screen. The instrument consists of a delicately-pivoted soft-iron needle with a long aluminium pointer attached to it, which works inside a coil of fine wire. The controlling force is a permanent magnet fixed under the coil. In case the coil is working under bad conditions, so that a reverse current due to the "make" of the circuit passes through the tube, the amount is added to the proper current. When the coil is worked from voltages up to, say, 30 volts, there is no appreciable current at the make. The instrument reads correctly when used as an ordinary milliampere meter for continuous current, and may also be employed to see if an accumulator gives its proper voltage.

PARLIAMENTARY POWERS.

The following applications for electric lighting provisional orders, tramway Bills, and other parliamentary powers are now being advertised in the *London Gazette* and elsewhere.

TRAMWAY AND LIGHT RAILWAY POWERS.

Aberdare District Council; London Southern Tramways Company; West Cumberland Electric Tramways Company (extension of time); Newark Tramways Company; Mansfield Light Railways Company (extensions); Ackworth and Immingham Light Railway Company; Armley and Bramley Tramways (Leeds Corporation); Bradford Corporation (extensions to Wike, etc.); Gorton Urban District Council; London United Tramways Company (extension of time); Whitechapel and Bow Railway (electrical powers); Bury Corporation (extensions and reconstructions); Halifax Corporation (extension powers); Blackpool, St. Annes, and Lytham Tramway Company (for compulsory running powers over Blackpool Corporation lines); Nottingham Corporation (extension of powers); Wellingborough and District Tramroads and Electricity Supply Company; Birmingham Corporation (extension of powers to King's Norton and Yardley, etc.); Croydon Corporation (extension of powers); London County Council (tramway extensions); Liverpool Corporation (extensions); Great Northern, Piccadilly, and Brompton Railway (extensions to Waterloo and confirmation of agreements); Charing Cross, Euston, and Hampstead Railway (extension of powers); Edgware and Hampstead Railway (extension of time and confirmation of agreements); Baker-street and Waterloo Railway (extension of time and confirmation of agreements; Luton Corporation; South Lancashire Tramway Company (extension of time and rearrangement of capital); Wigan Corporation (extensions to Upholland or Orrell and Aspull, etc.); Newark and District Light Railways Company; Accrington Corporation (reconstruction and electrification of existing tramways and construction of new tramways); King's Norton and Northfield Urban District Council.

TRAMWAY POWERS.

Basingstoke and Alton Light Railway Company (speed amendment); Southend and Colchester Light Railway Company; Rhondda Urban District Council (extension of time for tramway purchase); Stratford-upon-Avon (powers to transfer order and other amendments).

ELECTRIC LIGHTING ORDERS AND OTHER SUPPLY POWERS.

Bury Rural District Council; Urban District Council of Golborne; Houghton-le-Spring (transfer of powers); Croydon Corporation (supply in bulk to outside authorities); Hipperholme Urban District Council; Whitby Urban District Council (supply of electric fittings); Southall-Norwood (electric lighting), by the Metropolitan Electric Supply Company; Brentford (electric lighting), by the Metropolitan Electric Supply Company; Haydock Urban District Council; Tewkesbury Corporation; Barton-upon-Irwell, by the Lancashire Electric Power Company; Colne Corporation; Metropolitan Electric Supply Company (powers to supply in bulk, etc.); Hythe Corporation (powers to lay mains outside borough); Little Hulton Urban District Council; Woking Electric Supply Company (extensions to Byfleet, Pyrford, Chobham, and Bisley: Rushden, Higham Ferrers, Irthlingborough, and Thrapston (electric lighting), by E. P. Harvey; Acton (bulk supply), by the Metropolitan Electric Supply Company; Tottington (electric lighting), by the Lancashire Electric Power Company; Carmarthenshire Electric Power Company (transfer of rights to South Wales Electrical Power Distribution Company); Ealing Corporation (supply to adjoining districts, etc.); Charing Cross and Strand Electricity Supply Corporation (for powers to give bulk supply to certain surrounding districts); Bolton Corporation (further powers); Farnham and District Electric Supply Company; Shepton Mallet, by the local gas company; Bristol Corporation (further powers); Eastbourne Corporation (Willingdon extension); Weybridge and Walton-on-Thames Electric Supply (Urban District Supply Company); Clewer and Old Windsor (electric lighting), by the Windsor Electrical Installation Company; Andover (electric lighting) by the reconstructed Andover Gas Company.

FORTHCOMING EVENTS.

FRIDAY, NOV. 25.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., "A Comparison of Vertical and Horizontal Tubes in Water-Tube Boilers," by Mr. W. R. Cummins.

Physical Society.—At 5 p.m., "The Measurement of Small Differences of Phase," by Dr. W. E. Sampner; "The Curvature Method of Teaching Geometrical Optics," by Dr. C. V. Drysdale; "A Rapid Method of Approximate Harmonic Analysis," by Prof. S. P. Thompson; exhibition of specimens of crystals showing the phenomenon of luminous rings, by Prof. S. P. Thompson; and exhibition of apparatus by Prof. Dalby, Mr. Darling, Dr. Drysdale, and Prof. Thompson.

Civil and Mechanical Engineers' Society.—At 3 p.m., visit to Victoria Station in connection with the enlargement works.

SATURDAY, NOV. 26.

Glasgow Technical College.—At 7.30 p.m., "The Electrical Drive of Large Reversing Engines Working Intermittently," by Mr. M. Georgi.

Institution of Electrical Engineers (Students' Section).—Visit to Great Northern, Piccadilly and Brompton Railway (tunnelling).

MONDAY, NOV. 28.

Hull Corporation Telephones.—At 2 30 p.m., opening of exchange.

TUESDAY, NOV. 29.

Institution of Civil Engineers.—At 8 p.m., further discussion on Mr. J. F O Snell's paper, "Distribution of Electrical Energy."

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., "Compensated Alternating Current Generators," by Mr. M. Walker.

WEDNESDAY, NOV. 30.

Institution of Electrical Engineers (Students' Section).—At 7 30 p.m., "Motor-Controlling Switchgear," by Mr. L. J. Pumphry.

Society of Arts.—At 8 p.m., "The British Canals Problem," by Mr. A. Lee, J.P.

THURSDAY, DEC. 1.

Institution of Electrical Engineers.—At 7.30 p.m., annual dinner at the Hotel Cecil.

Tramways and Light Railways Association.—At 8 p.m., "Running Powers," by Mr. Stephen Sellon.

Rugby Engineering Society.—At 8 p.m., "Some Notes on High-Speed Electric Railway Work," by Mr. F. W. Carter.

FRIDAY, DEC. 2.

Junior Institution of Engineers.—At 8 p.m., "Some Points of Interest in the Construction of Torpedo-Boats," by Mr. H. E. Yarrow.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "Midland Railway, West Riding Lines: The Construction of Contract No. 1," by Mr. R. F. McCallum.

SATURDAY, DEC. 3.

Institution of Junior Engineers.—Visit to the London Coliseum to inspect its features of engineering interest.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to the Corporation sub-stations.

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TO CORRESPONDENTS.

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EXAMINATIONS.

In our last issue we referred to a scheme which had for its object the consolidation of examinations. The scheme proposed is of limited extent, but the suggestion is so enormously important that we should like to see it adopted almost universally. Broadly speaking, examinations are of two kinds—one for selective purposes, the other as a kind of guarantee that the individual who passes has received a more or less liberal education. So far as examinations generally are concerned, they travel over much the same ground; hence one common examination upon the subjects which form the foundation of all education ought to satisfy every requirement. Specialisation may require individual examination, as does selection, but in no case is examination conclusive. At the best it is a fairly good method of getting rid of responsibility. No one imagines that the man who comes out at the top in the examination will most certainly come out on top in the struggle of life. He possesses the tools, but may not be able to use them to the best advantage, while another with poorer tools may have capacity for better usage. The characteristics required for success in life are not always the same as those required for success in examinations But to hark back. All education is up to a certain point similar in character; it is only when specialisation comes in that differences commence. Take as one example various societies and various professions that admit by examination. Most of these indicate that having passed this, that, or the other examination will be held to satisfy the requirements on general and elementary subjects. These various accepted examinations have grown up in the attempt of far-seeing, energetic men trying to further the desire of education by the multitude. Incentives are given and prizes offered to pass examinations. Education has not always been sought for its own sake, but often for the sake of the prizes offered. We do not object to that; we honour and applaud those who endeavour to increase the knowledge of the people. It, however, seems pretty clear that at the beginning of the twentieth century a time has come when these numberless elementary examinations serve no very good purpose, and that variety might give place to uniformity. A real examination requires an examiner as much as an examinee. It is an intolerable nuisance to come across a lot of amateur examiners, whose sole idea of their work is to propose catch questions—in fact, not to find out what the student knows, but, on the contrary, to stump him. In our mind, one of the worst and most disgraceful forms of newspaper writing is that which deals with the funniosities of examination papers. The funny answers more frequently point to the crass stupidity of the examiner than to the lack of knowledge of the person examined. We wonder that someone with leisure has not long since analysed the value of the questions set, in reply to some of the lucubrations which every now and again appear in print relating to the answers. Not only could the examinations for general elementary knowledge be with advantage consolidated, but also many of the technical examinations. Of course, the one great difficulty in reform is that so many societies derive a large part of their income from examination fees, and while this is the case any movement towards improvement will be troublesome. We really see no valid reason why examinations should not throughout the length and breadth of the land be divided into three: first, for elementary subjects; secondly, for advanced subjects; thirdly, for specialised subjects. Every boy and girl should be put through the mill for the first, all preparing for business and

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professional careers prepared for the second, while the specialists are easily provided for. It is a big subject, and worthy of the most careful consideration.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COST OF PRODUCTION AND MR. SIEMENS'S PRESIDENTIAL ADDRESS.

SIR,—Mr. Byng's letter of the 16th inst. is interesting. If it were less academic and more precise, it might even be valuable. Confining one's attention solely to the electrical industries, can Mr. Byng give the volume of the respective internal electrical markets of Great Britain, Germany, and the United States? How many millions' worth of electrical machinery imported from abroad has found its way into our central stations, and how does this amount compare with the value which our own manufacturers have supplied? By what margin have these orders been lost? If Mr. Byng will leave generalities and obtain the compilation of such figures as those I have indicated, he will render a great service to the general community, but possibly a dis-service to the cause he has so strongly at heart.—Yours, etc.,

TURRIS.

THE RICHMOND (SURREY) GUARDIANS AND GERMAN TELEPHONES.

SIR,—To some of your readers the pseudonym "Englishman" appended to the letter published in your last issue must convey the idea of a necessarily disinterested opinion emanating from an unexpected quarter in favour of German telephones in preference to those of English manufacture. To those of us, however, to whom this individual voice sounds familiar, and who are accustomed to hear this plea made by the English agents of the German manufacturers, as if it were some palliation which should have weight with us, the signature does not convey the same idea. Although seeking your courtesy and influence on a matter of public interest, we are aware that your correspondence columns have advantages which, although of much value in themselves, are not possessed by those devoted to advertisement, a very important one being that they are inexpensive. Evidently your correspondent is not slow to appreciate this fact.

My excuse for asking your valued space for this letter must be that "Englishman" apparently thinks by his repeated references to "Disappointed Contractor," with capitals and inverted commas included in the gratuitous *nom de plume*, that he is answering the comments of an imaginary correspondent who has adopted it for himself.

Whilst preferring to choose my own, I am undoubtedly the only individual to whom he can be alluding, and, therefore, hasten to accept the implied challenge and to put him right upon certain facts which are evidently beyond his knowledge.

On more than one occasion, both before and after the acceptance of the tender in question, I visited the architect, and asked him why he had specified German telephones instead of English, as the ratepayers would undoubtedly have expected him to do. He distinctly told me his reason was that he wished to have them all *en suite* (I am quoting his words), and as those that are now at the workhouse are of German manufacture, hence the necessity. From the outset I contested the technical necessity. As a result, I was told that I might quote for the English goods in addition to those specified, and he promised that I should not be put "out of court" thereby, providing that I kept my tenders separate.

It was not until after the matter was settled by the Guardians that I had an opportunity of pointing out to the architect personally that his *en suite* ideas were impossible, seeing that some of the telephones were British, although an inferior grade of the same manufacture as those which I specified. All this, however, was made quite clear in my specification. His reply was that he had nothing to do with the acceptance or rejection of the tenders, that he was not present at the meeting of the Guardians at which this was done, and that he had never even seen my specification and tenders. In answer to this, I contended that the Guardians, whom we could not expect to have technical knowledge, had evidently relied upon him, and that by his specification he had practically excluded the British manufacturers. If now, Sir, as your correspondent suggests, he had by a comparison between the German telephones at the workhouse and the cheap form of British instruments there come to a conclusion adverse to the British, surely this was the time to have said so, if only to refute my contention.

From first to last, however, this was not even hinted at, and much, no doubt, as 'Englishman" would like to hear our architect pronounce in favour of German telephones, I must, in justice to a public servant, say that it would be contrary to all my impressions if he were the class of man to adopt these suggestions at the eleventh hour, however alluring a means of meeting a difficulty, when there was ample opportunity and good cause to have done so before had it been his conviction.

In regard to the 10 per cent. difference in price between the English and German telephones, I fear that "Englishman" is also speaking "without his book." If he had had the opportunity of seeing my specification, he would have found that I guaranteed the prime cost to be "in the aggregate practically the same as the German telephones specified by the architect." What more obvious, then, than that a sacrifice had been made to emphasise the appeal to patriotism. That such should have been necessary, even had it been accepted, is to our shame.

In regard to the problem why a body constituted for the express purpose of relieving distress should have formed such a misconception of its duties to us who have appointed them, to the community at large, and to the artisan classes in particular, I would say that its solution does not lie in the direction of the fond hopes of "Englishman," but in the thoughtlessness and spirit of *laissez faire*, which, unfortunately for us, in these times especially, enter so much into our character as a nation.—Yours, etc.,

PATRIOTIC ENGLISHMAN.

SIR,—The letter of "Puzzled" in the *Electrical Engineer* of Nov. 11 raises a question of great importance to the welfare of the country. "Englishman's" argument in your issue of the 18th inst. is based on a deal of assumption. Architects are not and cannot expected to be experts in everything that is included in their contracts. I have known some of them specify goods of foreign make without any logical reason whatever. London and many of our large towns are at present in a stage of siege, there being innumerable agents of foreign manufacturers attacking these professional gentlemen by methods and efforts which can only be used by very few British manufacturers. Architects and consulting engineers often specify goods of foreign make without knowing they are made abroad, and because the manufacturer has an office or agent in London; sometimes they know the origin and specify the goods because they know of no British maker. Clients other than public bodies usually do not accept everything their architect tells them, but use their own judgment.

It is remarkable that the municipal authorities do not take up a more patriotic position with regard to placing their contracts for machinery. To me, a patriotic Briton, it is painful to see in many works and electric lighting stations foreign machinery of all kinds—pumps, steam, and exhaust valves and instruments—which have been specified and ordered when goods equally good and cheap can be supplied of British make. I have seen boiler-feed pumps of American manufacture with cast cranks and rods, which would not have been accepted by the consulting engineers if so made by a British manufacturer.

It is very surprising that any member of a municipal body will vote under any conditions whatever for the placing of a contract for the supply of foreign-made machinery. I know of municipal works which have a considerable quantity of foreign-made machinery for which the British manufacturer has never been asked to tender. It is unfortunate that, generally, the members of a municipal body are ignorant of machinery, but if they were as careful in placing contracts for machinery as they are in placing

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tailoring or printing contracts, then there would be very little foreign machinery imported for municipal purposes.

Most municipalities impose conditions in their contracts with British manufacturers which cannot be imposed on the foreign manufacturer, and the cost of manufacture is sometimes increased owing to the imposition of these restrictions. The labour and trade unionist members of municipalities insist on these clauses and conditions being inserted, their object being to find work for more workmen. Why do they not vote for a clause prohibiting entirely the supply of goods of foreign manufacture? This would have far more effect in the direction desired. The "unemployed" question becomes more difficult to deal with every year. Are not the municipalities themselves much to blame for the bad condition of trade and employment, by their great expenditure in unnecessary undertakings, in increasing the burdens which both manufacturers and consumers have to bear? In the few cases when foreign-made goods are cheaper—and I believe there are only very few—would it not be good policy for a town to pay a little more for British-made goods, and cut down, by an equivalent amount, its expenditure on unnecessary undertakings?

If municipalities exercised more control over the specifications and placing of contracts, the trade of the country would be greatly improved because of the increased output. In the cases where British goods are dearer at present the cost of production would be lessened, and there would be still less reason to place orders abroad.

The Press of this country is often very much to blame in giving undue prominence to foreign manufactures. The Government departments are more patriotic than municipal bodies, as at times they take great pains to induce manufacturers to take up the manufacture of some article which is being made abroad. Electors should give this question the attention it deserves, and at election times impress on candidates its importance.—Yours, etc., LANCASTRIAN.

ELECTRICAL DRIVING FOR FACTORIES.

SIR,—As I am particularly interested in electrical driving for factories and workshops, I should feel much obliged if you could insert the following in your paper. I shall be fitting electric motors to several machines in a workshop, and I am desirous to know if there is any sound way of ascertaining the power required to drive various machines—*i.e.*: (1) planing machines; (2) lathes for wood or metal; (3) boring machines, etc; (4) emery wheels. Could any reader strengthen me in this subject, and also inform me if there is any book published which deals with this branch of the electrical industry.—Yours, etc.

A SUBSCRIBER.

[N.B.—Our correspondent will find a great deal of the information he requires in Mr. A. D. Williamson's paper entitled "Applications of Electricity in Engineering and Shipbuilding Works," read before the Institution of Electrical Engineers at the beginning of last year.—ED. *E. E.*]

SAPPHIRE SLABS.

SIR,—I should esteem it a favour if you could inform me who are the best *makers* of half-finished "sapphire slabs" and finished "cupped sapphires," as required for electrical meters. I understand that the most important centres of this industry are in Switzerland and Germany, and I should like to get into touch with reliable firms for this class of work. I should supply the "rough Ceylon sapphires" myself, and should expect to get the slabs and sapphires cut from the same "on commission."—Yours, etc.,

N. C. M.

PERSONAL.

Mr. J. D. Pember, A.M.I.E.E., electrical engineer and tramway manager to the Farnworth Urban District Council, has been appointed electrical engineer to the Dartford Urban District Council at a commencing salary of £250 per annum. There were 159 applicants.

Mr. C. Wyatt, of the County of London Electric Supply Company, has obtained the vacant position of assistant electrical engineer at the Croydon electricity works.

The Bury Corporation have decided to appoint Mr. Clough tramway manager at a salary of £250 a year.

LEGAL INTELLIGENCE.

TRAMWAY ACCIDENTS.

At Manchester Assizes, before Mr. Justice Walton and a special jury, an action for damages was brought against the Manchester Corporation by Mr J. Whiteley Jones, commercial traveller, of Fallowfield. Plaintiff was travelling on one of the Corporation cars, when, on reaching Fallowfield, the driver over-shot one of the loops, and the car ran on till it went on the main line again, and there was a risk of its colliding with another car travelling in the opposite direction. No collision, however, occurred. In attempting to regain the loop the trolley got entangled with one of the span wires. The effect of this was to snap off the shaft of the trolley pole, and it fell, striking the plaintiff on the head. His injury was dressed by a local surgeon, and ultimately he returned home. He had suffered intense pain ever since, and his condition now was so serious that it was impossible for him to appear in court. He was suffering from traumatic hysteria, and there were symptoms of paralysis. The Corporation admitted liability.

Medical experts on both sides differed as to the extent of plaintiff's injuries and as to the time which would elapse before he could recover. The plaintiff's salary was £2 10s. a week, with £1 a day for travelling expenses. A considerable bill had already been incurred for medical attendance and special nursing, and it was intimated that the plaintiff had lost his situation.

The jury found for the plaintiff, and awarded £790 damages. An application for stay of execution on the ground that the damages were excessive was adjourned.

On Saturday last, Mr. Justice Phillimore and a jury were engaged at the Manchester Assize Court in considering whether the Manchester Corporation were to blame for an accident which occurred in Palatine-road. The plaintiff was Margaret Jane Cropper, wife of Joseph Cropper, builder and joiner, Runcorn.

The Plaintiff deposed that she and her sister were asked by the timekeeper, "Are you ladies going by this car?" They answered "Yes," and they had just got on to the step of the car when the car gave a jerk forward, and Mrs. Cropper was flung into the road, injuring her head and back very much. She repudiated the suggestion that she and her sister were safely on the car when it started, and that in their alarm at finding that Mr. Cropper and the child were being left behind they got off the car as it was moving, and thereby brought the trouble upon themselves.

Corroborative evidence was given.

The evidence for the Corporation was to the effect that the ladies gave no heed to the question of the timekeeper, and that when they saw the car starting they sprang to the side and got on. Even then they would have been perfectly safe if, in their bewilderment at finding Mr. Cropper and the little girl not with them, they had not, despite the warning of the trolley boy, got off of their own accord.

The jury, after retiring to consider their verdict, found for the defendant Corporation.

At the Manchester Assizes on Saturday Mr. Justice Phillimore and a jury were occupied in hearing two actions against the Salford Corporation arising out of electric tramway accidents. Robert William Parker claimed damages for personal injuries sustained in a collision between a tramcar and his cart. The Corporation had compensated him for the damage done to the cart, but after the settlement he found that he was suffering from an incurable hernia, which he attributed to the effects of the accident. Parker is a seaman and holds a mate's certificate, but at the time of the accident, owing to lack of employment, he was engaged in business as a greengrocer. It was stated on his behalf that his complaint will incapacitate him permanently from following his occupation as a seaman or from doing any heavy work. The defence was that he was negligent in turning his cart into the way of the tramcar. After hearing the defence the jury returned a verdict for the plaintiff, and assessed the damages at £225.

In the second case, William Hickson, cab proprietor, claimed damages in respect of a collision between a tramcar and one of his cabs.

The Plaintiff deposed that he was sitting on the box seat of a cab which was being driven from his yard across the tramlines in The Crescent. On leaving the passage which leads from the yard on to The Crescent, he and the driver of the cab saw a tram approaching, but as it was some distance away they thought they had ample time to cross the lines. The tram came along at a high speed, however, and caught the rim of the back wheels of the cab with such force that the vehicle and the horse were thrown on to the footpath and overturned. The driver of the car did not slacken down or ring the gong when approaching, although the cab was carrying lights. The plaintiff and the cabdriver were thrown off the seat, and the plaintiff was jammed between the lock of the cab and the horse. He received a severe shock. Plaintiff therefore claimed damages for personal injuries and for the damage done to the horse and cab.

The Corporation denied that they were guilty of any negligence. As alternative pleas they contended that the plaintiff was guilty of contributory negligence, and that the damage was due to an unavoidable accident.

The Motorman stated emphatically that he both rang the gong and applied the brake, and his statement was corroborated by several of the passengers, who put the speed at which the car was travelling when the cab came in sight at six or eight miles an hour.

The jury found for the plaintiff, and awarded £250 damages, which the foreman explained was made up of £30 for out-of-pocket expenses and £20 as compensation for injuries.

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TELEPHONE CHARGES.

In the City of London Court the National Telephone Company, Limited, sued Mr. Henry J. Barclay, 99, Dashwood House, E.C., for £18. 10s. for a year's subscription for the telephone. The defendant had had the telephone for five years, and his subscription, due in advance in July last, had not been paid. He said he had lost his secretaryships one by one, until he had had to give up the offices, and had no use of the telephone for the period for which he was sued.

Mr. H. H. Gaine, plaintiffs' counsel, said that the defendant should have given six months' notice, and the telephone would have been removed.

The **Defendant**: I gave no notice because I did not know I should not want it.

Mr. Gaine said the cost to the company for putting on a new subscriber was £40, as they had to obtain wayleaves and enter into annual obligations.

The **Defendant**: I do not think a wealthy corporation like the National Telephone Company ought to press such a case.

Mr. Gaine said he must insist upon the defendant performing his contract and paying. If the company listened to all the people who said "I cannot pay," they might as well give up business at once.

Judge Rentoul, K.C., thought it a case of very great hardship on the part of a great company like the National Telephone Company, and one that ought not to have been brought. He did not like it at all; but the law was the law, and he must give judgment for the plaintiffs, with costs.

TRAMWAY FARES.

At the Bradford City Police Court on Tuesday Dawson Clayton was summoned for failing to pay a tram fare. The prosecution was initiated under a by-law which provides that any person riding on a tramcar shall, before leaving the car, pay the proper fare whether it is demanded or not.

Defendant was detected leaving the car before the conductor had finished collecting the fares by a plain-clothes constable.

The Magistrate imposed a nominal fine, but intimated that future offences of the kind would be dealt with more severely.

COMPANIES' MEETINGS AND REPORTS

EASTERN EXTENSION TELEGRAPH.

Sir John Wolfe Barry presided over the sixty-second half-yearly meeting of the Eastern Extension, Australasia, and China Telegraph Company, Limited, whose report appeared in our issue of the 11th inst.

The **Chairman**, in moving the adoption of the report, stated that an agreement had been entered into with the French Government for the acquisition by the latter of the Tonquin cable, the subsidy arrangement having expired. The proposed conference in regard to the relations with the Pacific Cable Company had again been postponed, and the ratification of the agreement between the Company and the Australian Government remained in abeyance. Though the competition between the rival routes continued, the Company had succeeded in maintaining its position.

The report was adopted.

CAPE ELECTRIC TRAMS.

The eighth ordinary general meeting of the Cape Electric Tramways, Limited, was held on Wednesday at the offices of the Company, 1, London-wall-buildings, Colonel Sir Charles Euan-Smith, K.C.B., presiding.

In moving the adoption of the report and accounts (particulars of which appeared in our issue of the 11th inst.), the **Chairman** stated, in regard to the Camps Bay tramways, that the Company had ample time before their option (as to the purchase of this system) expired in 1906 to decide what would be best to do. It was at present too early to attempt to make any forecast as to the results of the Company's operations during the current year; but, as he foreshadowed last year, considerable expenditure had still to be faced before the entire track, which had been in use for 10 years, could be thoroughly renewed. They had also to face two items of fresh expenditure, due to their obligation under the new Income Tax Act that had been passed in Cape Colony, and also the increased mileage tax on the metropolitan tramways which would come into force, these two items aggregating about £8,000.

Mr. L Breitmeyer seconded the motion.

A discussion ensued in regard to the lease of the Camps Bay tramline.

Mr. Theophilus thought it would be a long time before that part of the line would be made to pay, particularly as there were no houses in the district.

Two shareholders deprecated the Camps Bay transaction, though one acknowledged that if the object was to avoid competition the move might be justified.

The **Chairman** explained that the option was taken at the time of the war, when there were plenty of people in Cape Town and traffics were good. When the time came for the final decision as to the option to purchase the line, the matter would be decided simply in the interests of the shareholders of the Cape Electric Tramways Company.

Mr. Breitmeyer went into details with regard to the arrangement of the lease, and said that he believed in five or six years the Camps Bay line would have a flourishing traffic.

The **Chairman** reminded the shareholders that in nine years they had received 77 per cent. in dividends, and he considered they had nothing to complain of as to the success of the Company.

ARON ELECTRICITY METER.

The accounts for the year ended Sept. 30, after providing for general charges, depreciation, and share of expenses and discount on the issue of debentures, show a net profit of £10,679. 19s. 1d., which will be applied as follows: to remove from the balance-sheet the trading loss of the year 1901-1902, £4,645. 1s. 9d.; set aside for the debenture sinking fund in accordance with the trust deed, £2,500; out of the balance of £3,534. 17s. 4d. the directors propose to pay 2½ per cent. on account of the preference dividend in arrear, absorbing £3,122. 8s.; carried forward, £412. 9s 4d.—total, £10,679. 19s. 1d. The directors are pleased that the favourable anticipations of last year have to a great extent been realised. The demand for meters continues to increase, especially in Germany, and the business in England has also assumed a brighter aspect. The additional factory buildings in Schweidnitz were completed early in the year, and the facilities thus obtained have considerably helped to improve the results of the year's trading. The new alternating-current motor meter was placed on the market some time back, and appears to meet with general favour. The demand for the double tariff meter, the time switch, and other recent inventions is constantly increasing, and Prof. Aron, who is mainly responsible for their effective design and construction, continues to devote his attention to the development of all requirements connected therewith. Two of the directors—Sir James Pender, Bart., and Mr. Hugo Hirst—retire from office by rotation this year, but being eligible, offer themselves for re election. The directors much regret that, owing to business engagements, Mr. S. J. Blumlein was obliged to resign his position as director. Mr. Harry Kahn, a shareholder, has been elected in his place, and his appointment will require confirmation at the meeting.

GENEVA TRAMWAYS.

The report for the year ended Sept. 30 states that consequent upon the inability of the Compagnie Genevoise des Tramways Electriques to pay any dividend on its capital with which to meet this Company's indebtedness, the revenue account of the Company shows a loss for the period of £42,354, increasing the amount standing to the debit of revenue account to £117,288, mainly the result of the accumulation of unpaid interest on the debenture issues.

NEW COMPANIES REGISTERED.

Traction Corporation, Limited.—Capital, £100. Objects: to acquire any patents and rights relating to the production, treatment, storage, and use of any motive or mechanical power, and any apparatus therefor, and to carry on the business of manufacturers of and dealers in tramcars, carriages, motorcars, etc.

Immisch Launch and Boat Company, Limited.—Capital, £10,000. Objects: to acquire from the Immisch Electric Launch Company, Limited, their electric launches, boats, charging stations, property, and undertaking, and to carry on the business of electrical and mechanical engineers, electricians, contractors, etc. Registered office: Donington House, Norfolk-street, W.C.

British Electric Equipment Company, Limited.—Capital, £40,000. Objects; to adopt an agreement with H. G. Nicholson relating to the acquisition by this company of the business now carried on as the British Electric Equipment Company; to construct, etc., or acquire railways, electrical and other tramways, telegraphs, telephones, and other public works and conveniences in England or elsewhere; and to carry on the business of engineers, electricians, suppliers of electricity, rolling-stock manufacturers, makers of cables, wires, lines, accumulators, and lamps, etc. Registered office: 11, Queen Victoria-street, E.C.

Liens Registered.

Dewey Lighting Syndicate, Limited, Birmingham.—Lien registered Nov. 9 for £1,000 4 per cent. debentures. Holder: L. Barouche, 3, Norfolk-road, Edgbaston. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being, but excluding all patents in and for countries other than England.

Keynsham Electric Light and Power Company, Limited, Bristol.—Lien registered Nov. 14 for £300 5 per cent debentures, part of £1,500. Amount previously issued, £1,200. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital.

Notting Hill Electric Lighting Company, Limited, London, W.—Trust deed registered Nov. 16 for £50 000 debenture stock, supplemental and in addition to trust deeds dated July 12, 1900, and Nov. 18, 1902, for securing £150,000 debenture stock. Charged on the freehold station for generating electrical energy belonging to the company jointly with the Kensington and Knightsbridge Electric Lighting Company, Limited.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Porto Alegre (Brazil).—The term for receiving tenders for an electricity station, already announced, has been prolonged to Nov. 30.

Cheltenham.—The Corporation invite tenders for the supply of a traction storage battery. Tenders by Nov. 30. See advertisement.

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Pola de Siero.—The Municipality require tenders for the electric lighting for 10 years. Tenders by Nov. 30 to the Alcalde, Pola de Siero, Spain.

Madrid.—The General Telegraph Office require tenders for installation and working telephones in the town of Talavera. Tenders to above by Dec. 7.

Guirgia (Roumania)—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28 1905.

Kilmarnock.—The Corporation are prepared to receive tenders for the sole right of advertising on their tramcars. Tenders by Dec. 6. See advertisement.

Salamanca.—The Municipality require tenders for public electric lighting of the town. Tenders by Dec. 12 to above or to Direccion-General de Administracion, Madrid.

Edinburgh.—The Corporation invite tenders for the electric lighting installation at the branch free library, Morningside-road, Edinburgh. Tenders by Dec. 14. See advertisement.

Erith.—The Urban District Council invite tenders for motorcars, trucks, motors, and equipments, track sweeping and watering car. Tenders by Dec. 19. See advertisement.

Swansea.—The Corporation invite tenders for a 12 months' supply and delivery of motors and starting switches. Tenders by Dec. 1 to Mr. Jno. Thomas, town clerk. See advertisement.

Madrid.—The Public Works Branch of the Department for Agriculture require tenders for construction and working of an electric tramway between Azeritia and Zumaya. Tenders by Dec 10.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Llandilo (Wales).—The Urban District Council invite tenders for testing and calibrating the electricity meters installed in the town (70 in number). Tenders to Mr. R. Shipley Lewis, clerk, Llandilo, before Dec. 6.

St. Marylebone.—The Council invite tenders for the purchase of 1,000 house transformers, of from 1 to 5 kw. capacity together with a quantity of scrap cable and old cut-outs. Tenders by Dec. 5. See advertisement.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

London, S.E.—Tenders are invited for the erection of an electrical traveller to lift 12 tons over a span of 40 t. Persons desirous of tendering should send their names on or before Dec. 10 to B. E. Nightingale, Albert Works, Albert-embankment, Lambeth, S.E.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 84, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Glasgow.—The Governors of the Glasgow and West of Scotland Technical College invite tenders for a complete wiring installation and switchboards for the electric lighting of their new buildings. Specification may be obtained from Mr. H. F. Stockdale, secretary and director, 38, Bath-street, Glasgow, to whom tenders must be delivered by Nov. 26.

Stockport.—The Guardians invite tenders for providing and fixing electric light (wiring only), telephones, and bells required at the new infirmary, Stepping Hill. Plans and specification may be seen and all other information obtained from Mr. W. H. Ward, architect, Paradise-street, Birmingham. Tenders to Mr. Charles F. Johnson, clerk, and to be delivered by 10 a.m. on Dec. 12.

Brussels.—Tenders are invited for the construction of an electric generating station and other works in connection with the establishment of a goods station at Brussels. The estimated cost of the work is about £4,367. A deposit of about £280 is required to qualify any tender. Specifications (price 1s. 10d.) and further particulars may be obtained from M. De Rudder, Administrateur des Voies et Travaux, 11, Rue de Louvain, Brussels.

Perth (Australia).—Tenders are invited by the Deputy-Postmaster-General for the supply of the following telephone material; 19½ miles 26-pair lead-covered cable, dry core, to standard specification No. 7; 5,000 paper sleeves, 3in. long by $\frac{1}{16}$in. diameter; 350 yards paper stripe, 2in. wide. Conditions, etc., may be obtained at the General Post Offices at Perth, Adelaide, Melbourne, Sydney, Brisbane, and Hobart. Tenders by Dec. 28.

Withington.—The Guardians of Chorlton Union require tenders for electric lighting of old nurses' home, Withington Workhouse. Specifications, etc., can be obtained from the consulting electrical engineer, Mr. G. R. Peers, A.M.I.E.E., 16, John Dalton-street, Manchester (£1. 1s.). Tenders, endorsed "Electric Lighting, Nurses' Home," to be delivered to Mr. David S. Bloomfield, clerk, Union Offices, All Saints', Manchester, by 12 noon on 29th inst.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Tenders by March 31.

Sydney.—Tenders will be received at the office of the Acting Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 28, for the supply and delivery at the Departmental Stores, Sydney, of telegraph, telephone, and electric light material. Specifications and general conditions may be seen and tender forms obtained at the General Post Offices Sydney Melbourne, Brisbane, Adelaide, Hobart, and Perth. Samples may also be seen at Sydney, Melbourne, Brisbane, and Adelaide.

Bromsgrove (Worcs.).—The Visiting Committee invite tenders for the supply and erection at their new lunatic asylum of the following plant: (Section A) engines, dynamos, booster, and steam services; (B) storage battery and accessories; (C) main switchboard, ring main, feeders, distribution boards, wiring, lamps, and accessories. Specification, etc., may be obtained from Mr. Robert J. Oliver, clerk of the Visiting Committee, Shirehall, Worcester, on payment of £5 for each section of the work as above, which will be returned on receipt of a bona fide tender.

Leith.—The Corporation invite tenders for the supply of the following tramway cars, delivered free at Leith: Passenger cars—double-deck, single-truck cars with reversed staircases, equipped with motors, controllers, brakes, lifeguards, lights etc., complete; number, 30. Alternative tender for the same car with ordinary staircase. Double-deck, single-truck cars with reversed staircases and covered top, equipped complete as above; number, 7. Alternative tender for same covered-top car with ordinary staircase. Sprinkler car—sprinkler car with water-tank, sprinklers, grooved watering pipes, revolving brooms, snow-plough, with motors and all other necessary electrical equipment and brakes complete; number, 1. Conditions, etc., may be obtained from Mr. T. B. Laing, town clerk, Council-chambers, Leith, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide offer. Tenders by Nov. 26.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegraph Office Yard, Thursday Island, of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Brussels.—The Corporation have accepted the tender of Messrs. W. F. Jones and Co., of 50 Cannon-street, E.C., for 2,500 cable connectors, with special pilot-wire terminals.

Ballinasloe (Ireland).—The Committee of the District Lunatic Asylum have received the following tenders for wiring the temporary buildings for 35 incandescent lamps of 16 c.p. each, at a pressure of 200 volts, and the necessary overhead cables to connect same with engine-house, and all else necessary:

J. Dowdall and Sons, Dublin (accepted)	£53 10 0
National Electrical Company, Dublin	75 0 0
Taylor-Smith Electrical Company Dublin	74 0 0
Ampere Electrical Company, Dublin	40 0 0
Mansfield and Meldon, Dublin	62 15 0

London County Council.—The following tenders have been received for wiring the new fire station at Kensington:

Donnison, Sillem, and Co., 116, Great Portland street, W.*	£176 10 0
W. H. Johnson, 200, Upper Kennington-lane, S.E.	183 15 0
F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W.	189 10 0
A. H. Marshall and Co., Limited, 270, High-road, Leytonstone	189 10 0
Durrell and Co., 58, Fenchurch-street, E.C.	189 13 0
O. Clark and Co., St. Mark's-road, North Kensington, W.	205 0 0
National Electric Construction Company, Limited, 34, Victoria-street, S.W.	213 0 0
L. Sunderland and Co., 39, Victoria-street, S.W.	215 0 0

* Recommended for acceptance.

APPOINTMENTS VACANT.

Pupil in company's light and power station. See advertisement.

Assistant Electrical Engineer, Worksop Urban District Council. Salary, £150 per annum.

Senior Operator, Glasgow Telephone Department. Applications by Dec. 5. See advertisement.

Engineering Apprentice, Gilbert Little and Sons, Limited, Smethwick. See advertisement.

Draughtsman, Electrical Department of the Admiralty. Applications by Dec. 5. See advertisement.

Switchboard Electrician, Glasgow Telephone Department. Applications by Dec. 5. See advertisement.

Shift Engineer, Battersea Borough Council. Salary, £104 per annum. Particulars and forms from Town Clerk. Applications by Nov. 29.

Demonstrator in Engineering, London County Council Paddington Technical Institute. Applications by Nov. 23. See advertisement in previous issue.

Chief Electrical Engineer and Manager, Leigh Corporation. Salary, £250 per annum, rising—subject to approved service—by annual increments of £20 per annum to a maximum of £350. Applications by Nov. 29. See advertisement.

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BUSINESS NOTES.

TRACTION.

Keighley.—The Town Council have passed a resolution empowering the Tramways and Electricity Committee to fix or vary tramway fares.

Southampton.—The Tramways Committee are likely to advertise for a properly qualified general manager of the tramways undertaking in a few days.

Dover.—The Corporation have decided to extend the electric tramways to the suburb of River at a cost of £21,000, the work to be done by the unemployed.

Geneva Tramways Co.—The traffic receipts for the month of October, 1904, were £7,806. 14s., showing an increase of £287 as compared with the same period of 1903.

Rawtenstall.—The Town Council are bringing pressure to bear on the Rossendale Valley Tramways Company to make them proceed with the work authorised under their Act of 1902.

Greenock.—At a meeting of the Corporation it was agreed to increase the electrical energy supplied to the tramway company from 500,000 to 600,000 units per annum, the company to pay for the additional 100,000 at 1½d. per unit.

Rowley.—The electric tramways have commenced running upon the new line which has been constructed by the Rowley District Council from Old Hill to Blackheath at a cost of £32,000. The official sanction has been received from the Board of Trade.

Llanelly.—The dispute over the Llanelly tramways, it is rumoured, is settled, and there are indications that matters are now really progressing for the abandonment of the ancient tramcars at Llanelly, and that a system of electric light and traction cannot be much longer delayed.

Metropolitan Railway.—A trial run, which is stated to have been satisfactory, has been made from Neasden power-house to Uxbridge, and it is reported that the line between the latter place and Baker-street will be opened for traffic on Jan. 1. It has been decided to have two classes, and 1d. fares will be retained.

Swansea.—The important section of the Swansea Corporation tramway extensions—the line to Brynhyfryd and Pentre Estyll—has now been joined at the top of Llangyfelach-road, near Zoar Chapel. It opens out a teeming industrial district, which had hitherto been unprovided for in the way of transit facilities.

Dundalk.—The Privy Council have granted an extension of two years for the completion of the tramways authorised by the Dundalk Electric Tramways Order, 1897. Mr. Healy, K.C., for the promoters, intimated that the condition of the money market had hindered the undertaking, but there would be no further delay.

Metropolitan Electric Tramways.—The traffic receipts for the week ending Nov. 18, 1904, with 10 miles open, were £1,589 as compared with 8½ miles and £1,046 in the corresponding week last year, making an increase of £543. The aggregate this half-year is £37,980, against £27,576 in the corresponding period last year, or an increase of £10,404.

The Snowstorms.—Reports from nearly all the large towns in the Midlands and the North show that the recent snowstorms have interfered largely with the electric tramway services. The delays have been mostly due to the mechanical obstruction of the snow drifts. Snow-ploughs quite capable of dealing with ordinary falls had difficulty in coping with the drifting snow.

Cardiff.—On Thursday last Major Druitt, R.E., from the Board of Trade, inspected the tramway extensions at Cathays and Canton, and probably these will be opened to the general public within a week. The extension at Cathays is from the terminus near the Board schools in Orwys-road to Talygarn-street, some distance beyond the barracks. In Canton the extension is from Clive-road to a point beyond Victoria Park.

Worcester.—The City Council were asked at the last meeting to bring pressure to bear on the tramway company in order to obtain the extension of the tramways from the present terminus at Bransford-road to the city boundary on the Malvern-road. The inhabitants in that part are very numerous, and they feel they were deprived of something they were really entitled to. The matter was referred to the Streets Committee.

Morecambe.—At the annual meeting of the Morecambe Tramways Company, the balance-sheet showed a balance to revenue account of £1,310 5s. 8d. The Chairman said negotiations were proceeding with the local authorities respecting the electrification of the trams, and it was hoped that before long the shareholders would be called together to consider some proposal. A dividend at the rate of 3½ per cent. was declared, carrying £340 to next account.

Johnstone.—The representatives of Mr. Murphy, proprietor of the Paisley and District Tramway Company, have had a conference with the magistrates and Town Council of Johnstone to try and adjust some matters connected with the extension of the system to the boundary of the burgh. It was stated at the meeting that Mr. Murphy will apply for an order to authorise the construction of a tramway from Kilbarchan to join the Johnstone line, and thus give not only the west end of Johnstone but also Milliken Park and Kilbarchan districts tramway facilities.

Tube Extensions—The Central London Railway are promoting a Bill in Parliament empowering them to make far-reaching additions to their system running from the Bank to Shepherd's Bush. The intention of the company is to extend their present route eastwards from the Bank to Liverpool-street Station, returning by loop and proceeding westwards *via* Ludgate-hill, Fleet-street, Strand, Piccadilly, and Knightsbridge-road to Hammersmith. From this terminus the line will curve up, to meet the present one at Shepherd's Bush. Stations will be placed at convenient points along the system, varying from a half to three-quarters of a mile apart.

Belfast.—On Friday last a meeting of the Tramways and Electricity Committee was held in the Council-chamber at 2.30 p.m. for the purpose of opening the tender for the tramway works. We understand that almost a hundred tenders were received for the different portions of the work in connection with the electrification of the system, and these were duly opened, initialled, and listed. These were referred to Messrs. Lacey, Sillar, and Leigh, the consulting engineers. A joint report from this firm, the city surveyor, the electrical engineer, and the tramway manager in regard to the tenders will be prepared, and will be presented to the committee at the earliest possible moment.

Stirling.—For some time past the Town Council has been considering proposals for taking over and electrifying either the whole or part of the Stirling and Bridge of Allan tramways. At the last meeting a letter was read from the tramway company offering a sale of the portion of the line from King-street to St Ninians for the sum of £5,000, together with a satisfactory arrangement and guarantee that the company will not be disturbed in the possession of the portion of their line between King-street and the burgh boundary at the bridge over the Forth. The electrical engineer was asked to report on the probable financial results of a tramway on the basis of the above conditions.

Brighton.—At the last meeting of the Corporation Alderman Carden referred to the tramway returns for October, and said that although there was a decrease in the number of passengers, the trams were paying better than they were last year. They had more than made up for the decrease by cutting down the service and running fewer trams. Last month, although the takings showed a decrease of £23, they made a profit of £35, and last year at this time they were losing money. He might also tell the Council that the balance-sheet for the half-year ending Sept. 30 would probably show a profit of over £3,000 on the half-year. It was true that was the best half-year, but so far they had not lost any of it.

The Lorain System.—A horse was killed at Wolverhampton the other day after a fall of snow, and its death is naturally put down to electricity. Mr. Shawfield, the Corporation electrical engineer, says the system is not responsible for the animal's death. The question that will have to be decided is whether the horse slipped owing to the frost and died from natural causes. When the ground is frozen it may be difficult to decide whether the frost or the electrical current is responsible for accidents of this character. On the previous night a man fell down in Newhampton-road and suffered from the shock, but he was walking on the footpath, which was covered with frozen snow. Had he been in the tram track it might have been said that he also had been in contact with the electric current.

Proposed Railway.—The *Westminster Gazette* announces a scheme for an overhead electric railway from east to west above the Regent's Canal. The canal runs for 10¾ miles through a populous and busy commercial district from the East of London to Paddington. A *Westminster Gazette* representative interviewed one of the leading officials of the Regent's Canal and Dock Company, and learned that the scheme is undoubtedly contemplated. Although the canal company is not a promoter of it, it is aware of the details, and not averse to such a development of its property. The scheme it is stated, will not, if carried out, interfere with the waterway. As the route of the proposed line is open, it is pointed out that the cost of construction will be trifling compared with the outlay which would be necessary if lands, buildings, leases, etc., had to be acquired.

Burton.—The new top covers for the tramcars are much appreciated. They were supplied by Messrs. Milne, Voss, and Co., of Birkenhead. The roof runs from end to end of the car, and the portion of the upper deck which is enclosed is of precisely the same length, although a little narrower, as the inside. Sliding doors at each end are fitted, and along either side is a window, which can either be kept closed in very wet or windy weather, or let down altogether or partly lowered according to the nature of the elements. The windows, it should be pointed out, are entirely under the control of the conductor, and cannot be interfered with by the passengers. Under the canopy at the front and back of the car there is a curved seat for three passengers who prefer riding in the open, although at the same time they are protected overhead from the rain. The new arrangement will increase the accommodation of the car by two, seats being provided for 25 as against 23 passengers, this being due partly to the fact that additional space is provided by the removal of the trolley standard to the roof of the cover. The upper deck—or rather the enclosed part of it—will be lit by four electric lights, and, altogether, the interior presents a most cosy appearance. The design of the new covers is similar to those in use in Birmingham and Leeds, and they cost £82 each.

Liverpool.—Sir Charles Petrie, when thanking the Tramways Committee for re-electing him chairman, said that in the ensuing year some important matters would come before the committee, particularly in regard to the extension of the tramway system to the outer parts of the city, which work the Council empowered them some little time ago to apply to the Board of Trade for authority to carry out. There was also the question of the conveyance of parcels and merchandise which the committee would have to take into serious consideration. While the committee did not succeed in getting through all the extensions which were recommended to the Council, they did manage to get some, and before very long he thought the Council would come to see eye to eye with the committee, and give them the extensions they desired. He was one of those people who believed that they ought to have a belt of their tramway system right round the borough boundaries, and he felt certain a scheme of that sort would commend itself to the public. The traffic returns for the fortnight ended Nov. 12 showed that the receipts amounted to £20,485. 9s. 9d., an increase over the

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corresponding period of last year of £422. 4s. 10½d.; the passengers carried numbered 4,442,552. an increase of 102,666; the mileage run 463 650, an increase of 5,862; and the number of cars in use 379, a decrease of 14.

Mansfield.—It is expected that the work of constructing the tramways in Mansfield will shortly be commenced. The Light Railway Sub-Committee of the Mansfield Town Council report that they had met a representative of the company, and had been over the route of railways in the borough, and, having been able to dispose of the objections of the Corporation, they recommended that such objections be withdrawn, subject to any electric cables being laid in a manner approved by the Council. At the last meeting of the Town Council it was resolved to authorise the committee, as soon as they were satisfied that the works were actually in progress, to order the additional generating plant necessary to supply energy to the company. It was also resolved to appoint Mr. R. Hammond, the consulting engineer, as arbitrator on behalf of the Corporation, and Mr. Harris on behalf of the tramway company, to fix terms on which the current was to be supplied to the company. Alderman Chadburn said the original contract for the supply of electrical energy included three sets of generating plant, but the order for one set was postponed owing to the delay in regard to the trams. The price of the set was £1,933. The company required the energy to be delivered to the car-shed situate on land near Radford-street, Stockwell-gate, and the cost of the necessary mains would be £2 150.

London County Council.—In reference to our note last week upon the Rosebery-avenue line, the Council have decided to enter into an agreement with the North Metropolitan Tramways Company, providing: "(1) That the tramways, authorised by the London County Tramways Act, 1900, in Rosebery-avenue, shall, when constructed for the underground conduit system of electrical traction, be worked by the company by horse traction pending the reconstruction, for electrical traction, of the tramways with which they will be connected; (2) that during the period that the new tramways are worked by horse traction the company shall pay to the Council a rent in respect of them equal to 8 per cent. per annum on the estimated cost—namely. £10,285—of their construction for horse traction, with the addition of £660 in respect of parliamentary, etc., expenses, making £10 945 in all; and (3) that when the new tramways shall be worked by electrical traction the amount by which the actual cost of constructing the tramways exceeds the sum of £10,285 above mentioned shall, for the purpose of calculating the rent provided for in the company's lease, be taken as the cost of reconstruction for electrical traction." The traffic from April 1 to Nov. 12 total £417,611, against £328,357 for the corresponding period of last year. At a recent meeting of the Bartholomew Club, the resolution in favour of trams over the bridges, following the reading of a paper by Mr. Carl Hentschel, C.C, was duly passed. The Council have purchased a site at Wandsworth for £4,500 on which to build a sub-station. The first consignment of top-covered cars has been placed on the Greenwich line. Others are expected to follow shortly. Systematic observations are to be taken of the earning capacity of the new type of cars.

LIGHTING AND GENERAL.

Enniscorthy.—A loan of £6,000 has been sanctioned for electric lighting at the lunatic asylum.

Armagh.—Mr. H. T. Harris is reporting upon the Urban District Council's proposed electric lighting scheme.

Clonmel.—Mr. Enright is about to report upon the proposed installation of electricity plant at the asylum.

Devonport.—An enquiry will be held on the 1st prox. into the application of the Borough Council to borrow £7,958 for the extension of the generating plant at the Corporation electricity works.

Electrical Trades Union.—It has been decided to form a branch at Hull. The London branch are holding a smoking concert on Dec. 10 and the Glasgow branch on Dec. 16, when non-members will be welcomed.

Bury.—The Electricity Committee on Thursday decided to obtain powers in the proposed Bill to borrow £30 000 for general electrical works, as the present equipment at the works is being used to its utmost capacity.

Dorchester.—The Dorchester and District Electric Supply Company, Limited, 11, Carteret-street, Westminster, intend to apply for a provisional order for the whole of the borough of Dorchester, in the county of Dorset.

Finchley.—The Electric Lighting Committee, in their last report, state that up to date 285 consumers have applied for 14 762 8-c.p. lamps. The capital expenditure to Sept. 30 was £32,145, and the balance unexpended £2 855.

Derbyshire and Nottinghamshire Electric Power Co.—A special meeting is to be held on the 30th inst. to sanction the issue of permanent debenture stock to a nominal amount of £100,000 to carry interest at the rate of £5 per cent. per annum.

Bradford.—The Corporation Electricity Committee have received a memorial from the Drapers' Association with respect to the scale of charges for illuminating purposes and have instructed the electrical engineer to prepare a report on the subject for the benefit of their customers.

Norwich.—It has been decided to reduce, from Jan. 1, the maximum price of current for lighting from 5d. to 4½d. per unit, which is a reduction of 10 per cent. The committee consider that they can safely do that, and not only pay their way, but put a substantial sum away for reserve.

Brighton.—Deputations from Portslade, Southwick, and Shoreham Councils have visited the large electric station now being built by the Corporation at Shoreham. The station borders the canal, and it is claimed that, notwithstanding its remoteness from coalfields, Brighton will be able to supply electricity at as low a price as is charged anywhere in the country.

Fulham.—A brick chimney shaft is to be erected at the electric lighting works at a total estimated cost of £4,000, and we understand that the borough surveyor has been instructed to have the concrete foundations carried out by direct labour under his supervision at an estimated cost of £2,250.

Dunfermline.—The Fife Power Company's generating station at Townhill is nearing completion, and an early application is expected to the Town Council for permission to open the roads and streets for the laying of cables The Dunfermline Abbey authorities have decided to adopt electric light in place of gas.

York.—A tender has been accepted for the installation of electric haulage plant at the works on Foss Islands in connection with the coal storage, at the sum of £735. By this means it is expected to save 6d. per ton on the coal. This would mean £125 a year, and the interest and sinking fund amount to less than £50.

Handsworth.—At last week's District Council meeting it was proposed that, in view of recent experiences in street-lighting of other local authorities, the Council reconsider the electrical engineer's report of May, 1903, and especially that part dealing with street-lighting by arc lamps. The motion was negatived by 15 to 3.

Portsmouth.—Eastney Barracks are to be fitted with the electric light. No less than 3 000 lamps will be required. It is anticipated that the Municipal Telephone Committee will within a few days be able to make the gratifying announcement that the undertaking has no fewer than 2 000 instruments fixed and working.

Ormskirk.—The Guardians are purchasing from Messrs. Guinness, of Dublin, electrical plant, including two engines, two dynamos, and certain instruments in connection with the switchboard. The plant has been in use seven years, and the Guardians are to pay one-third of the original cost. The machinery is stated to emanate from the best makers and to be in good condition.

Dover.—The Corporation intend to apply for a provisional order to authorise them to produce, store, supply, sell, and distribute electrical energy for public and private purposes within the parishes of Hougham, Poulton, River, Alkham, Ewell, Whitfield, West Langdon, East Langdon, St. Margarets-at-Cliffe, West Cliff, and Guston, in the rural district of Dover, in the county of Kent.

Buxton.—At the last Urban District Council meeting, upon an estimate for balancing apparatus being submitted, the engineer's suggestion that he should inspect the apparatus at work at Wolverhampton or elsewhere was approved. Inspection is to be made at the same time of hoisting gear and winch for lowering arc lamps, and a report on tenders received will be made to the next meeting.

Stock Exchange.—Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Calcutta Electric Supply Corporation's further issue of 20,000 ordinary shares of £5 each (£3 paid), Nos. 60,001 to £80 000; and W. T. Henley's Telegraph Works' further issue of 5 000 4½ per cent. cumulative preference shares of £5 each (fully paid), Nos. 35,001 to 40,000.

Rawtenstall.—The Rawtenstall Branch Social Democratic Federation have forwarded to the Town Council a resolution condemning their action with regard to electric lighting arrangements, and recommending that the Council adopt a scheme to generate and distribute its own electricity, instead of buying in bulk from a power company. The letter will be dealt with at the same time as other matters of a kindred character when they are brought before the Electricity Committee.

Hemsworth.—The Hemsworth Electricity Supply Company, Limited, intend to apply for an electric lighting provisional order authorising them to supply electricity within the townships of Hemsworth, Wintersett, Ryhill, Havercroft, South Hiendley, Shafton, Brierley, South Kirkby, South Elmsall, North Elmsall, Upton, Badsworth, and Ackworth, within the rural district of Hemsworth. Messrs. R. J. Nicholson and Co., 26, Cannon-street, Manchester, are the company's engineers.

Agencies.—The Rhodes Electrical Manufacturing Company, Limited, have opened a branch office at Newcastle-on-Tyne, at 17, Eldon-square, under the management of Mr. Joseph P. Sleigh, late manager of the branch office of the British Thomson-Houston Company.—Mr. John Child, A.M.I.M.E., 108, Claremont-road, Liverpool, W., has been appointed sole representative in Great Britain for central condensing and cooling plant, oil separators, etc., manufactured by Messrs. Eugen Blasberg and Co., Düsseldorf.

Croydon.—The County of London Electric Supply Company, Limited, intend to apply for a provisional order to supply electricity, electrical energy, and power within the rural district of Croydon (Surrey), to construct works, to lay down wires and other apparatus, to break up streets therein, and to make agreements with local authorities. The repeal of the Mitcham Electric Lighting Order, 1901, and the transfer of right of purchase contained in the Wimbledon Electric Lighting (Extension) Order, 1903 are included in the application.

New Malden.—Last week's meeting of the District Council was specially convened, principally for the purpose of considering the Council's policy relative to the electric lighting provisional order. A resolution, "That an expert electrical engineer be appointed to inspect the district and give a report with reference to the provisional order, at a fee not exceeding 30 guineas" and a number of amendments were discussed in succession, and lost. Finally, notice of motion was given to rescind a previous resolution embodying a request to the committee not to act.

Kensington.—Applications from the Post Office for permission to lay pipes for telephone wires, etc., in Cromwell-place (east side) and Thurloe-place (centre), Old Brompton-road (south side), Lansdowne-road (west side), Beaufort-gardens (north-east side); notices from the

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Brompton and Kensington Electricity Supply Company relative to proposed extensions of their mains, etc., in Earl's Court-road; and an application from the National Telephone Company for permission to lay a branch pipe from Queen's-road along Phœnix-place have been agreed to.

The Tariff Commission.—The Tariff Commission has held four meetings during the past fortnight at the Whitehall Rooms, under the chairmanship of Sir Robert Herbert, G.C.B., making 75 sittings to date. At the last four meetings evidence was taken in regard to the engineering, building, furniture, and textile trades. The witnesses examined in the engineering section were as follows: Mr. John McLaren (J. and H. McLaren, Midland Engine Works, Leeds, engineers); Mr. George Cradock (Geo. Cradock and Co., Wakefield, wire drawers and rollers).

Awards.—We are informed that the Westinghouse Companies' exhibits at the St. Louis Exposition have received a special award in the department of machinery for the best, most complete, and most attractive exhibit, and no less than 12 grand prizes and 25 ordinary awards. The gold medals were for complete alternating-current and direct-current switchboards, Bremer arc lamps and arc lighting system, Nernst lamps, Cooper Hewitt lamps for photo-engraving, water and gas meters, electric measuring instruments, and for industrial betterment work and housing of the working class.

Staff Dinner.—There was quite a large muster of local talent at the first staff dinner and smoking concert of the electricity department of the Stretford Urban District Council last Friday. Councillor S. Lawton (chairman of the Electricity Committee) presided, supported by Councillor T. Johnson, J.P. (chairman of the Council), Councillor Estcourt (vice-chairman, Electricity Committee), Councillor Fulford, Mr. G. H. Abrahams (clerk to the Urban District Council), and Mr. R. Rowland (resident engineer). The attendance, the speeches, and the songs testified to the greatest harmony existing within the department, and with the Council and district in general.

Blackpool.—Mr. C. Furness, the electrical engineer, in his last report states that the returns for October show an increase in the works output of 10,729 units, as compared with the corresponding month of last year, made up as follows: Private lighting: October, 1904, 116,909; October, 1903, 102,409—increase, 14 500. Public lighting: October, 1904, 22,746; October, 1903 20.601—increase, 2,145. Lytham and St. Annes trams: October, 1904, 6 540; October, 1903, 6,457—increase, 83. Corporation trams: October, 1904, 71,075; October, 1903, 77,074—decrease, 5,999. Totals for month: 1904, 217,270; 1903, 206,541—net increase, 10,729 units.

Electrical Shares.—It is reported that there is some abatement in competition in the electrical industry, due partially to the greater activity in trade in Germany, which has caused makers there to compete less keenly for orders in foreign markets. That German electrical manufacturers are well supplied with orders is evident by the last report of the Allgemeine Electricitäts-Gesellschaft, which has recently increased its dividend from 8 to 9 per cent., paying the larger rate on considerably increased capital. The company's turnover during the first three months of its new financial year shows an increase of nearly 50 per cent. compared with 1902-3. British manufacturers should now, therefore, have an opportunity of doing better.

Battersea.—The agreement entered into by the Council with the County of London Electric Supply Company, Limited, relative to the supply of electrical energy in areas transferred under the provisions of the London Electric Lighting Areas Act, 1904, has been confirmed by the Board of Trade, and the areas are to be transferred on Jan. 1, 1905. The works necessary to be carried out to enable the Council to supply in the transferred areas will be taken in hand, and are estimated to cost £5,900. If both schemes are carried out concurrently a large saving will be effected, inasmuch as the feeder cables, etc., would follow the same route for some considerable distance. The net amount to be paid to the company under the agreement in respect of consumers in the transferred areas is approximately £2600.

Kilkenny.—The Irish *Engineering Review* says: "At a recent meeting of the Urban Council a letter was submitted from the Local Government Board in response to the Council's enquiry if they could have a loan of £10 000 for electric lighting, that the Board were unable to sanction such a loan as the Corporation had made default in their supply of a water and sewerage system, and also that the Lords of his Majesty's Privy Council had ceased to make advances for electric lighting purposes After some discussion in the Council the matter dropped. At a further meeting of the Council, after a long discussion, it was proposed that the lighting of the city be offered to any local company which would be formed for 15 years at £400 per year, and that the question be adjourned for six weeks to see if such company could be formed."

Fireproofing.—We have received particulars from the Snowdon's Flame Preventers Company of the solutions which they are now supplying in quantity for fireproofing all kinds of flammable material. This they can do without injuring in any way the actual texture or colour of the material which is treated. The compositions used are water repellent, and, therefore, the articles become more or less damp-proofed. One of the solutions which is absolutely waterproof as well as flame resisting can be obtained, but this cannot be applied universally, as it affects the colour of the articles treated. Mr. Snowdon is also developing a flameless celluloid, which should be of great service to electrical engineers. It will be remembered that the Admiralty test all their insulating materials with flame before passing the same for construction in electrical apparatus.

Standard Metal Engraving Co.—This firm, which have their offices at 93 and 94, Chancery-lane, make a speciality of engraved name-plates, which they prepare by a special method. The result, from samples which have been shown to us, is most effective, and, what is much to the purpose nowadays, they are not expensive. The engraving is, we believe, done by chemical means by a patented process. These name-plates are well known, and have been adopted by a number of engineering firms. The same company also specialise in the construction of dials for electrical measuring instruments, which they can make suitable for voltmeters, ampere-meters, etc. We understand that the engraving can be done after calibration, and the result is exceedingly neat and effective. The dials are made in a variety of styles to suit the demands of purchasers of electrical instruments.

Cardiff.—The Finance Committee on Monday sanctioned the borrowing of £87 868 for extensions of the electric lighting and power plant, which has, as previously announced by us, already received the sanction of the Electric Lighting Committee. Mr. Ellis, in order to keep down the expenses of the town as far as possible, has decided not to put any more plant in for the present winter. The result is that both the Canton and the Roath stations are running up to their full capacity without any spare plant. Already the committee have had to give notice to contractors in the town that they cannot take further consumers for the present winter. The proposed new loan will cover the whole of their applications to the Local Government Board for the next two or three years. There are already contracts in hand for power equivalent to over 8,000 lamps. The town hall and law courts will require another 8 000 lamps. The Electricity Committee have borrowed altogether from the rates to pay their debts £11 000 from time to time. During the last two or three years the whole of this sum has been repaid, and £1,800 in addition has been placed to the credit of the rates. In two years nearly 60,000 lamps had been connected out of 110,000 during the past 10 years.

London Gazette.—The first meeting in the estate of Albert Smith, electrical engineer, lately trading as the Electrical Motor Supply Company, residing at 107, Exchange-road, West Bridgford, Notts, and lately trading at 54, Houndsgate, Nottingham, will be held at the Official Receiver's Offices, 4, Castle-place, Park-street, Nottingham, on Nov. 30 at 12.15 p.m. The last day for receiving proofs in the estate of William Wenham, electrical engineer, 5, Century-buildings, London-road, Croydon, is Dec. 5. A receiving order has been made out on creditor's petition in the estate of William Sumner, electrical engineer, 140, Dale-street, Liverpool. The first meeting in the estate of Henry Coles, electrical engineer, 10, York-street, Swansea, will be held at Bankruptcy-buildings, Carey-street, London, at 11.30 a.m. on Nov. 29. The first dividend of 6s. 6d. in the £ has been declared in the estate of Charles Aubrey Smith, electrician, 23, King-street, Regent-street, London. The partnership between Benjamin Reid and Arthur Fishlock, electrical engineers, 2A, Maryland-street, Liverpool, under the style of Reid and Fishlock, has been dissolved by mutual consent. The first meeting in the estate of Alfred James Hollington, electrical engineer, residing at Barclay Oval, Woodford Green, Essex, and employed at 93, St. Martin's-lane, Charing Cross, was held at Bankruptcy-buildings, Carey-street, London, at 12 noon on Nov. 23. An adjudication order has been made out *re* Arthur Edgar Brooks, electrical engineer, 110, Cheapside, London.

Colliery Plant.—Messrs. Ernest Scott and Mountain, Limited, of the Close Works, Newcastle-on-Tyne, report recent orders for electrical machinery for use in collieries, and amongst which we mention the following: (1) For the Bedminster Coal Company, Bristol, a complete installation in hand, consisting of a steam-engine of 300 h.p., together with generator, and a complete equipment of electric motors for driving the underground haulage, pumps, etc. In this contract the machinery throughout will be of the three-phase alternating-current type, as it is proposed at a later date to add considerably to the installation, and to drive the whole of the collieries under the control of the Bedminster Company from one central station, and as some of the pits are some distance away from this station, the utilisation of three-phase current will have great advantages, as the pressure can be readily increased for the long-distance circuits. (2) For the Whitwick Colliery, near Leicester, a three-throw horizontal pump, with electric motor, cables, etc., constructed to deliver 30 to 40 gallons per minute against a vertical head of 500ft. (3) Other plant is for one of the leading collieries in India, Messrs. North's Navigation Collieries, Limited, the Wallsend and Hebburn Coal Company, etc. Messrs. A. Hirst and Son, Limited, electrical engineers, Crescent Works, Dewsbury, have secured an order for an electric generating and haulage plant to be installed at the Wheldale Colliery, Castleford. The plant comprises a 150 kw. dynamo direct coupled to a high-speed vertical engine, two 60-h.p. motors and one 24-h.p., two hauling gears, and over three miles of cables.

Macclesfield.—Messrs. Foote and Milne, Limited, 66, Victoria-street, Westminster, intend to apply for a provisional order authorising them to produce, store, supply, sell, and distribute electricity for all public and private purposes in the borough. The terms offered to the Macclesfield Corporation provide that the powers to be contained in the order are only to be exercised by a company to be approved by the Board of Trade, and in which company residents in the area of supply shall be given the opportunity of subscribing not less than one-half of the capital to be issued on the company going to allotment. The Corporation will have the right to requisition the company to lay down distributing mains for the purpose of a general supply throughout any street or part of a street in which the Corporation have the control and management of the public lamps, but such requisition is not to be binding upon the company unless the Corporation give a written undertaking at the time of service to take a supply of energy for lighting the public lamps in such street or part of a street for a period of not less than three years, and it shall not be binding upon the company to supply energy to public lamps outside the compulsory area named in the order unless such public lamps be placed at intervals of not more than 75 yards from each other, or from any existing distributing main of the company. The Corporation will, further, have the right to purchase the undertaking at any time after 10 years from the date of the completion of the works upon giving one year's notice in writing, at valuation as a going concern. In default of agreement the price is to be settled by arbitration under the provisions of the Arbitration Act, 1889.

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PROVISIONAL PATENTS, 1904.

Nov. 14.

24599. Improvements in guards or shields applicable for electric incandescent lamps. John Devitt and Charles Maskrey, 6, Bank-street, Manchester.

24605. Improvements in or relating to wattmeters. William Edward Sumpner, St. John's House, Sevenoaks, Kent.

24616. X-ray obstructing material. William Morley Martin, 16, Penryn-street, Redruth, Cornwall.

24620. Electric clocks and the like. Isaac Hardy Parsons and Alfred Ernest Joseph Ball, St. Elmo, Woodland-avenue, Stoneygate, Leicester.

24627. Improvements in subscriber's call signalling devices for telephone exchange systems. John Macfee, 65, Chancery-lane, London.

24632. Improvements in electrically-operated switches. August Eckstein and Edwin Parker, Peel Works, Adelphi, Salford, Manchester.

24660. Improvements in gas and electric lamps or fittings. George Arthur Walker, 7, Staple-inn, London.

24663. Improvements in electrical valve-controlling systems. Isaac George Waterman, 111, Hatton-garden, London. (Complete specification.)

24675. Improvements in electric brakes for trams and other vehicles. Robert Bolton Ransford, 24 Southampton-buildings, Chancery-lane, London. (The American Electric Brake Company, United States.) (Complete specification.)

24689. Improvements in and relating to electric storage batteries. Louis Nestor Joseph Roselle, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 16, 1903, being date of application in France.) (Complete specification.)

24692. Improvements in means for ascertaining the power factor in alternating-current systems. Alexandre Grammont, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 24 1903, being date of application in France.) (Complete specification.)

24698. Improvements in electric switches. (The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24699. Improvements in electric motor control and apparatus therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24700. Improvements in systems of electric motor control and in apparatus therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24701. Improvements in electric motor control and in apparatus therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 15.

24708. Improvements in the control of electrically-propelled vehicles. Charles William Godson Little, 99, Albemarle-road, Beckenham, Kent.

24710. Improvements in or connected with coin-freed games of skill and apparatus for administering electric current. John Henry Gibb, 58, St. Vincent street, Glasgow.

24715. Improvements in incandescent gas and electric globe lamps. John Westwood Lea and John Hall Perrins, Midland Works, Bracebridge-street, Birmingham. (Complete specification.)

24722. Improvements in electric tramcars and the like, and in lifeguards or obstruction removers for use therewith. William Whittaker, 254, Colne-road, Burnley. (Complete specification.)

24744. Electrical timekeeper and alarm clock. Hermann Ferdinand Schmidt, 135, East-road, City-road, London.

24769. Improvements in or connected with electrical commutators. Nalder Bros. and Thompson, Limited, Francis Henry Nalder, and Oswald Cox, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

24770. Improvements in electric signalling devices for elevators or the like. Oliver Imray, Birkbeck Bank-chambers, Chancery-lane, London. (Fred S. Payne, United States.) (Complete specification.)

24788. Improvements in electric arc lamps. Willis Rodney Whitney, 83 Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 16, 1903, being date of application in United States.) (Complete specification.)

Nov 16.

24828. Improvements in apparatus for raising and lowering electric arc lamps. William Frederick Mason, 64, Barton-arcade, Manchester.

24831. Improvements in apparatus for actuating the points in electric tramway systems. Ernest Rothwell, 17, St. Ann's-square, Manchester.

24874. Improvements in and relating to alternating-current electric generators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24850. Improvements in instruments for detecting and measuring alternating electric currents. John Ambrose Fleming, University College, Gower street, London.

24857. Improvements in electricity meters. Charles Alfred Adolph Capito, 5, Eardley-crescent, South Kensington, London.

24873. Improvements in or connected with regulating arc lamps. James Brockie, 33, Chancery-lane, London.

24875. Improvements in controlling apparatus for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24876. Improvements in and relating to electromagnetic speed-changing and reversing devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24900. Improvements in electric breaks or interrupters, and means for operating the same. Albert Lewis Davis, 70, Chancery-lane, London.

24915. Improvements in or relating to methods of insulating coils and the like, especially applicable to the construction of high-tension electrical machinery. John Somerville Highfield, 322, High Holborn, London.

Nov. 17.

24918. Improvements in the manufacture of leading-in wires for incandescent electric lamps or other vessels requiring leading-in wires with gas-tight joints. Augustus Charles Hyde, 7, Crown Office-row, Inner Temple, London.

24927. Switches for electric railways and tramways. Arthur Marshall, 38, Sunninghill-terrace, Loampit-hill, Lewisham, London.

24951. A new or improved medical electric and magnetic appliance. Tom Cooke and John Robert Cooke, 111, Hatton-garden, London. (Complete specification.)

24955. Improved ironing machine with electrically-controlled pressure. Albert Ernest Hacking and John Pycroft, 11, Burlington-chambers, New-street, Birmingham.

25010. Improved process for producing nitric acid by aid of electricity. Westdeutsche Thomasphosphat-Werke Gesellschaft mit Beschränkter Haftung, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Oct. 19 1904, being date of application in Germany.) (Complete specification.)

25026. Improvements in and relating to electric switch-operating mechanism. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25027. Improvements in and relating to electric switch-operating mechanism. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 18.

25029. Improvements in potentiometer apparatus for localising the position of faults in electric wires and cables. Trubie Moore, Park-crescent, Roundhay, Leeds.

25041. Improvement in trolley heads in connection with electrical tramways on the overhead wire system. William Kneen, 11, Euston-road, London.

25072. Improvements in terminals for use in electric main and other switches. John Richardson Craig, jun., 25, Renfield-street, Glasgow.

25078. Improvements in electric ignition devices. Eugen Aron, trading as the Continental Hardware and Cycle Company, 61, Fore street, London. (Louis Boulez, France.) (Complete specification.)

25095. Improvements in electric accumulators. Ernst Waldemar Jungner, 18 Buckingham-street, Strand, London. (Complete specification.)

25105. Improved device for distinguishing between the poles of an electric circuit. Henry George Prested, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25106. Improved apparatus for regulating the current through an electric lighting circuit. Henry George Prested, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25112. Improvements relating to electric light systems. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Charles Albert Gould, United States.) (Complete specification.)

25114. Improvements in electric accumulators. Jacques Marie de la Croix and Henry Francis Joel, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

25128. An improved fireproof, acid-proof, and electrically insulating material. U. Marga, 322, High Holborn, London. (Complete specification.)

25129. Improvements in electric braking apparatus. William Phillips Thompson, 6, Lord-street, Liverpool. (Levi Stamm and Edward Dudley Lewis, United States.) (Complete specification.)

Nov. 19.

25172. Improvements in dynamo-electric machinery. Samuel Thompson Webster, 34, Castle-street, Liverpool.

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25171. Improvements in electric light baths and the like radiant therapeutic appliances. John Scott, 34, Castle-street, Liverpool.

25175. Improved electrical apparatus for timing the speed of motorcars or other vehicles over measured distances. Gerald Higginbotham, 4, St. Ann's-square, Manchester.

25181. An improvement in and relating to electric lamps. Charles Patrick Joseph Fitzsimon, 30, Lower Ormond-quay, Dublin.

25189. An improved composition for electrical conduits. Robert Starke, 195, Upper Thames-street, London.

25191. Application of a coherer to any electric transmission by means of conductors for any distance, for telegraphic, telephonic, signalling, bell, or other systems. Giuseppe Magini, 52, Chancery-lane, London.

25196. Improvements in means for improving the power factor of alternating-current circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25218. An enclosed electromagnet. David Perret, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 12, 1904, being date of application in Switzerland.) (Complete specification.)

25219. Improvements in protective systems for electric distribution lines. Leonard Wilson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 20, 1903, being date of application in United States.) (Complete specification.)

25220. Improvements in protective systems for electric distribution lines. Leonard Wilson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 20, 1903, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 8, 1904.

1903.

22423. Electric generators and motors. Hindle.

23465. Safety devices for alternating-current electric distribution systems. British Thomson-Houston Company, Limited, Clinker, Wedmore, and Whitcher.

24847. Electro-mechanical automatic switches for surface contacts for electric tramways and railways, also applicable for automatic signalling on railways and tramways, and for other similar purposes. Matthew George Waggott, Michael Rosenberg, and William Smyth.

24864. Electrical clocks. Chandler and Bonniksen.

24912. Apparatus for utilising electrical energy, particularly applicable for cigar lighters and such like purposes. Ayer.

25122. Electric arc lamps. Fournier.

25146. Controllers for electric motors. Laird and Todd.

25236. Apparatus for commuting electric currents passing through combined arc lamp and incandescent lamp circuits. Smart.

25282. Telegraphic signalling keys. Fleming and Marconi's Wireless Telegraph Company, Limited.

25283. Transmitting instruments for wireless telegraphy. Fleming and Marconi's Wireless Telegraph Company, Limited.

25298. Bodies adapted for lighting purposes, and rendered incandescent by heat or electricity. Ladd.

26963. Suspension of magnetic compasses and other instruments. Lilley.

27497. Devices for lighting gas burners by electricity. Duckham.

28324. Automatic weigher for grain, coal, or other flowing materials electrically controlled. Simeon, Parnall, and Hipkins.

1904.

214. Electric batteries. Kamperdyk.

574. Construction of the armatures of dynamo-electric machines and electric motors with a view to facilitate the mounting of the same upon their shafts. Rees.

623. Electric incandescent lamps. Schwab and Vogel.

1011. Electric winches. Laing.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	15/32 9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	5¼-6
—— 5 per cent. Cum. Pref., 1-100,000	5	–	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	–	⅞ 3⅝
—— 4 per cent. Mortgage Debenture Stock	100	–	8-91
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	–	¼-¼
—— Non. Cum., 5 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	69-73
Callender's Cable, Debentures	100	–	104 106
—— Ordinary	5	–	9¼ 10
—— 5 per cent. Pref.	5	–	5-5¼
Crompton and Co.	5	–	1¼ 1⅜
—— 5 per cent. Debentures	100	–	90 95
Edison and Swan United, "A" Shares, 1-98,261	5	–	¾-⅞
—— "A" Shares, 01-017,139	5	–	1-1¼
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼ 1½
—— 7 per cent. Cumulative Pref.	2	–	2¼ 2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98 00
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10¼-11¼
—— 4½ per cent. Preference	5	–	5¼-5⅝
—— 4½ per cent. Debentures	100	–	109 111
India Rubber, Gutta Percha, and Telegraph Works	10	–	20 20½
—— 4 per cent. Debentures	100	–	99 102
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	38 40
—— 5 per cent. Bonds	100	–	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock, Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	7⅜ 8 xd
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	106-109
Charing Cross and Strand, Nos. 1-70,000	5	–	8¼ 9
—— 70 001-80,000	5	..	8-8¼
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 40,001-80,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	103-106
Chelsea Electricity Supply	5	–	6¼ 6⅜
—— 4½ per cent. Debentures	100	–	109-111
City of London, Ordinary	10	–	10¼-11
—— 6 per cent. Cumulative Pref.	10	–	13¼-14
—— 5 per cent. Debenture Stock	100	–	125-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	104-106
County of London Electric Supply, Ordinary	10	–	9¼ 9⅜
—— 6 per cent. Cum. Pref.	10	–	12-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	101-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	5⅜ 6
—— 6 per cent. Cum. Pref.	5	–	5⅜-6
—— 4½ per cent. First Mort. Deb.	100	–	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-1⅜
—— 5 per cent. Debenture Stock, Red	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-6
—— 4½ per cent. First Deb Stock, Red.	100	–	102 106
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited Ord., 1-13,000	5	–	7¼ 8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	99-101
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum Pref., 1-150,000	1	–	7/16-9/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent Debenture Stock Red	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10¼
London Electric, Ordinary	5	–	2-2¼
—— 6 per cent. Pref.	5	–	5⅜ 5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	97 99
Metropolitan Ordinary	10	–	16 6¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112 117
—— 4½ per cent. Cum. Pref	5	..	5⅜-5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98 101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	–	14¼ 15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100		101-103
Oxford Electric, Ordinary, 1-96 and 4,514,210	5	–	6 6¼
—— 4 per cent. Debenture Stock	100	–	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2⅜-3¼
—— 4 per cent. Debenture Stock	100	–	83-87
South London, Ordinary	–	–	4¼-4½
South Metropolitan Electric Light and Power Co., Ord.	1	..	¾-1
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	106 110
—— Ditto, June, 1904		..	
St. James's and Pall Mall, Ordinary, 101-80,000	5	–	14¼-14⅜
—— 7 per cent. Pref.	5	–	8¼ 9
—— 3½ per cent. Deb.	100	–	99 101
Urban Electric Supply Co., Ordinary, 8-30,007	5	– 4	15/16-5 1/16
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	– 4	15/ 5-5 1/16
Westminster, Ordinary	5	–	12⅜ 13¼
—— 5 per cent. Cum. Pref., 110,101-132,251	5	–	6¼ 7
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-250,007	5	– 5	7/16-5 9/16
—— Ord.	5	..	6¾-7¼
—— Permanent 5 per cent. Debenture Stock. 1888	100	–	143 146
Auckland Elec. Trams., Ld., 5 p.c 1st Mor. Deb. Stk., Red.	100	–	105¼-106¼
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98 101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways, Ld, Pref. Ord. Shs., 75,001-110,606	1	..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/ 6-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅜ 13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3⅜ 4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96 100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103 xd
—— Ord Pref.	100	..	102- 05
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	–	102-104 p c
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-500,000 & 60,001-90,000	10	–	9⅜ 10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10⅜-11
—— 5 per cent. Perpetual Debenture Stock	100	..	117-118
—— 4½ per cent. 2nd Deb. Stock	100	..	86-97

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	..	3¾ 4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	6⅜ ⅞
—— "B" 6 per cent. Cm. Pf., 1-87,500	5	—	5⅛ ⅜
—— 5 per cent. Deb. Stock, Red.	100	—	107-108
—— Prov Cert., all paid	100	..	102 105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7⅜-7⅞
—— 4½ per cent 1st Deb. Stock, Red.	100	..	10 -108
Cape Electric Tramways, Nos. 1 480,000	1		1 7/16 1 11/16
City of Birmingham Tramways, 5 per cent. Cum. Pref. ..	5	—	4¾-5
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	—	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100		101-104
Cork Electric Tramways and Lighting Co. Ordinary	10		9⅛-10
—— 5 per cent. Cum. Pref.	10	—	11-12
—— 4 per cent. Debentures	100	—	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	94-97
Imperial Tramways Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14½
—— 4½ per cent. Deb Stock	100	—	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5		3¾-4½
—— 4 per cent. Debenture Stock	100	—	90-93
Kidderminster and District Lighting and Traction, Pref.	5	—	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	10⅜-10⅝
—— 4 per cent. 1st Mt. Deb. Stock, Red.	100	—	103 106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb Stk., Red.	100	..	103 106
Metropolitan Elec. Trams., Ld., Defd., 1 000,001-1,314,016.	1	..	⅜ ½
—— 5 per cent. Cum. Pref., 500,001-1,000 000	1	..	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	..	103-105
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cen. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	¼-1½

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	-12½
—— 5 per cent. Cum. Pref.	10	—	9½ 9¾
Perth Elec. Tramways (W. A.) 5 per cent. 1 Mrt. Deb. Stk.	100	—	103 106
Potteries Electric Traction, Ordinary 20,001-40,00	10	—	8 ⅝
—— 5 per cent. Cum. Pref., 1-20,000	10	—	8¼ 9¼
—— 4½ per cent Debenture Stock	100	—	99 102 xd
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,132 5 per cent. Preference	1		1
—— £528,093 4½ per cent. Debenture Stock	100	p.c.	c.
Electric Railways.—			
Central London, Ordinary	100	—	93-95
—— 4 per cent. Pref.	100	—	101 103
—— ,, ,, deferred	100	—	84 86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid).	100	—	108 110
City and South London, Consolidated Ordinary	100	—	46-47
—— 4 per cent. Debenture Stock	100	—	104-107
—— 5 per cent. Pref. Stock '91	100	—	122-125
—— ,, ,, ,, '96	100	—	117-120
—— ,, ,, ,, '01	100	—	114-117
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
—— Ordinary, 1-50,000	10	—	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	98-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	—	99-99½
Waterloo and City, Ordinary	100	—	88-90
Telephones.—			
National Telephone, Preferred	100	—	107-108
—— Deferred Stock	100	—	96½ 97½
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	12 13
—— 5 per cent. Non. Cum. Third Pref.	5	—	5¼-5⅝
—— 5½ per cent. Deb. Stock, Red.	100	—	97½-98½
—— 4 per cent. Deb. Stock, Red.	100	—	104 105½
—— 4 per cent. Prov. Cert.	—	..	67½-68½
Oriental Telephone Company	1		15 16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£							d.	d.	£	d.
Aberdeen Corporation	Nov. 19	1,118	1,040	+ 78	+ 5,791*h*	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 19	181	170	+ 11	+ 511	8	8	,, 15	14,160	3,201,586	316,049	1·03	10·11	1,770	5·04
Barking Corporation	,, 19	44	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 20	947	934	+ 13	+ 430	23·53	23½	March 31	56,073	11,327,932	1,319,701	1·158	9·98	2,383*b*	6·1
Birmingham Corporation	,, 19	319	—	—	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 19	5,252	4,875	+ 377	—	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 11	826	750	+ 76	+ 3,173	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·59
Blackpool Corporation	,, 17	353	295	+ 60	+ 5,910	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 19	194	186	+ 8	+ 381	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	,, 20	1,683	1,638	+ 45	+ 478	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 16	873	778	+ 95	+ 2,107	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 12	3,864	3,616	+ 248	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 20	795	751	+ 44	— *h*	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 18	4,631	4,303	+ 328	—	51½	51½	Dec. 31*g*	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 19	1,015	751	+ 264	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 13	316	329	- 13	—	8½	—	March 31*f*	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 12	1,903	1,865	+ 37	+ 1,664	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 19	176	159	+ 17	+ 217	—	—	Dec. 31*g*	9,937	2 805,977	334,393	—	7·17	—	—
Central London Railway	,, 19	7,057	7,138	- 81	- 353*h*	6	6	,, 31	362,471	44,933,938	1,292,674*a*	1·87	64·87	58,229	35·60
City & South London Railway	,, 20	2,965	3,030	- 67	- 1,914*h*	6½	6⅝	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Colchester Corporation	,, 16	181	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 17	429	391	+ 37	- 2 514	—	—	,, 31*g*	25,657	6,355,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 8	226	208	+ 18	- 81	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 19	163	157	+ 6	- 254	4½	4½	,, 31	11,255	2,371,332	280,901	0·91	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 18	96	101	- 5	— *h*	7	6⅔	Dec. 31*g*	6,234	888,905	107,164	3·88	14·09	932	7·39
Dublin U. T., electric cars	,, 18	3,705	3,458	+ 248	—	47	46	,, 31*g*	134,648	—	3,429,356	—	—	—	— *k*
Dublin S. District, Electric	,, 18	841	725	+ 16											
Dundee City Tramways	,, 16	817	796	+ 21	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 13	561	588	- 27	+ 1,453	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 19	14,470	13,392	+1,078	+20,169*h*	143	123	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	,, 16	322	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 16	2,625	2,352	+ 273	+ 3,872	33	30½	March 31	68,283	16,322,054	1,387,885	1·0	11·79	2,0·9	8·77
Huddersfield Corporation	,, 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,652,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 19	2,039	1,834	+ 205	+ 9,615	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 12	370	343	+ 27	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 16	106	124	- 18	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 16	202	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 22	5,091	4,993	+ 98	+11,646	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 19	1,709	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 12	10,342	10,163	+ 179	—	103	103	Dec. 31*g*	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 20	1,445	1,592	- 147	- 1,753*h*	6·57	—	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	,, 5	12,382	10,010	+2,372	+73,926	46½	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Oct. 28	160	175	- 15	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	Nov. 17	108	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 19	11,679	10,793	+ 886	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 11	1,752	1,130	+ 621	+ 9,851*h*	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 19	109	78	+ 31	+ 1,251	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 19	3,523	3,451	+ 77	—	45	38½	,, 25	185,027	39,715,120	4,059,807	1·1	10·94	4,111*b*	7·19
Newport (Mon.) Corporation	,, 19	498	414	+ 84	+ 387	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 19	1,462	1,319	+ 143	+ 5,675	29	29	,, 31	91,448	18,204,426	1,828,193	1·15	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 19	419	433	- 14	—	—	—	,, 31	23,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 5	81	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 20	4,443	4,235	+ 197	+ 3,239	34½	—	,, 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 17	886	854	+ 32	+ 2,124	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Oct. 19	272	243	+ 29	+ 1,292	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	Nov. 18	460	330	+ 130	+ 7,788	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 6	1,117	1,094	+ 23	+ 720	19·51	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	,, 9	160	—	—	—	3½	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 19	645	569	+ 76	+ 1,666	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 10	1,047	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 16	708	420	+ 288	—	7½	—	,, 31*g*	20,873	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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$\frac{1}{2}$in., and there are the usual two tool boxes. This planer works on the edge of a deep pit so that work up to about 18ft. by 18ft. by 4ft. can be taken. In addition to these large planers are a number of smaller planing machines, mostly by the Niles Tool Company. A little further down the shop from the two large planers comes the largest boring mill at present installed. This is a horizontal mill, and will take work up to 19ft. 6in. diameter. This mill was manufactured by Messrs. Smith and Coventry, and works at 12 different speeds, the feed being from $\frac{1}{32}$in. to $\frac{5}{8}$in., and there being two tool boxes on the cross slide. Near this machine the foundations have been provided for a larger boring-mill, which will take up to about 30ft. diameter, now in course of construction. All these larger tools have individual motors, so that there is no waste in heavy belting or countershafts, nor in the motor when the machine is idle. It will also be seen from Fig. 8 that these larger machine tools are served by the two-ton jib cranes referred to above. In consequence of this the work can be adjusted without requiring the presence of the main travelling cranes over the tools. This leaves the travellers free to move materials up and down the shop, which is their real purpose, and it avoids endless delays. There are also a large number of smaller horizontal boring machines

FIG. 12.—View of the North Gallery where the Field Coil Winding is carried out.

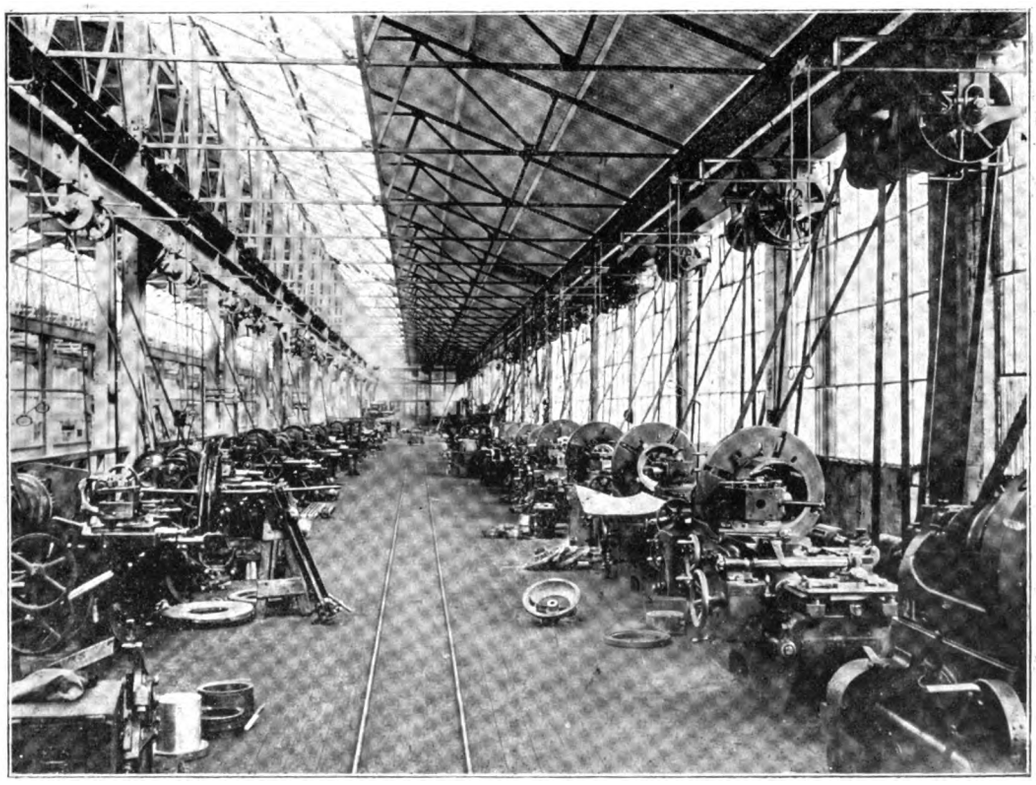

FIG. 13.—South Gallery, equipped with Turret and Capstan Lathes for Machining Motor Parts and general Repetition Work.

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in the shop, the smallest of these having a 3ft. bed, as it is found that a great many classes of work can be done much more expeditiously on these mills than on ordinary horizontal lathes. The majority of the smaller boring mills are by Messrs. Richards.

Farther down the shop is the erecting department for the heavy machines, where such work as that shown in Fig 9 is carried out. On the left-hand side is the erecting shop for motors, which is illustrated in Fig 10. The parts and finished motors seen at the right hand of this illustration show that work is going through in large quantities. A considerable number of the motors in question are for his Majesty's dockyard at Chatham. Fig. 11 is a view taken farther down the main shop, at a point where the armature winding is carried out. This department is partly under the north gallery, and immediately adjoining the hot-room for drying out the wound armatures and coils. It will be seen that the varnishing-room opens out of this hot-room, spirals, after being wound, have a slight cut taken off the outer circumference, and the appearance then of the magnet with this edgewise copper round them is as pleasing as the construction and insulation is sound. An interesting case of strip winding of field coils was going through the shop at the time of our inspection. This was on the field-magnet system of a large turbo-generator, part of an order of six machines, each of 1,000 kw. output. The small diameter and great length of this four-pole magnet, and also its construction in cast steel, prevented the adoption of edgewise winding. Instead of this, the firm adopted a broad copper strip equal in width to the winding space, and wound in a spiral over each magnet. The result, when the bronze packing pieces had been added, was a most mechanical one, and well able to withstand the enormous centrifugal strains found in turbo-generator working. Fig. 14 is a view of the stator of this machine, which is designed for high voltage, and is wire-wound through micanite tubes.

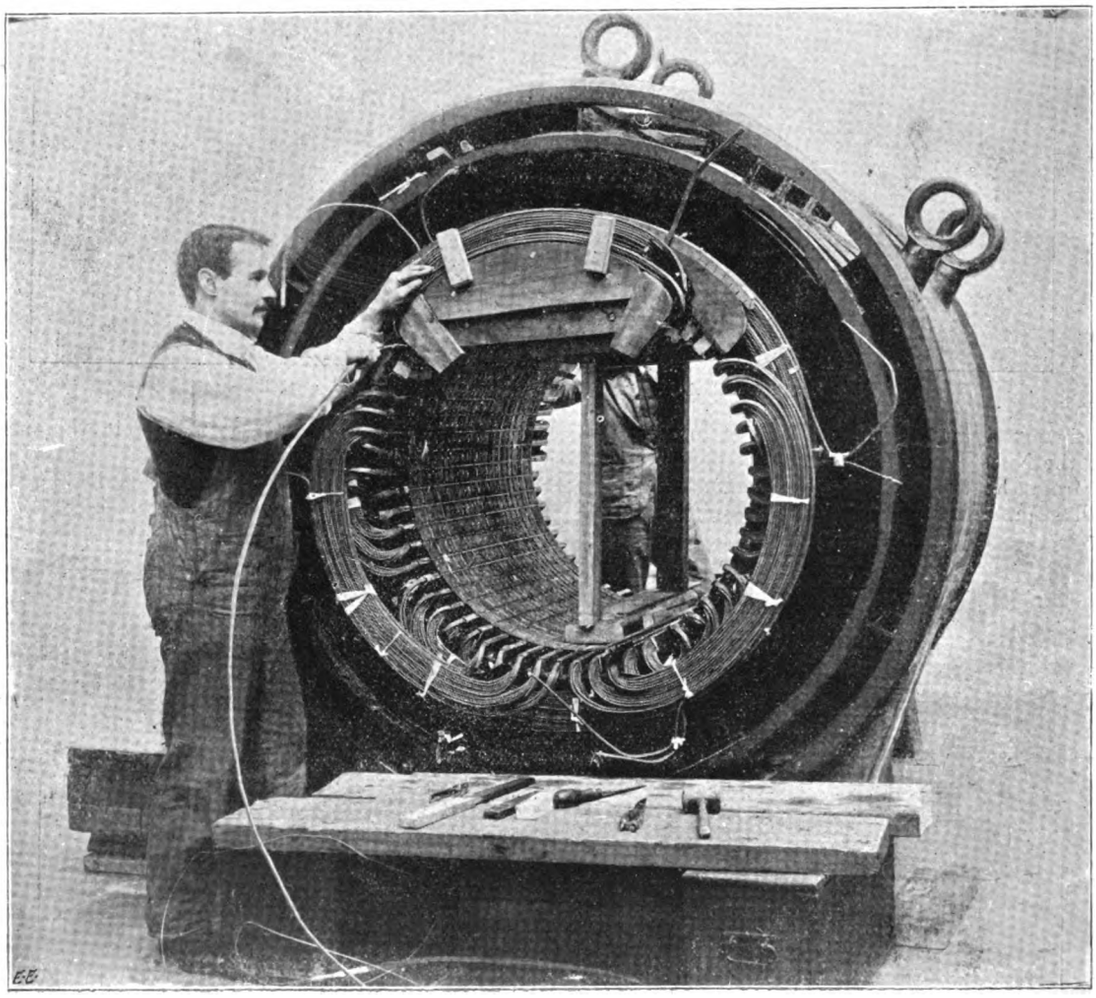

FIG. 14.—Winding the 1,000-KW. Three-Phase Turbo-Generator, built for the Poplar Corporation.

and this avoids any delay in the application of the varnish on to the dried and heated windings. The field-coil winding department is in this north gallery, in the space labelled "Magnet" in the first-floor plan in Fig. 5. In this gallery the insulated bobbins are wound, but not those field coils which are wound with copper strip on edge. This work is done in the south gallery (Fig. 13), and we were particularly struck with the excellent results obtained with the special tools designed by the firm for this purpose. It is well known that if a rectangular copper strip is wound on edge over a circular core, the strains in winding leave the copper thicker on the inner edge than on the outer. In order to avoid this and the consequent looseness at the other edges of the coil, Messrs. Bruce Peebles and Co. use a strip which is not rectangular in section in the first instance. The thicknesses are so proportioned that after winding the thickness is uniform, and the insulation is thus gripped equally at the inner and outer edges of the coil. These

The whole of the micanite used in the works is built up in the department marked "Girls' Room" in Fig. 5, where a number of ingenious moulding devices are in regular use. In this department is also carried on the insulation of the former-wound coils for direct-current armatures. A view of this department is given in Fig. 15, and Figs. 16 and 17 show stators of induction motors before and after winding.

Of the testing shop and test-room we have no illustration to give, as in this hard-driven department the machines are made to show rather what good work they will do than how well they look. The lay-out of the testing shop is good, and the system of dividing up the testing work on to five switchboards enables a large number of machines to be tested simultaneously. By means of throw-over switches, either alternating or direct current machinery can be supplied from each of these boards. Underground mains are provided from these testing boards to groups of terminals at the floor level. In this way the chief of the

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testing department is able to keep down to a minimum the loose wires, which, lying on the floor of the test-room, become a nuisance to the testing staff, and involve frequently a great waste of time in tracing connections.

stamping and core building department, in which some of the latest tools for punching iron discs are to be seen, nor have we described at all the tool-room with its excellent system of checking the delivery of tools to the workmen

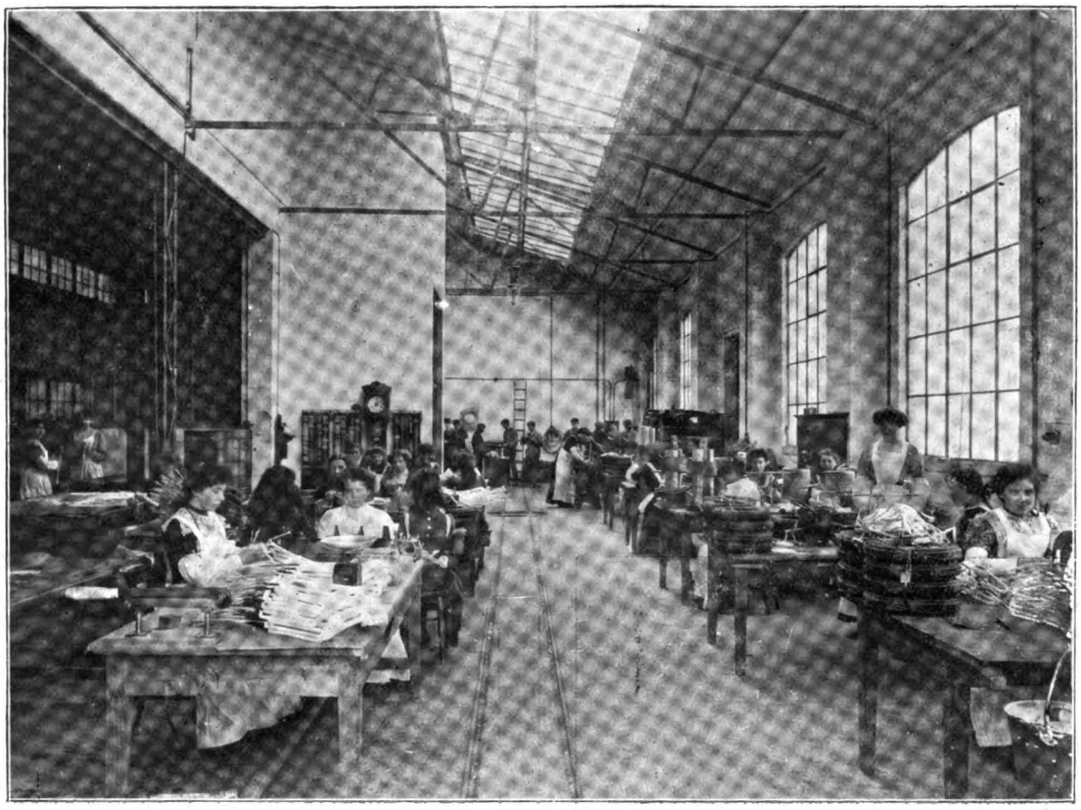

FIG. 15.—The Coil-Insulating and Micanite Manufacturing Department.

After the machinery has passed the critical examination of the testing staff, it passes down the shop through the painting and varnishing rooms. Outside the latter is the packing department, from which goods are dispatched other than those passed into the finished stores. With the large number of orders in hand and demand for prompt delivery. it seemed to us that the packing department was at present

and their return. We can only record our general impression that the firm has been as careful in the design and equipment of these works as they were in the design and construction of their first electrical apparatus, which

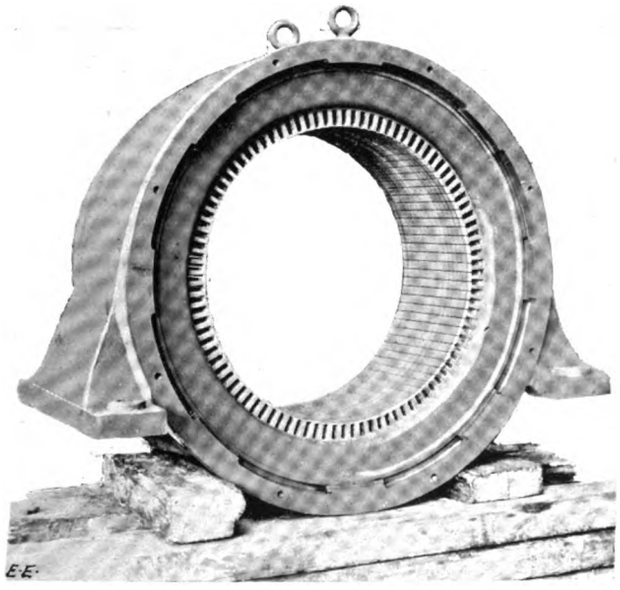

FIG. 16.—Stator Core of Induction Motor.

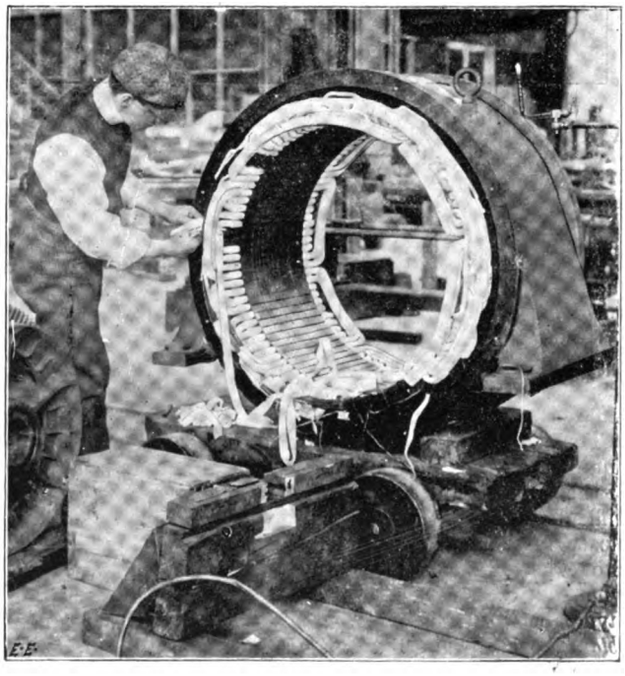

FIG. 17.—Winding a Stator for an Induction Motor.

receiving the great bulk of the goods, leaving the finished motor stores little chance of being filled. This shows that even with the large works, which are now employed night and day, the commercial department of Messrs. Bruce Peebles and Co. are keeping ahead of their manufacturing departments.

Our description of such large works is bound to be incomplete. For instance, we have not mentioned the

gained for them the reputation they enjoy as electrical manufacturers. With the improvements in manufacturing facilities, we see every reason to expect that the machines manufactured at East Pilton will surpass even those turned out from the Tay Works, and that they will more than hold their own in the markets of the world.

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HYDRODYNAMICAL AND ELECTROMAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.*

BY PROF. H. S. HELE-SHAW, F.R.S., LL.D., ALFRED HAY, D.SC., AND P. H. POWELL, M.SC., M.ENG.

INTRODUCTION.

Some four years ago, two of the authors of the present paper described a hydrodynamical method of attacking two-dimensional magnetic problems. A full account of this method, including a detailed description of the apparatus used and examples of the results obtained, will be found in a Royal Society paper for 1900 † Here it will be convenient, for the sake of those members who do not happen to have seen an account of the method, to give a brief outline of it. The laws which govern the distribution of magnetic flux in space of two dimensions are identical with those which apply to the stream-line motion of a perfect incompressible fluid in two-dimensional space. If, therefore, we had such a fluid at our disposal, and by causing it to flow between parallel bounding walls determined the distribution of the stream-lines, this distribution would also represent that of the magnetic lines or tubes in a corresponding two-dimensional magnetic problem. This

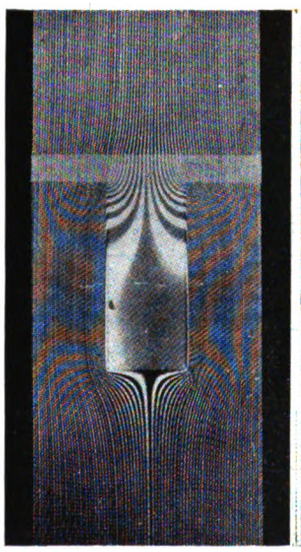

FIG. 1.

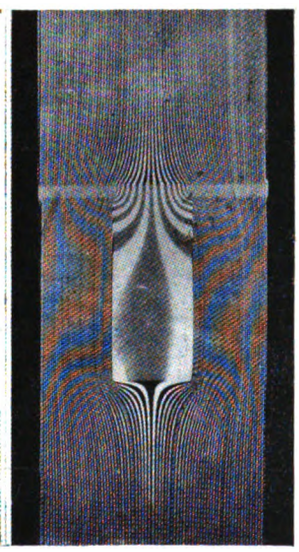

FIG. 2.

is the underlying principle of the hydrodynamical method as applied to magnetic problems.

In trying to put the principle of this method into practice, we encounter the following difficulties: (1) the difficulty of mapping out the invisible stream-lines of the fluid; (2) the fact that there is no such thing as a "perfect" fluid at our disposal, every actual fluid being more or less viscous; (3) the difficulty of finding an analogue for magnetic permeability, in order to enable us to study the flux distribution in cases where the field consists of regions having different permeabilities.

The first difficulty is surmounted by using a colourless liquid into which are injected thin colour bands, consisting of the same liquid mixed with a suitable dye. The second difficulty at first sight appears insurmountable. But a closer mathematical investigation by the late Sir G. G. Stokes‡ has revealed the somewhat astonishing fact that when any viscous liquid is made to flow in a very thin layer between parallel bounding walls, *the stream lines obtained are identical with those of a perfect liquid.* This theoretical deduction was subsequently fully confirmed by us in the paper already referred to. The liquid used by us was glycerine, and the dye for mapping out the stream-lines was a mixture of aniline dye with permanganate of potash. The colour-bands were injected through a series of very minute apertures at one end of the slide between whose parallel plate-glass walls the liquid was allow to flow. The third difficulty consists in devising a method by means of which the effects of varying magnetic permeability may be imitated Now it may be shown, both theoretically and experimentally, that when a viscous liquid flows in a thin parallel layer, the quantity of liquid passing per second across a plane of unit length drawn normally to the stream-line is, for a given pressure gradient, inversely proportional to the cube of the thickness of the liquid layer. Hence, if the liquid is made to flow through several regions of different thickness, the ratio of the cubes of the thicknesses gives the ratio of the permeabilities in the corresponding magnetic problem.

The practical method employed by us consisted in coating one of the thick glass plates forming the slide with a thin layer of paraffin wax, and then forming a cavity or cavities of the required shape by carefully scraping away the wax over certain areas. These areas, over which the liquid layer had a greater thickness, represented the regions of high permeability. The permeability varying in proportion to the *cube* of the thickness of the liquid layer, no difficulty was experienced in constructing slides in which the permeability over certain regions had as high a value as 1,000. The slide through which the liquid flowed being suitably illuminated, a photograph of it was taken, and thus a permanent record obtained of the particular stream-line

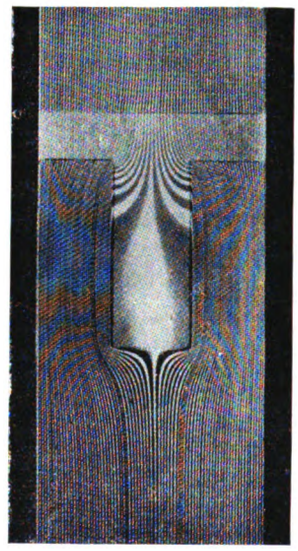

FIG. 3.

FIG. 4.

distribution. The stream-line diagrams which accompany the present paper are reproductions of the photographs so obtained.

The validity of the hydrodynamical method having been established, we proceeded to apply it to some problems in dynamo design whose solution has always been a matter of considerable difficulty. In order to render the investigation more complete, however, we decided to supplement the results obtained by the hydrodynamical method by experiments carried out on an actual dynamo fitted with several armature cores having different sizes of teeth and slots, and different air-gaps. In the calculation of the magnetomotive force required to produce a given magnetic flux in a dynamo having a toothed-core armature, the designer encounters two important difficulties. The first of these is the determination of the reluctance of the air-gap, including the allowance to be made for the distortion due to the armature teeth and for the fringing effect around the edges of the pole-pieces; and the second is the determination of the reluctance of the teeth themselves It is in connection with the first problem—that of air-gap reluctance—that the hydrodynamical method is of particular value. Although attempts were made to apply it to the second problem—that of tooth reluctance—by *continuously* varying the thickness of the liquid layer representing the tooth, yet the difficulties of doing this satisfactorily proved so great that the attempt had to be abandoned, and we preferred to carry out this part of the investigation electromagnetically, using the ballistic method.

* Paper read before the Institution of Electrical Engineers.
† *Phil. Trans.*, vol. 195 (Series A), pp. 303-327.
‡ B.A. Report, 1898.

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Hydrodynamical Investigation of Air Gap Reluctance.

For the sake of completeness, and with a view to rendering the present paper as useful as possible to the dynamo designer, we propose in what follows not to restrict our attention to our own investigations, but to supplement these by an account of the more important researches carried out in this direction by other workers, and to state the results obtained in a form which will render them available for immediate practical use.

A. *Fringing Problem.*—If we except various more or less arbitrary and imperfect empirical rules, the first attempt to deal with this problem in a scientific manner is due to Messrs. C. C. Hawkins and R. Wightman, who, in a paper entitled "The Air-Gap Induction in Continuous-Current Dynamos,"* obtained a correction for the fringing effect on the basis of certain very simple, though incorrect, assumptions regarding the form of the magnetic lines in the vicinity of the polar edges. Shortly afterwards, Mr. F. W. Carter† succeeded in obtaining an exact mathematical solution of an ideal case, which, however, so closely corresponds to the actual problem that from a practical point of view the solution may be regarded as furnishing a perfect correction. The most convenient way of taking the fringing effect into account is to add to the length of the polar

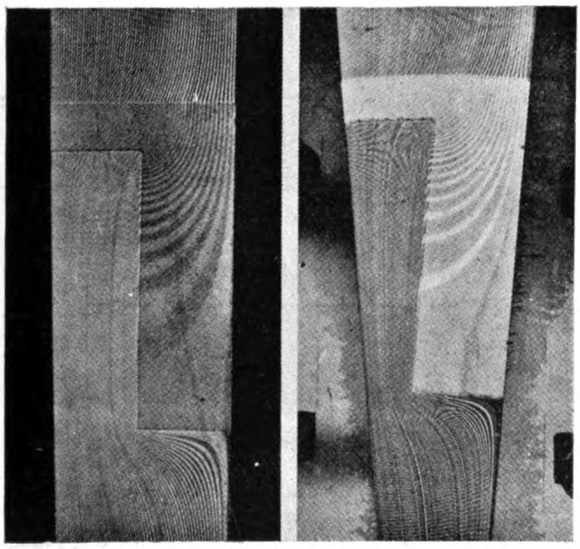

Fig. 5.

Fig. 6.

arc (in estimating the effective cross-sectional area of the gap), a term consisting of the product of the single air-gap length into a certain coefficient, c, whose value depends on the ratio $r = \frac{\text{distance between pole-pieces}}{\text{length of single air-gap}}$, the "distance between the pole-pieces" being measure along the armature circumference, and hence representing the length of the interpolar arc. The following table contains the values of c corresponding to various values of r:

$r=$ 4	5	6	7	8	9	10	12	14	16	18
$c=$1·32	1·59	1·79	1·89	2·15	2·30	2·43	2·65	2·84	3·00	3·15
$r=$ 20	22	24	26	28	30	35	40	45	50	60
$c=$3·28	3·40	3·51	3·61	3·70	3·78	3·98	4·14	4·28	4·40	4·66

By means of this table the necessary correction in any given case may be at once applied.

B. *Problem of the Flux Distortion brought about by Armature Teeth.*—It is at once obvious, without the necessity of going into any elaborate investigation, that the presence of teeth in the armature core is equivalent to an increase in the gap length (or a reduction in the gap area); for the teeth disturb the uniformity of the flux distribution, causing a crowding of the lines into the regions of the polar surface which are opposite the teeth, and thereby increasing the fall of magnetic potential, from the polar surface to the crown of any tooth, above the value which it would have if the distribution were uniform—*i.e.*, if the core were smooth—and the total flux unaltered. Assuming that the exact effect produced by the teeth is known, a convenient method of applying the necessary correction consists in multiplying the gap length by a certain "correction coefficient," and then, using this corrected value, in proceeding with the calculation as if the armature core were smooth—*i.e.*, as if the flux distribution were uniform. The "correction coefficient" clearly represents the ratio of the maximum to the mean induction. It is not difficult to see that the value of the correction coefficient depends on the two ratios s/t and s/g, where s = width of slot, t = width of tooth (at top), and g = length of gap. In Figs. 1-9 are given a series of stream-line diagrams for various values of the two ratios s/t and s/g, and a careful examination of these enables one to form a very good idea of the effect produced by the teeth. The chief value of the diagrams, however, lies in the fact that they enable us to determine the numerical values of the correction coefficient in the various cases. All that is necessary for this purpose is to determine the number of stream-lines per unit of length in the space well under cover of a tooth, and to divide this by the mean number of stream-lines per unit of length for tooth and slot. The values of the correction coefficient so obtained are given in Table I.

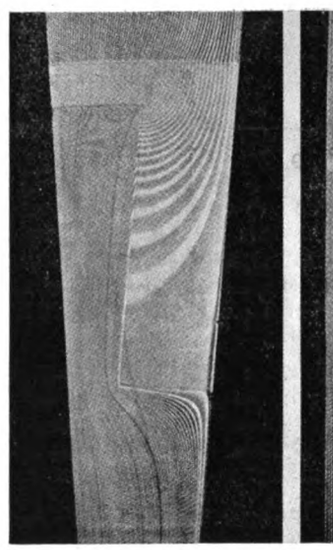

Fig. 7.

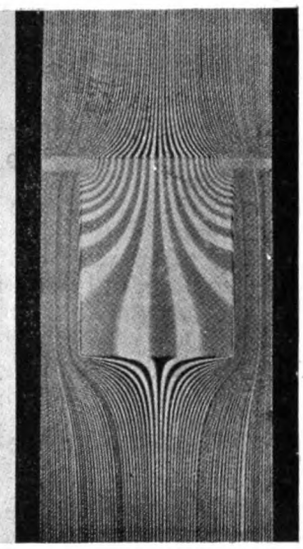

Fig. 8.

Attention may be drawn to one or two features clearly exhibited by the diagrams. Two well-known effects are shown very plainly: the *refraction* of the lines as they pass from a medium of low into one of high permeability, and the crowding of the lines along the sharp edge of the tooth. It will be further noticed that between the straight lines in the region immediately above the tooth and the curved lines entering the slot and passing into the flank of the tooth, and exhibiting a concavity towards the tooth, there are certain intermediate or transition lines which are characterised by a point of inflection, the upper part of the line being concave and its lower part convex towards the tooth; the convexity gradually decreases as we take lines further and further away from the tooth, and is ultimately replaced by a concavity along the entire length of the line. While our experiments were in progress, a very important contribution to this subject appeared by Mr. F. W. Carter,* who followed up his previous success in attacking the fringing problem by working out a solution for the air-gap flux distribution in the case of a toothed-core armature, on the assumptions of negligible pole-face curvature and infinite permeability in the teeth. According to Mr. Carter, the correction coefficient is given by

$$\frac{1+\frac{s}{t}}{1+(1-\sigma)\frac{s}{t}},$$

* *Journal* of the Institution of Electrical Engineers, vol. xxix. p. 436.

† *Ibid.*, p. 925; also *Electrical World and Engineer* of New York, vol. 37, p. 884.

* *Electrical World and Engineer* of New York, vol. 38, p. 884.

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where $\sigma = \frac{2}{\pi}\left\{\tan^{-1}\frac{s}{2g} - \frac{g}{s}\log\left(1+\frac{1}{4}\frac{s^2}{g^2}\right)\right\}$.

Mr. Carter's solution furnishes a correction coefficient which may be regarded as quite accurate enough for all practical purposes, and a reference to Table I. shows very satisfactory agreement between the values determined by our stream-line method and those calculated by means of Mr. Carter's formula. Such divergencies as exist in some cases are to be attributed to want of accuracy in working

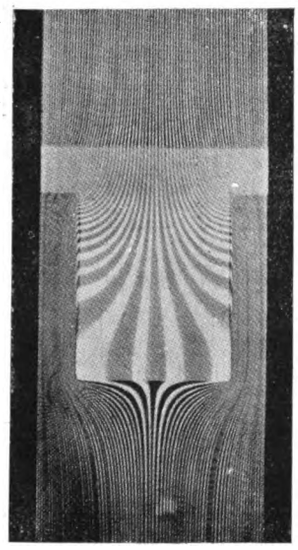

FIG. 9.

out the values from the stream-line diagrams, due to their comparatively small scale. Previous to the appearance of Mr. Carter's paper various attempts were made to deal with the problem, and it is interesting to compare the results furnished by some of these older methods with the correct values now at our disposal.

Method I.—A first very rough approximation may be obtained by assuming that none of the lines pass down towards the slot, but that they all crowd into the tops of the teeth, forming a series of isolated patches, as shown in Fig. 10. The correction coefficient is on this assumption given by $\frac{t+s}{t} = 1 + \frac{s}{t}$, and leads to a very considerable over-correction, which increases with increase of $\frac{s}{t}$.

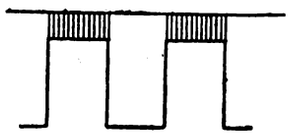

FIG. 10.

Method II.—It is assumed that the effective area of the air-gap is the arithmetic mean of the polar area and that corresponding to the tops of the teeth. The correction coefficient is given by

$$\frac{t+s}{t+\frac{1}{2}s} = \frac{1+\frac{s}{t}}{1+\frac{1}{2}\frac{s}{t}}$$

This method leads to an over-correction when $\frac{s}{g}$ is small, and to an under-correction when $\frac{s}{g}$ is large.

Method III.—The lines are assumed to be straight, and to be distributed in wedge-shaped masses, as shown in Fig. 11. The reluctance over a width of one tooth and slot of a thin layer of unit breadth (measured in a direction parallel to the shaft), and at a distance x from the top of the tooth is $\frac{dx}{t+\frac{s}{g}x}$, where dx is the thickness of the layer. The total reluctance is thus

$$\int_0^g \frac{dx}{t+\frac{s}{g}x} = \frac{g}{s}\log\left(1+\frac{s}{t}\right).$$

But the reluctance corresponding to a smooth core is $\frac{g}{t+s}$.

Hence the correction coefficient is $\left(1+\frac{t}{s}\right)\log\left(1+\frac{s}{t}\right)$

This method leads to an over-correction in most cases. The three methods so far considered take no account of the ratio $\frac{s}{g}$.

Method IV.—This method, due to Messrs. Hawkins and Wightman,* assumes that the lines which fall outside the space immediately above a tooth consists partly of straight lines and partly of quadrants of circles whose common centre is at the edge of the tooth, as shown in Fig. 12. The reluctance of the air-space above the tooth is, per unit length of tooth measured in a direction parallel to the shaft, equal to $\frac{g}{t}$, while the reluctance of an equal length of air-space above a slot is

$$\frac{1}{2\int_0^{s/2}\frac{dx}{g+\frac{1}{2}\pi x}} = \frac{\pi}{4\log\frac{g+\frac{\pi}{4}s}{g}}$$

Hence the joint reluctance of the two air-spaces is, per unit length along shaft, given by

$$\frac{\pi g}{4t\log\frac{g+\frac{\pi}{4}s}{g}} \Big/ \left(\frac{g}{t} + \frac{\pi}{4\log\frac{g+\frac{\pi}{4}s}{g}}\right) = \frac{\pi g}{\pi t + 4g\log\frac{g+\frac{\pi}{4}s}{g}}$$

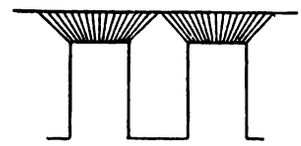

FIG. 11.

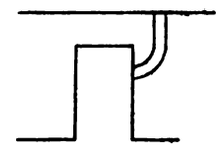

FIG. 12.

Now, since the value of this reluctance for a smooth core is $\frac{g}{t+s}$, it follows that the correction coefficient is given by

$$\frac{1+\frac{s}{t}}{1+\frac{4}{\pi}\cdot\frac{g}{t}\log\left(1+\frac{\pi}{4}\frac{s}{g}\right)}.$$

For the sake of comparison, the values calculated in accordance with each of these methods are included in Table I., and an examination of the results shows that none of these older methods is reliable.

RELUCTANCE OF TEETH IN A SLOTTED ARMATURE.

The problem of determining the reluctance of the teeth has generally been dealt with on the assumption that the equipotential surfaces in the teeth and slots are cylindrical surfaces coaxial with the core discs. This assumption is far from being correct, as is at once evident by an inspection of the stream-line diagrams and an examination of the experimental results given below. Nevertheless, for practical purposes the assumption yields sufficiently accurate results. The problem is considerably more complicated in the case of armatures of small diameter, where the taper of the teeth may produce a very considerable difference between the cross-sectional areas of the top and bottom of a tooth. The most satisfactory method of dealing with the problem in such cases is that given by Mr. W. B. Hird in a paper contributed to the *Journal* of this Institution.†

* *Journal* of the Institution of Electrical Engineers, vol. xxix. p. 436.

† *Journa* of the Institution of Electrical Engineers, vol. xxix., p. 933.

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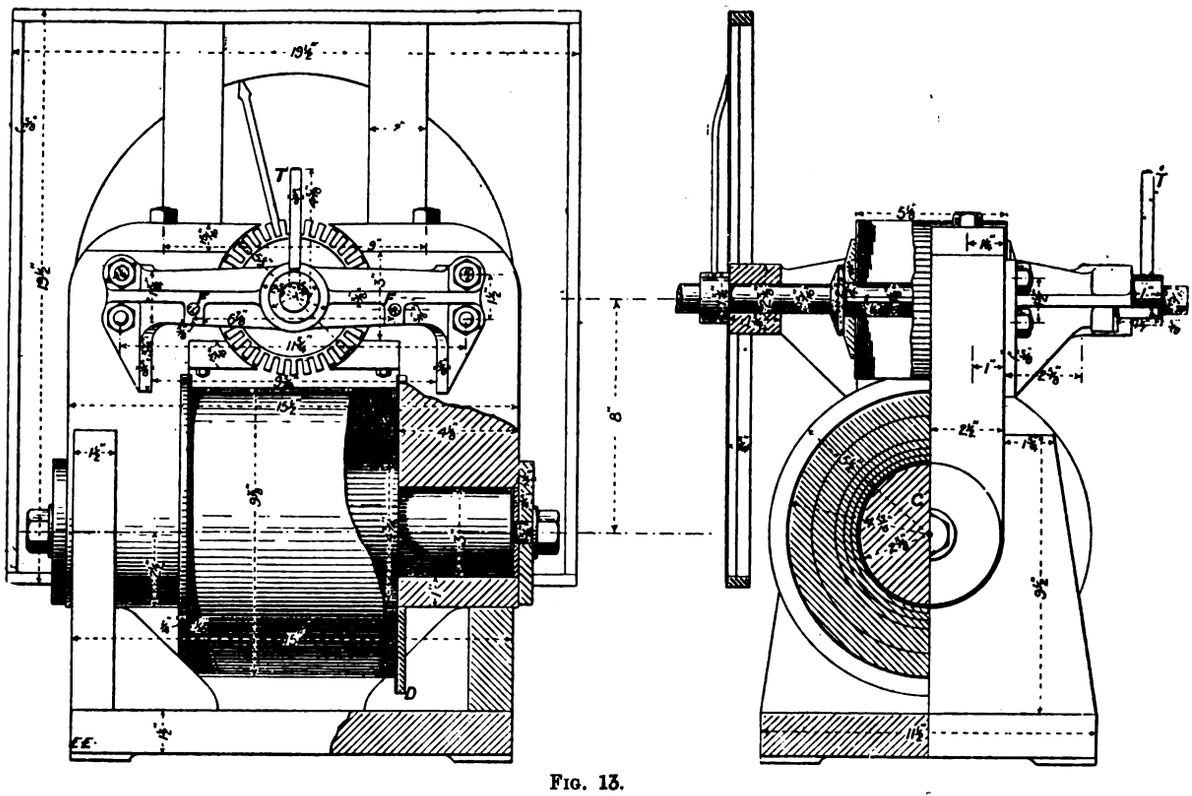

FIG. 13.

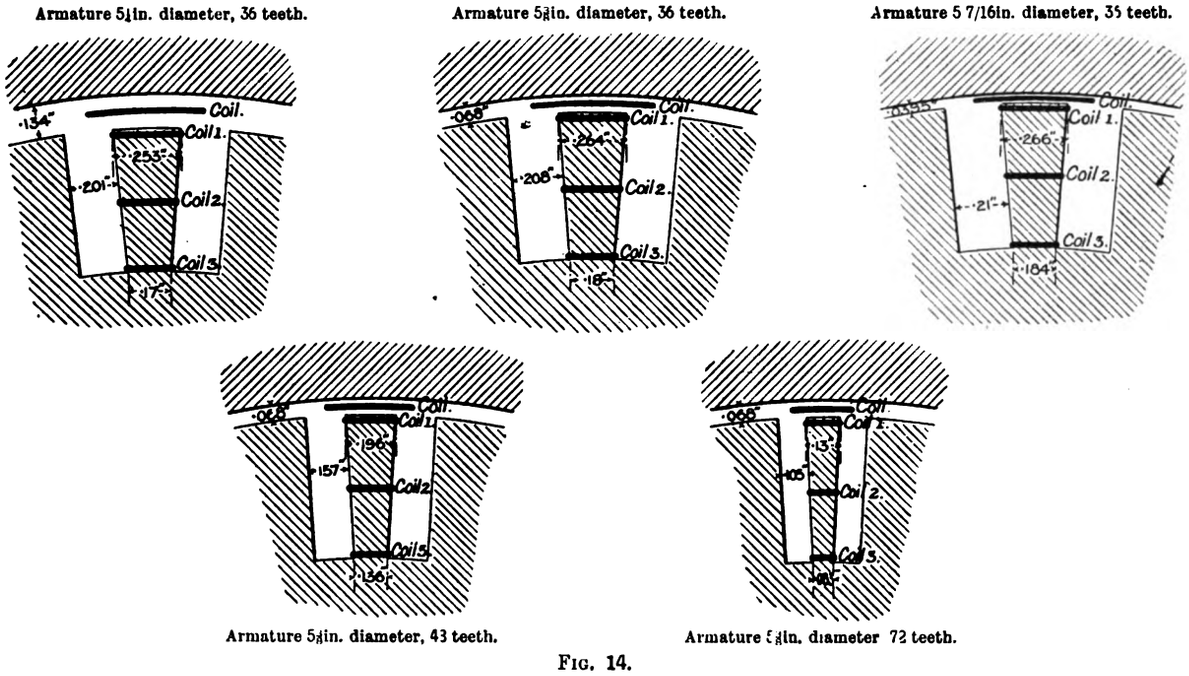

FIG. 14.

TABLE I.—Air-Gap Correction Coefficients.

Fig.	$\frac{s}{l}$	$\frac{s}{g}$	Stream-line method.	Carter's method.	Methods I.	Methods II.	Methods III.	Method IV. (Hawkins and Wightman.)
—	·500	3 42	1·18	1·16	1·50	1·20	1 22	1·21
1	·510	2 80	1·13	1·14	1·51	1·20	1·22	1·19
2	·515	6·66	1·26	1·24	1·515	1·21	1 22	1·28
—	·524	2 38	1·11	1·12	1·524	1·21	1·23	1·18
3	·530	1·68	1 10	1 09	1·53	1·21	1·23	1·14
—	·670	4·57	1·21	1·24	1·67	1·20	1·28	1·30
—	·770	2 27	1·22	1·16	1·77	1·28	1·32	1·23
—	·810	4 00	1·23	1·25	1 81	1·29	1 33	1·32
4	·940	9 60	1·52	1·48	1·94	1 32	1·37	1·53
—	·945	4 30	1·31	1·30	1·945	1 32	1 38	1·38
5	1·00	4 00	1·25	1·29	2 00	1·33	1·39	1·38
6	1·00	4 40	1·37	1·32	2·00	1·33	1·39	1·40
—	1 00	4 50	1·32	1·32	2 00	1 33	1 39	1·40
7	1 02	4·45	1·35	1·32	2 02	1·34	1·40	1·41
—	1 28	3·90	1·33	1·34	2·28	1·39	1·52	1·44
8	1 88	13 2	1·98	1·95	2·88	1·48	1·62	1·95
—	1·94	3·86	1·37	1·40	2·94	1·49	1·63	1·55
9	1·98	3·34	1·39	1·36	2·98	1·50	1·64	1·51

The object of the experiments about to be described was to investigate the exact distribution of the magnetic flux in the teeth and slots of a slotted core under varying conditions of excitation, and with varying length of gap and width of tooth.

DESCRIPTION OF APPARATUS.

The apparatus used was specially designed for the purpose, and was constructed in the workshops of the University of Liverpool. The dynamo (Fig. 13) was of the single-bobbin type, with field core and pole-pieces of Allen's dynamo steel. The pole-pieces were bored out to a diameter of 5½in., and into the space between them could be introduced any one out of a set of five experimental armature cores. The cores consisted of sheet-iron stampings, supplied by Messrs. Sankey and Co., threaded on the shaft, and maintained in position by means of a feather key. The details of the five cores are given in Fig. 14, which also shows the positions of the search coils, by means of which the flux at three different cross-sections of a tooth was determined. The three cross-sections corresponded to the

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top, the middle, and the bottom of a tooth. In addition to the three coils surrounding the tooth, a fourth coil, of width equal to that of a tooth and slot, was used for the purpose of determining the total flux per tooth and slot, and the mean value of the gap induction. This coil was slung in position by means of silk threads suitably supported from the armature shaft, and provided with a device for adjusting the coil in the exact position required (the middle of the air-gap). Each of the three coils surrounding the tooth consisted of five turns of No. 46 wire. Considerable difficulty was experienced in insulating the coils satisfactorily, but this was successfully overcome.

In order to avoid the various difficulties and uncertainties connected with the measurement of the magnetic flux by the methods of breaking and reversing the exciting current, we decided to produce the reversal of flux by a bodily rotation of the armature with its search coils through 180deg. For this purpose the armature was first placed in such a position as to bring the tooth carrying the search coils opposite the middle of one of the pole-pieces. The particular search coil in use being in connection with the ballistic galvanometer, the armature was then suddenly rotated through half a revolution, the tooth being thereby brought opposite the middle of the other pole-piece. This operation occupied an interval of time not exceeding one second. In order to limit the motion of the armature, the shaft was fitted with a striker, T (Fig. 13), capable of moving between two steel stop-pins, F F. In order to prevent excessive shock due to the sudden stoppage of the

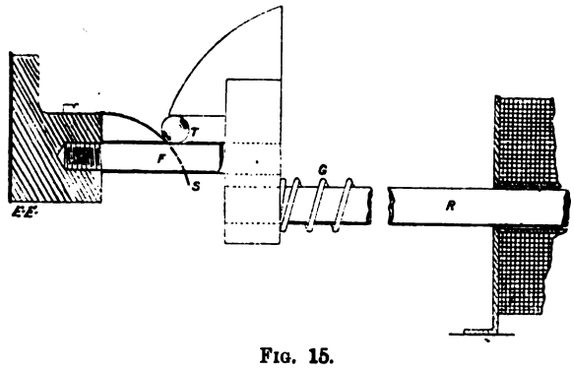

FIG. 15.

armature, buffer springs, S (Fig. 15) were provided, and in order to prevent subsequent recoil suitable catches, one of which is clearly shown in Fig. 15, were fitted. Each catch is forced outwards by a spring, G, which is normally in compression, and which surrounds the core, R, of a solenoid, the catch being attached to the end of the core. When the solenoid is excited, it sucks in its core, withdrawing the catch and leaving the armature free to rotate through 180deg. A similar coil-and-plunger release was fitted to the catch on the other side.

In order to arrive at a correct estimate of the net cross-section of iron in the tooth, a large number of measurements was made of the thickness of the discs forming the different cores, and the number of discs in each core was carefully counted. The exact dimensions of the various exploring coils were also determined with great care. The results of the more important of these measurements are given in Table II.

TABLE II.—Details of Armature Cores and Search Coils in Gap.

Diameter of core, in inches ...	5¼	5⅜	5⅜	5⅜	5 7/16
Number of teeth.....	36	36	48	72	36
Length of single air-gap, in cms.	·340	·173	·173	·173	·100
Width of slot, in cms.....	·5105	·528	·399	·267	·533
Width of tooth at top, in cms.	640	·671	·498	·330	·675
,, ,, middle ,,	·510	·528	·399	·267	·559
,, ,, base ,,	·430	·457	·345	·211	·467
Width of coil in gap, in cms.	1·165	1·15	·833	·62	1·20
Length ,, ,, ,,	9·70	9·68	9·5	9 39	9·49

The moving-coil ballistic galvanometer used in these experiments was of special construction; we found that no suitable commercial instrument could be obtained. A detailed account of the principles underlying the design of such an instrument has already been published by one of us.* It may, however, be mentioned that the periodic time of the instrument was about 80 seconds, and that the electromagnetic damping device consisted of a copper disc suspended below the coil and acted on by a small electromagnet. Throughout the experiments the galvanometer was very frequently calibrated by means of a standard solenoid.

(To be continued.)

* B.A. Report for 1903; or *Electrician*, vol. li., p. 1,013.

ELECTRIC RAILWAY TESTS.

The Electric Railway Test Commission have concluded a series of tests at the St. Louis Exhibition on a single-truck car of the St. Louis Car Company. The car measures 33ft. over all. Its weight with equipment is 15 tons, besides which 3,100lb. of steel billets were carried to represent an average load of passengers. The testing equipment included a General Electric Company recording ammeter for the line current, an ammeter in each motor field, a line voltmeter, and voltmeters across each motor. A Boyer speed recorder was used for speed readings. The car was also equipped with an electrical speed time and speed distance recording device, consisting of a chronograph drum revolved at constant speed and furnished with two pencils, one of which records the time at intervals of five seconds, and the other denotes the distance by means of a track circuit breaker. This breaker consists of a sliding contact, held in place by springs and mounted on the car truck. As the car moves, the circuit is broken by the arm on which the contact is mounted, striking wire "trippers" located at various distances apart. The speed is indicated on a voltmeter connected to an ignition dynamo, which is driven from the axle. In order to preserve an absolutely uniform field strength, this dynamo is excited by storage-battery current maintained at a constant value. The observer follows the needle with a pointer rotating about an axis on the instrument case and fastened to the second pencil on the drum. This pencil is moved against the tension of a spring. Satisfactory results have attended the use of this device. The tests included motor heating runs with several different schedules, with hand braking, and repetitions with magnetic braking. The car was fitted with two Westinghouse No. 56 motors, magnetic brakes of the Westinghouse Company, and the B 23 controllers of the same company. The schedules were run throughout the day until a constant temperature was reached, and two sets of complete readings were taken during the run, each of about an hour's duration. The distance run was 825ft., giving 6 6 stops per mile. The average time from start to start of each run was 52 seconds, corresponding to a schedule speed of about 11 miles an hour. During these runs the indicating instruments were read every five seconds The Boyer speed recorder was run back and forwards between the two points marking the ends of the run, and thus gave the average curve direct. High-speed tests are to be carried out on a typical interurban car and a special car to measure the air resistance.

Wireless Telegraphy.—The German Society of Naval Architects, which was founded five or six years ago on the model of the British Institution of Naval Architects for the discussion of technical and scientific questions connected with the navy, held the first meeting of its annual session at the Charlottenburg Technical High School last week. Prof. Braun, of Strassburg, read a paper on the methods and aims of wireless telegraphy. One of the speakers, in commenting upon the subject, expressed a desire to see the various systems of wireless telegraphy united or amalgamated as a matter of international convenience. It is announced that installations of De Forest wireless telegraph instruments are to be made by the United States Navy at Panama, Guantanamo, Key West, Pensacola, and Porto Rico for ranges varying from 450 to 1,000 miles, and within the near future stations will also be established in Hawaii, Guam, and the Philippines. One contract calls for 300 stations in the Philippine Islands.

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NOTES.

Wireless Telegraphy.—We understand that the "Telefunken" system is now being tried on the lightship "Nantucket."

The De Forest System.—It is reported that the De Forest Wireless Telegraph Company of America are competing with the land wires in sending messages between St. Louis and Chicago at the ordinary Western Union rates.

Royal Society.—The anniversarial dinner was held at the Hôtel Métropole on Wednesday, the president, Sir Wm. Huggins, in the chair. A large and distinguished gathering assembled, and a number of interesting speeches were made, of which particulars will appear in our next issue.

Electro-Harmonic Society.—For the next concert, which takes place on the 9th inst., with Mr. F. H. Nalder in the chair, another entertaining programme has been arranged. The vocal talent comprises Messrs. Harold Wilde and Robt. Radford, and the instrumental performers will be Messrs. E. F. James, B. W. O'Donnell, and A. E. Izard, while miscellaneous items will be contributed by Messrs. H. Scarsdale, C. Wreford, and N. Jackson. The musical directors will, as usual, be Prof. Izard, R.A.M., and Mr. T. E. Gatehouse.

Junior Institution of Engineers.—A large number of the members, accompanied by the president (Mr. W. H. Lindley) and the chairman (Mr. Samuel Cutler, jun.), availed themselves the other day of the opportunity of visiting the central station of the South Staffordshire Mond Gas Company at Dudley Port, and the most recent additions to the Birmingham Corporation gasworks at Nechells. The party spent an enjoyable and useful time in a thorough inspection of these extensive works, aided by the descriptions and explanations of the officials.

Electric Wiring Loans.—We notice that the London County Council have recently authorised a further loan to the Woolwich Borough Council for the purpose of assisting the wiring of consumers' premises for electric lighting, and for the supply of motors and other electrical appliances on hire. The interesting point in this case is that the period fixed by the County Council for the repayment of the loan is eight years, which seems to us to be a liberal one considering the risks of the business which the Woolwich Council are undertaking. It will be remembered that powers for wiring consumers' premises and hiring out motors, etc., were granted by the Woolwich Borough Council Act of 1903.

Marconi Long-Distance Transmission. — A message by wireless telegraphy has been transmitted from the Marconi Company's station at Poldhu to a station belonging to the Italian Government at Ancona. It was addressed to Admiral Mirabello, Italian Minister of Marine, who has taken a great interest in wireless telegraphy. The station at Ancona is a small one, and was not originally intended for long-distance work. The mileage between Poldhu and Ancona is about 1,000, and almost entirely over land, and in order to reach their destination the waves had to pass over nearly the whole of France and a considerable portion of Italy, including the highest mountains of the Alps.

Personal.—We regret to note that owing to indifferent health Mr. Musgrave Heaphy has retired from the position of electrical engineer and scientific adviser to the Phœnix Assurance Company. The services rendered by Mr. Heaphy to the electrical industry in its earlier days by fixing a high standard for electrical wiring work are well known and highly appreciated throughout the country. This appreciation is shared by the directors of the Phœnix Assurance Company, who have retained his services as their consulting electrical engineer. We understand that the retaining fee is a most liberal and substantial one. Mr. Heaphy is to be succeeded by Mr. L. G. C. Russell, A.M.I.E.E., who for some time past has acted as electrical engineer to the company. We trust that Mr. Heaphy will long be spared to enjoy relaxation from the arduous duties which he has so ably performed for many years past.

Leeds Section.—This local section last week paid visits to the works of Messrs. W. T. Glover and Co., Limited, at Trafford Park, Manchester, and to the power station at Formby for operating the Liverpool-Southport line of the Lancashire and Yorkshire Railway, the party being indebted for permission to Mr. E. A. Claremont, managing director of Messrs. Glover and Co., and Mr. J. A. F. Aspinall, general manager of the railway company. The party were piloted around the extensive Trafford Works by members of Messrs. Glover's staff, who described the process of manufacture in detail. Subsequently the company proceeded to Formby, where they were shown over the generating station by Mr. O'Brien, the resident engineer, and others of the staff, who explained everything in the most lucid and able manner. Altogether, a most enjoyable and instructive day was spent. Both Messrs. Glover and the Lancashire and Yorkshire Railway Company made careful arrangements for the conveyance of the visitors.

Personal.—Lord Kelvin, who was elected to the chancellorship of the University of Glasgow in April last, was installed in that office on Tuesday, in the presence of a distinguished gathering. Apart from his lordship's great record in the world of science, it is particularly fitting that this honour—usually reserved for the politician—should have been conferred upon him, as he has been identified with the university in various capacities practically all his life, while his father, also one of its students occupied the chair of mathematics. In opening the ceremony the vice-convener associated his lordship with Bacon and Newton as the leading exponents of Christian philosophy. No sooner had the ceremony been completed than it devolved upon Lord Kelvin to confer the honorary degree of LL.D. upon a Royal lady—Princess Louise (Duchess of Argyll)—who has taken a prominent part in the promotion of the higher education for women. Subsequently his lordship delivered a short address of a reminiscent character, and expressive of his gratification at attaining the highest honour his *alma mater* could bestow. We trust that his lordship may be spared to enjoy for many years this recognition of his services to the university and to science.

The Enlargement of Victoria Station.—The Civil and Mechanical Engineers' Society visited last Friday the works connected with the enlargement of the Victoria Station of the London, Brighton, and South Coast Railway Company. It will probably take another two years to complete the work, but the progress already made enabled the party to obtain a good idea of the general scope of the undertaking. The immediate reason for the enlargement is the need of greater facilities for dealing with traffic at the station. Hitherto there has been but one "up" and one "down" line at the terminus, rendering it difficult, if not impossible, to develop the traffic. The company hope that with the service of fast trains which the enlargement will enable them to run, more business people will be induced to live 20 or 30 miles from town in the picturesque rural districts of Surrey. The new station will have a width of 320ft. and a length of 1,500ft., as compared with

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a width of 230ft. and a length of 800ft. in the case of the present station, while the number of running tracks at the entrance to the station will be increased to something like a dozen. Great improvements will also be carried out in the external features of the station. When the work, which involves a total outlay of something like a couple of millions, has been completed, the old station will scarcely be recognisable. This indicates an admirable spirit of enterprise, but what of the electrification project?

Water-Tube Boilers.—At last week's meeting of the North-East Coast Institution of Engineers and Shipbuilders, Mr. W. R. Cummins read a paper on "A Comparison of Vertical and Horizontal Tubes in Water-Tube Boilers." The author discussed the relative merits of the two types of tubes, with special reference to the conditions which have to be fulfilled to make a commercially successful boiler. The necessary conditions for success he divided under four heads—those affecting the fuel economy, those affecting the weight and space economy, the conditions affecting the cost or capital economy, and the conditions affecting the working or maintenance economy. The balance of advantages appeared to Mr. Cummins to be with the vertical tube boiler. This was to a great extent confirmed by the last report of the Boiler Committee, who gave much praise to the Yarrow boiler. The choice of a boiler, however, must depend entirely on the conditions required in each particular case. On a torpedo-boat everything must be sacrificed to weight and space economy. On a battleship or cruiser weight and space were still important, but sacrifices must be made to fuel economy and working economy. On a liner fuel economy and working economy were paramount. On a tramp steamer cost economy was most important. In all cases, however, fuel economy must be a paramount consideration. An interesting discussion ensued on what Lord Armstrong, the president, termed "this very vexed question."

Tramway Accidents.—One consideration which actuated the Sheffield Corporation in framing a by-law (since withdrawn) for limiting compensation for injuries to £25 was the prevention of exorbitant claims, and to this extent, at any rate, their action was justifiable, if the method adopted was not. Where a passenger sustains serious injury, physical or mental, he has a legal and moral right to adequate compensation; but it is no uncommon thing for a traveller who meets with a few abrasions to put in a claim for substantial compensation, often on the plea of shattered nerves. This procedure has not infrequently been attended with success, and ultra-sympathetic juries have been known to award damages quite out of proportion to the extent of the injuries. The spectacle of a melancholy-looking individual with elaborately-bandaged arm is apt to create upon the too-compassionate juryman an impression which medical evidence does not always counteract. A case came on for trial the other day in the Nisi Prius Court (Ireland) in which the plaintiff claimed damages to the tune of £500 for injuries which he alleged he had received through the negligence of the Dublin United Tramways Company. When the case was called on the plaintiff was conspicuous by his absence, and the action was thereupon dismissed. Seeing that the case had advanced to the trial stage, it could scarcely have been pecuniary motives that restrained the plaintiff from pursuing his suit, and the inference, therefore, is that he was dubious about the possibility of establishing his claim. Whatever be the explanation in this instance, it is not surprising that many tramway owners are apt to look askance at claims for heavy damages.

Publications Received.—"The Dynamics of Particles and of Rigid, Elastic, and Fluid Bodies," by A. G. Webster (Leipzig, B. G. Teubner. Marks 14).—"Elektrotechnik in Einzel-Darstellungen," by Dr. G. Benischke (Braunschweig, Friedr. Vieweg und Sohn. Marks 5·50).—We have received the November number of the *Journal* of the Electric Club, Pittsburg, U.S.A., which contains articles on "Electric Railway Braking," by S. J. Fuller; "Polyphase Induction Regulators," by G. H. Garcelon; "A Slip Indicator," by C. R. Dooley; "The Polyphase Induction Motor" (continued), by B. G. Lamme, and other matter.—"The Metric Fallacy and the Metric Failure in the Textile Industry," by F. A. Halsey and S. S. Dale. (New York: D. Van Nostrand Company. 1dol.) This volume, as the title indicates, is uncompromisingly hostile to the metric system. The reader may not agree with all the conclusions it contains, but the authors have evidently been at considerable pains to collect information and statistics on the subject, so that the work furnishes a compilation of no little interest on this vexed question. We reproduce the following passage from the introduction: "With their system of weights and measures as a foundation, the English-speaking peoples have built up the greatest commercial and industrial structure the world has known. This system they are asked to abandon for the benefit of others at a cost that is beyond estimate, and for compensating advantages that to themselves are wholly trivial and imaginary." The publication is primarily designed to present the case for the United States, but in many respects the arguments are of a general character. The *Transactions* of the American Institute of Electrical Engineers for November contain a paper on the "Transposition of Conductors," by Mr. F. F. Fowle, an abstract of which appeared in a recent issue; and the discussion at St. Louis on "Different Methods and Systems of Using Alternating Current in Electric Railway Motors."

Rats!—To enlist this destructive rodent in the construction of telephone systems may sound empirical to the English engineer, but we have it on the excellent authority of our American contemporary *Sound Waves* that the familiar pest has been found a valuable assistant in this work. To stimulate our four-footed coadjutor, however, it is necessary to introduce his traditional enemy the ferret. Then the process is simple. The subterranean tubes for the reception of the cables having been laid, a rat is let loose at the starting point. Having run a little way, a trained ferret, with a string to his leg, is turned in after him. The tubes run into manholes at intervals, and the rat, furtively glancing back, sees the glaring eyes of his arch-foe rapidly approaching. By the end of the section of tube the rat is either overtaken or falls into the manhole, and then another rat is requisitioned to run the next block. At the end of each section the string is removed from the ferret's leg, and a small rope, which is then attached to the other end of the string, is hauled through. In turn a heavy cable, consisting of two or three hundred wires, is attached to the rope and likewise hauled through the tube. Presumably, it is necessary to see that the rat receives a liberal handicap, otherwise his opponent might catch him prematurely and malinger midway in the tube; but our Transatlantic cousins are capable sportsmen, and doubtless adjust these matters satisfactorily. This new ally was of such utility in the laying of the Des Moines-Omaha line that the Sioux City Telephone Company, who are about to construct a system, have advertised for a large consignment of them, "church rats preferred." Apparently, the ecclesiastical species yield a "higher efficiency" than their larger brethren of the stable. As the result of this novel method of laying cables a decadent industry shows signs of revival, the cult of the rat-catcher having received a fresh impetus among the juvenile division of the community.

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Commercial Conditions in South America.—Enterprise in some foreign countries, and particularly Spanish-speaking countries, is often beset with peculiar difficulties. Not long ago it was stated at the meeting of a Spanish electric tramway, financed with English capital, that trouble had been experienced with the employés because the conductors resented the company's action in objecting to their appropriating a considerable portion of the fares to their own use. Engineering pioneers have sometimes been assisted by the aptitude of the natives; at other times they have been handicapped by their racial eccentricities In the South American republics, where there is a large amount of British capital invested, proprietors of public undertakings have suffered from the exactions of the authorities as well as the vagaries of the workmen. It is gratifying, therefore, to see the Argentine Government lending substantial support to commerce in the latest difficulty with which it finds itself confronted in that part of the globe. The leading countries of that continent have, statesmen opine, emerged from the long era of perpetual revolution, but, like the most progressive nations, they are still subject to disputes between capital and labour. An extensive strike movement is proceeding, and although certain services have had to be curtailed, the inconvenience to the public has been largely ameliorated through the firm attitude of the Government. The English-owned railways and tramways have been comparatively free from molestation, and the telephone service has been resumed through special police protection being afforded to willing workers, while the Government has loaned some of its engineers and stokers to private enterprise. This conduct is in happy contrast to that of the late administration during the last railway strike, and is calculated to inspire investors with confidence in developing the great natural resources of those regions.

Telephonic Eavesdroppers.—The denizens of the remote parts of Kansas State enjoy the advantages of the telephone, but, rather singularly, they—or, at any rate, the female portion—relish its disadvantages still more. The outlying districts are in telephonic communication with four centres, whence messages can, if desired, be transmitted by telegraph to any part of the continent. It is chiefly for local purposes, however, that the service is utilised. By means of the telephone tradesmen order goods from the towns, ladies make their purchases, and sometimes the physician is consulted. Among the inhabitants of these regions are numerous ranchmen, who no longer pursue, or are pursued by, predatory Indians, as in the days of Mayne Reid, but participate in the use of the telephone and other up-to-date achievements of civilisation. To their wives the telephone is a source of especial gratification. The instruments are all on the same wire, and the sound of the bell is a signal for all to "get in" and listen. They even volunteer to interpret what the speaker is saying if the other communicant cannot understand, regardless of irritable commands to "get off." In this way the news of the locality for 60 miles around is circulated, and over the evening fireside the good wives faithfully detail to their lords the advent of the latest babies, the impending weddings, and other joys and tribulations of their neighbours, to say nothing of the sales of cattle and the prices realised. One of the functions of wireless telegraphy has been to institute transmarine journalism; the effect of telephony in Kansas seems to be to supplant the newspaper. We learn from our Chicago contemporary, the *Telephone Magazine*, that some of the lines are constructed in primitive style, and are ill-fitted to withstand rough climatic and other conditions. It is probable that before long the different lines will be merged into one concern and reconstructed upon more stable principles, but in modernising the system the owners may perhaps feel constrained to retain the single-wire arrangement, lest the service be divested of its great attraction to a large section of the subscribers.

New Schemes.—We gave last week a list of applications for power to embark upon electric traction and lighting schemes, and another crop appears in the current issue. This concludes the roll of projects for which sanction is sought by provisional order, Friday last being the final day for depositing such notices, but there is further time for lodging Bills. Out of the numerous applications, a quantity are, as usual, merely for extension of time or similar purposes, but the list includes some notable schemes. The most ambitious is that presented by a concern styled the Administrative County of London and District Electric Power Company, which seeks power to distribute as well as to supply in bulk an area extending from Hounslow to Gravesend and from Walthamstow to Sutton. Another attempt is being made to pass the East London and Lower Thames Electric Power Bill, which was rejected last year from financial considerations. The Metropolitan Electric Supply Company, the North Metropolitan Electric Supply Company, the Charing Cross and Strand Corporation, the County of London Supply Company, and the City of London Electric Lighting Company, are all seeking power to extend their areas, and in some cases to distribute energy as well as to supply in bulk. In the department of traction, the Central London Railway Company are making another effort to extend their line to Liverpool-street, returning by a loop through the Strand and Hammersmith to the present terminus at Shepherd's Bush. The London County Council are having another try with their over-the-bridges' scheme, and the Croydon Corporation seek power to construct additional tramways within and without the borough, and also to supply electrical energy in bulk outside their boundaries. The Liverpool and Birmingham Corporations are applying for sanction to their big schemes of tramway extension. Promoters are evidently not deterred by the notice issued a few weeks ago in regard to new tubes, and the London Traffic Commission, as besides the Central Railway Company's scheme, the Great Northern, Piccadilly, and Brompton Railway are applying for power to construct an extension from Kingsway to Waterloo, and the Baker-street and Waterloo Railway Company ask permission to construct new and abandon existing subways. The projected line from Hammersmith to the City and thence to Palmer's Green is also being revived by the Hammersmith, City, and North-East London Railway Company. If the bulk of these schemes are proceeded with, the parliamentary committees are likely to be kept pretty busy during the next session.

Double-Carbon Arc Lamps.—A direct-current constant-potential twin arc lamp adapted to modern conditions has been patented in the United States by Mr. C. E. Harthan, of the General Electric Company, and some particulars of the invention, with a diagram showing the general arrangement of the electrodes and wiring, appeard in the *Western Electrician* of Chicago. The construction of the lamp permits the two pairs of carbons to be placed near together, preferably about 2in. apart, so as to prevent the arcs from being too near the inner surface of the globe. It is found that by bringing the carbons near each other the current traversing one pair has a steadying effect on the arc between the other pair, but this effect is lost if they are so near as to exert a blow-out action. The positive line, 1, is connected with the resistance coil, P_1, from which a

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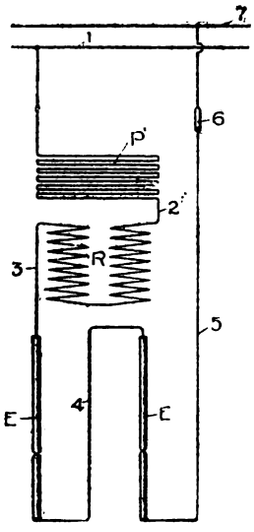
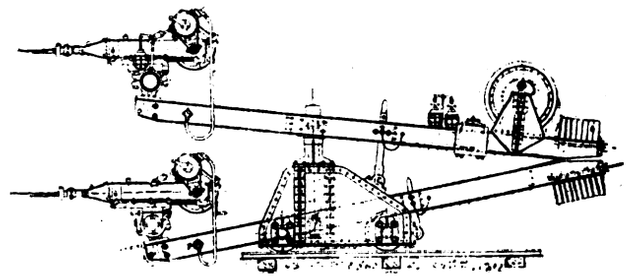
lead, 2, runs to one terminal of the magnet, R, whose other terminal is connected by lead 3 with that one of the carbon tubes whose lower carbon is supported by a leg of the lamp. The binding post at the other end of this leg is connected by lead 4 with the other carbon tube, and the circuit therefrom is by way of the other leg of the lamp, a gas-cap lead, 5, and switch, 6, to the negative side of the line 7. In order to permit the use of enclosing globes of different lengths, an improved supporting device is provided, consisting of a wired bail suspended by springs, and having at its lower end a ring to receive the lower end of the globe, and a depending loop serving as a fingerhold in pulling down the bail to release the globe. The ring may be either of sheet metal,



or integral with the bail and loop. Each spring is supported by an eyelet on the underside of the base-plate. The upper end of the enclosing globe fits in an annular groove in the gas-cap, and the hot gases escape through tortuous passages in the cap to the outer air.

An Electrically-Bored Tunnel.—Electricity is figuring extensively in the construction of the Karawanken tunnel in Austria. The tunnel has a minimum height of about 9ft. 10in. and a minimum width of about 8¾ft. Boring operations were commenced from both ends. The material excavated is removed by an electric railway, the tunnel is illuminated electrically, ventilation is provided by electrically-driven compressors, communication is maintained by telephone, and electric boring machines are in use. The *Electrical World* of New York describes the power stations, one being installed at Rothweinbaches, a distance of six miles from the south tunnel portal, and another at Rosenbach, a distance of 1¼ miles from the northern tunnel portal, the line voltage being 5,000. The water power available at Rothweinbach was equivalent to 900 h.p., with a fall of 28·4m. The power house at Rothweinbach was equipped with three turbines of 450 h.p. each, a three-phase alternator of 400 kw. capacity being directly coupled to each turbine, the speed being 750 revolutions per minute. These machines supplied three-phase currents with a frequency of 50 periods per second and a pressure of 550 volts. The entire loss on the transmission line from the station to the tunnel was found to be 10 per cent. For operating the electric locomotives, a sub-station was erected and equipped with step-down transformers and a 250-kw. rotary converter. The sub-station received current from the transmission line at 5,000 volts, and two stationary step-down transformers of 230 kw. each were provided for lowering the pressure to 350 volts, which the rotary raised to 560 volts direct current. The electric boring machines constitute an interesting feature. These are each equipped with four motors of 43 h.p. capacity, together with transformers on each machine, the boring tools each being provided with 2-h.p. motors operating the drills as indicated in the illustration. The electric boring machines consist of a car provided with a cable drum and several electric drills mounted on the adjustable frame. Both direct-current and alternating-current motors have been utilised in the operation of these machines. The 5,000-volt, three-phase current from the high-tension power transmission line is conducted through a three-conductor, iron-armoured, high-tension cable of 3×6mm.^{2} copper cross-section to a transformer of 25 kw. capacity, which is used for transforming the pressure to 250 volts. The low-pressure cables are also iron-armoured and lead-covered, with three conductors each of 35mm.^{2} cross-section. These cables connect with the boring machines, which are provided with drums holding about 200ft. of cable. The results obtained compared very favourably with those given by pneumatic boring machines in another part of the tunnel.



The electric boring machines constructed by the Oesterreichischen Siemens-Schuckert Werke, now in operation at the north side of the tunnel, excavated 3,300ft. during the six months from January to June last.

The St. Louis Exhibition.—One of the greatest, if not the greatest, of the features of the St. Louis Exhibition has been the electrical section. In an historical *résumé* of the whole exhibition *Dun's Review* gives a comprehensive survey of the electrical department. Of the many exhibits shown, some of the most interesting and impressive were a few that showed the amazing progress that has taken place in the practical employment of electricity during the lifetime of men still young. The display included the famous electric locomotive built at Menlo Park, N.J., in 1880, the first Edison direct steam-driven electric generator, the first three-wire installation ever made — that of the electric lighting plant at Sunbury, Pa., in 1883—the first electrolier ever made, and a collection of relics of various kinds connected with the earlier work of Edison, in whose honour the exhibit was arranged. Specimens were shown of practically every type of incandescent lamp made during the quarter-century that has elapsed since this great invention was first given to the world. In many other exhibits, not primarily intended to be historical, the historical element was a noteworthy feature—in fact, the spectator was constantly impressed with the rapidity with which epoch-making inventions in nearly every department of electricity have been evolved, perfected, and adopted for commercial use on a scale that has already caused them to seem commonplace. Since the Chicago Exposition the number of fundamental types of electric lights have been increased from two to five, to the incandescent lamp and arc light being added the Nernst light, the Bremer arc and the Cooper Hewitt mercury or vapour lamp. One of the most interesting exhibits showed a piece of dry goods under four different forms of electric light—the effects varying in a most surprising manner as the lights were changed. Several exhibits, notably in the French section, showed the progress made in the manufacture of electric light fixtures, while others indicated in a most

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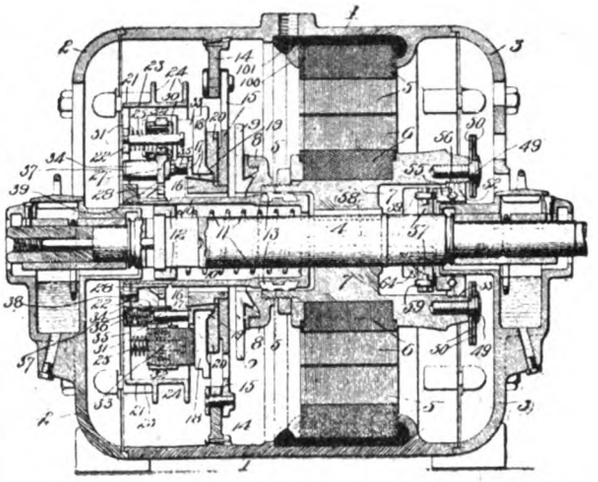
effective manner the part that suitable globes and reflectors play in the attainment of satisfactory lighting effects. The western end of the machinery building contained the most important portion of the exhibits illustrating the latest developments in electrical generators. These exhibits exemplified the steady increase shown in the size of steam-driven electrical units in response to the widespread demand for enormous power-houses, chiefly for electric traction work. By means of models, and some examples of the machines themselves, a fairly clear conception was given of the progress in electrical generation from water-power plants. At Buffalo, in 1901, the keynote of the exposition was electricity thus generated, yet at that time Niagara only furnished 120,000 h.p., while shortly the total in use there will be 550,000—a startling increase in three years. In California, Mexico, and in many parts of the world, electric plant driven by turbine waterwheels are being installed on a mammoth scale, while current is being transmitted successfully to distances that a decade ago would have been deemed impossible. One noteworthy exhibit at St. Louis was a motor for street cars designed to use an alternating current without the intervention of a sub-station. Motors were shown in every size and for every purpose, the smallest, of $\frac{1}{8}$ h.p., supplying just enough power to run a sewing machine. The exhibition of electrical street railway appliances included a controller so adjusted as to turn on the power gradually and automatically, obviating the annoying jerk caused by careless motormen. The Intramural Railway, owned and operated by the Exposition Company, constituted in itself a model exhibit, every feature of the equipment being of the latest type. Many electric locomotives were shown for a wide variety of uses, the more powerful types to replace steam-engines on railways, others for mines, factory yards, etc. A memorable feature of the exhibition has been not only the exhibits, but the use commercially of the De Forest wireless telegraph. Two long-distance wireless telegraph stations were erected on the grounds, one a steel tower 300ft. high, the other a wooden mast 210ft. in height at the opposite end of the exposition enclosure. Messages were sent between the two for the general public, while Press messages were sent from the steel tower to two newspaper offices in the city of St. Louis. About 5,000 words of copy were transmitted daily, consisting of world's fair items collected by regular reporters of the papers and sent at a speed of 30 to 35 words per minute. Messages were also sent successfully all summer to Springfield, 105 miles distant, and eventually to Chicago, 300 miles away. These tests were especially interesting, as heretofore most wireless experiments have been across water spaces. A telegraph transmitter for sending messages y wire on the Morse system was shown that was capable of telegraphing 1,000 words per minute. All the numerous improvements in telephonic apparatus during the past decade were to be seen. In the department of measuring instruments the exhibits testified to the great progress of recent years. The British, Italian, and German sections contained a number of interesting displays, Germany being particularly prominent in electro-chemistry.

New Single-Phase Alternating-Current Motor.—The development of the single-phase alternating-current motor has for a long time engaged the attention of Mr. E. S. Pillsbury, an American engineer, who, after introducing several improvements upon the motor originally patented by him, has recently evolved another design. The special features of his earlier type consisted of the combination of a progressively-wound armature with a slot-wound field, in such a manner that it started as a series motor. After the machine had acquired the proper speed, the brushes were moved away from the commutator, connected together, and simultaneously the winding on the armature short-circuited, after which the motor ran purely as an induction motor. These motors were also provided with a short-circuited winding on the rotor, to prevent it from going above synchronism in case the operator failed to throw the lever at the proper time. In the latest design the motor is so constructed that in starting, instead of the secondary current induced in the armature or secondary member being commutated, the current supplied to the field or primary member is commutated. This makes it possible to employ larger and heavier conductors in the



armature or secondary member in place of the fine-wire conductors heretofore employed, the armature thus being rendered more substantial, of lower resistance, and smaller self-induction, and it will carry a greater load than an armature provided with the fine-wire windings. The armature is thus less susceptible to changes in frequency, and capable of withstanding a greater overload. The *Electrical World* of New York gives the accompanying diagram illustrating the action of the motor. After it has attained the proper speed, the governor weights, 50, operate a cam, 55, which transmits motion for throwing off the brushes and short-circuiting the commutator on the armature, and at the same time making four connections in field coils diametrically opposite. The second

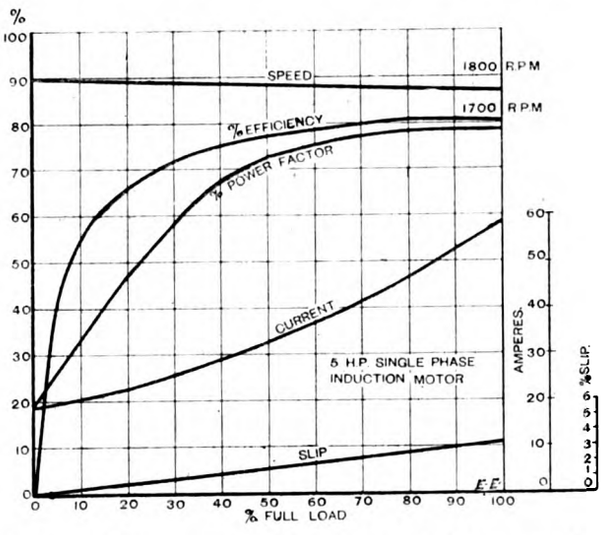


diagram gives curves plotted for a 5-h.p. machine, showing the efficiency and power factor, current consumption, speed, and slip. In developing this motor commercially, the Century Electric Company, of New York, with which the inventor is associated, has departed somewhat from the details shown in the above illustration, in order to combine simplicity with high efficiency.

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THE HULL CORPORATION TELEPHONE SYSTEM.

The formal opening of the Hull Corporation telephone system took place this week, and Hull now is the fifth town working a municipal exchange. The history of the starting of the undertaking is a long one, extending over some five years, but throughout that time the Corporation have exhaustively considered every method of avoiding the duplication of the telephone equipment within the town. The object of the Hull Corporation in establishing a municipal telephone service was twofold—first, to provide a much cheaper service, and, so place telephones within the reach of a larger number of users, and second, to introduce a more efficient service. The question was first considered by the City Council in the latter part of 1899, prior to which there was considerable dissatisfaction expressed in Hull, both as to the cost and working of the existing telephone service. Upon the passing of the Telegraph Act, 1899, a petition was presented to the City Council by shipowners, merchants, and traders, bearing upwards of 800 signatures, urging the Corporation to establish a municipal service in Hull, and on Nov. 9, 1899, the Council were entered into with the existing company, with a view to the Corporation acquiring the company's system in Hull, but as the lowest price required would have precluded the Corporation giving a cheaper service, no satisfactory arrangement for purchase could be made.

Negotiations for purchase having failed, the Corporation then endeavoured to arrange with the company for a substantial reduction of their rates, on condition that the Corporation did not enter into competition, but they were unable to induce the company to agree to such rates as would have been acceptable. The negotiations above referred to extended over a considerable period, and have delayed the carrying out of the work, but the Corporation felt they would not be justified in going to the cost of laying down a duplicate system until they had exhausted every effort to avoid it by obtaining, if possible, satisfactory terms from the existing company. One important result, however, of the negotiations with the company must be mentioned—viz., that an arrangement was made by which the Corporation subscribers have free intercommunication with the subscribers of the National Telephone Company, both in Hull and in other towns. The Corporation of Hull had the advantage in these negotiations of having already

FIG. 1.—The Hull Corporation Telephone Exchange.

appointed a special committee to consider and report as to the desirability of doing so.

In order to ascertain the cost for which a municipal service could be provided, the committee consulted the well-known telephone engineer, Mr A. R. Bennett, M.I.E.E., and after a careful enquiry came to the conclusion, in November, 1900, that the establishment of such a service was desirable, and their conclusion was adopted by the Council. Before taking any steps, however, to carry the resolution into effect, a circular was issued to, and a canvass made of, likely subscribers, so as to make certain that a sufficient number of persons were prepared to avail themselves of a Corporation service at the rates offered, the result of which was in every way satisfactory. Resolutions in favour of the scheme were also passed by the Hull Chamber of Commerce, the Hull Guardian Society, the Hull Chamber of Trades, and other trading bodies. The Corporation applied to the Postmaster-General for the necessary license, which was opposed by the National Telephone Company, but, notwithstanding such opposition, the license was granted in August, 1902. The Corporation were anxious to avoid, if possible, the cost of laying down a duplicate telephone system, and accordingly negotiations given the National Telephone Company underground wayleaves under an agreement which could, we understand, be terminated. The company tried to get the House of Lords to break this agreement without success, and the matter was finally settled on the above lines—*i.e.*, there is free intercommunication between the two systems, and, at the same time, the underground wayleaves granted by the Corporation to the company are extended for the period of the telephone license.

Having decided to commence, working tenders were advertised for, and the total of the accepted tenders proved to be less than Mr. Bennett's estimate. The successful tenderers were as follows: W. T. Henley's Telegraph Works Company, cables and street work; Ericsson Bell Company, switchboard and instruments; International Electric Company, lightning and high-tension guards; Messrs. Bolton and Co, copper wire; Electrical Company, bronze wire; British Insulated and Helsby Cables, Limited, insulators; Messrs. Wade and Co., of Hull, poles; Hart Accumulator Company, accumulators; General Electric Company, primary batteries.

The exchange is situated in the building known as the Trippett Baths, which belong to the Corporation, and were

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being closed through the equipment becoming obsolete. This building, with alterations, was admirably adapted for telephone work.

The alterations to the building were carried out under the supervision of the city architect, but the building (Fig. 1) has been unaltered exteriorily. The upper floor is used as the exchange switchroom, as shown in Fig. 2, while the cable terminals are in the basement. The test frames (Fig. 3), with the high-tension and lightning guards, are also placed in the basement, close to the end of the underground cables. As will be gathered from the above list of contractors, the wires in Hull are chiefly underground. The final distribution, however, is carried out with overhead wires from terminal posts at the ends of the underground mains. The street work involved 19 miles of trenching, in which have been laid 35 miles of Sykes earthenware ducts. The Henley cables used are of the dry-core paper type, lead-covered, and the largest size contains 624 wires. Air pressure is kept on these cables by means of an air-pump of the Reavell type, which is driven by gearing by a B.T.H. motor. The air forced into the cable is first passed through a number of calcium chloride dryers. These underground cables, which enter the main building from two directions, terminate in pot-heads which contain the joints between the paper-insulated wire and the vulcanised indiarubber covered wires which are carried up the frames shown in Fig. 3.

The cables from the switchboard terminate on the test jacks, and the cross-connecting is done by means of asbestos-covered wires. Situated in the testroom is also the power switchboard fitted with the switches, volt and ammeters, and other necessary apparatus for charging the accumulators by means of a motor-generator. The accumulators supplied by the Hart Accumulator Company are in duplicate, and a pair of heavy leads run from the switch on the power board to the switchroom, by means of which either set can be used for supplying current to the exchange. The pair of leads in the switchroom are then branched off to the operators' telephones, pilot lamps, calling, clearing, and other circuits, through retardation coils and lamp resistances, the operators' telephones being shunted by two microfarad condensers. Primary cells are used for the speaking, the accumulators supplying all other circuits.

The switchboard design and connections are of a new type, worked out by the consulting engineer, and a description of the same is shortly to be given before one of the engineering societies, hence we are not publishing a technical description of the same at the present time. The whole of the work has been carried out under the supervision of Mr. Thomas Holme, who was appointed manager in the middle of January. It is an evidence of the energy of all concerned, from the consulting engineer to the contractors, that while work was only commenced then, there are now over 700 subscribers actually connected and working. The switchboard has accommodation at present for 2,000 subscribers, but it is designed so that it can be extended afterwards to provide for 5,000 subscribers. This extension is likely to be needed shortly, as already no less than 1,800

ALDERMAN F. LARARD, MAYOR OF HULL, AND VICE-CHAIRMAN OF THE HULL TELEPHONE COMMITTEE.

COUNCILLOR J. BROWN, CHAIRMAN OF THE HULL TELEPHONE COMMITTEE.

MR. A. R. BENNETT, M.I.E.E. CONSULTING TELEPHONE ENGINEER TO THE HULL CORPORATION.

MR. EDWIN LAVERACK, TOWN CLERK, HULL.

MR. T. HOLME, A.M.I.E.E., MANAGER OF THE HULL CORPORATION TELEPHONE DEPARTMENT.

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names are on the Corporation books. Besides the exchange in Hull, a small exchange has been opened in Hessle, one at Cottingham will be open in a few days, and another is being organised at Beverley. The Corporation telephone

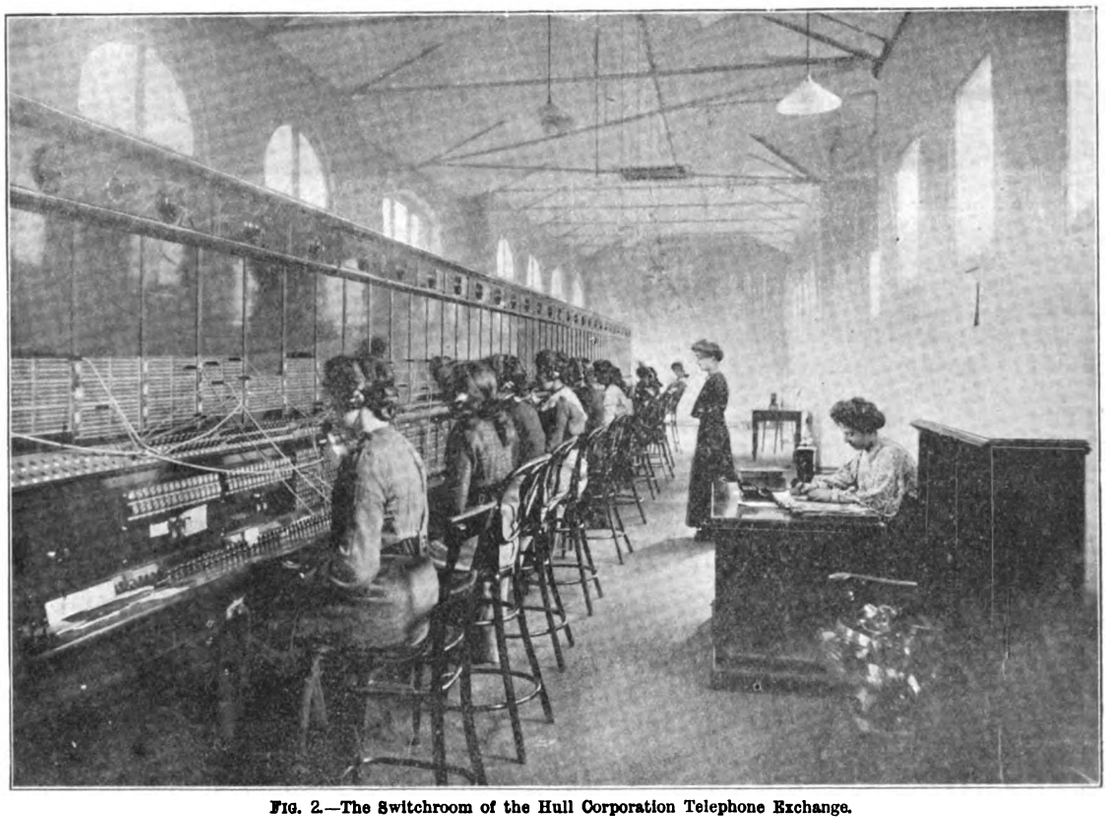

FIG. 2.—The Switchroom of the Hull Corporation Telephone Exchange.

area is a fairly large one, and is the same as that controlled by the license of the National Telephone Company.

As regards the financial side, the Corporation have the sanction of the Local Government Board to borrow £43,202 for carrying out the work. The local enquiry, after which this sanction was obtained, lasted four days, and was as remarkable for the disinterested nature of the opposition as most telephone enquiries in this country. It seems to us, however, that the Hull Corporation, with their free intercommunication with the company, are less likely to cause that wasteful competition which has been met with in other towns. There can be no need for a small subscriber to join both systems, and there is no opportunity for the practice of boycotting which unfortunately has prevailed in some other towns. The tariff adopted by the Corporation should be a remunerative one, and provide amply for capital charges and contingencies. It is as follows: Exclusive line, unlimited use for business premises, £6. 6s. per annum; second connection, £5. 15s. Special quotations for large users. Exclusive line, unlimited use £5 per annum for private houses. Exclusive line, toll-rate £3 per annum, and 1d. per outward call; all inward calls free. Extension instrument in the same building as exchange line, 20s. per annum. Desk sets, 5s. per annum extra.

The opening ceremony on Monday last was a most successful one. The guests assembled in the town hall, and then drove in cabs through some of the principal streets on their way to the exchange. There Mr. Councillor Brown, the chairman of the Telephone Committee, was presented by the Mayor with a golden key with which to open the door. Having entered the building, a similar gift was handed to the Mayoress to open the door of the switchroom. The working of the exchange was then explained by the consulting engineer to the Corporation, Mr. A. R. Bennett, and the whole of the equipment was open for inspection. Our description of this equipment is given above.

After returning to the town hall the guests were entertained by Mr. Brown, and the following toasts were proposed. The CHAIRMAN gave "The King," and then Mr. THORNTON-VARLEY proposed "Success to the Undertaking." He said he had no fear that the Hull Corporation would sustain any loss in consequence of the charge of six guineas for unlimited service. He based his views on the prices which elsewhere had proved remunerative. He did not think that competition, however severe, would be injurious to either party. In Glasgow, for instance, before the municipal system was introduced there were only 5,000 subscribers. To-day the municipal system had 12,000 subscribers, and with the National subscribers there was a total of 25,000. Then it must be remembered that in Glasgow there was no intercommunication, as there was in Hull, where anybody taking either service had the

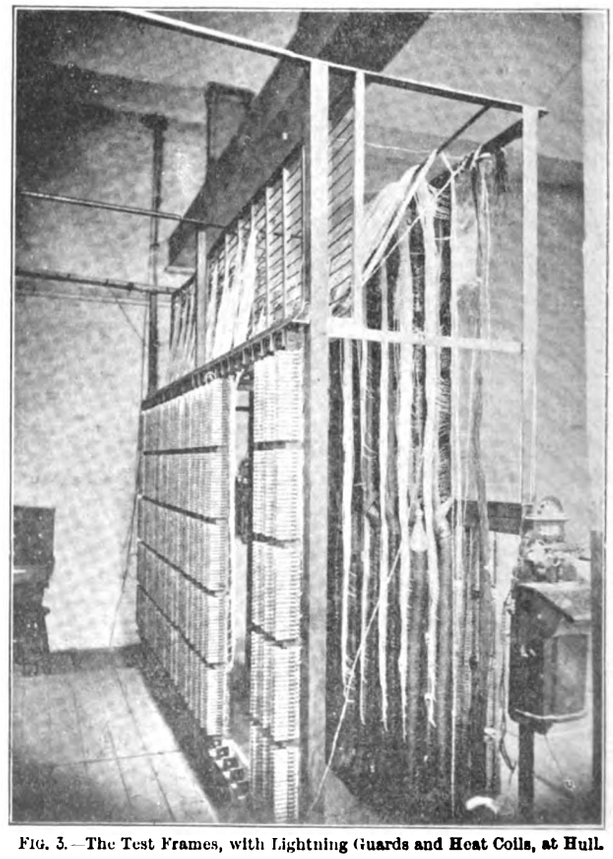

FIG. 3.—The Test Frames, with Lightning Guards and Heat Coils, at Hull.

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advantage of both. In Hull, too, the municipal system was a perfectly secret system. Directly a subscriber was put into communication with his correspondent nobody else could hear the conversation.

Mr. J. BROWN, the chairman, in reply, advocated the carrying out of telephone work by corporations because it was essentially a local service. According to their returns, with 2,000 calls per day 98½ per cent. were local calls, and only 1½ per cent. were trunk calls. The Corporation had the power to charge under their license anything from £5 to £10 for unlimited service. They had, after consideration, adopted the £6. 6s. rate, which he thought would be found high. It was better to start high and reduce than to have to increase after commencing with a low charge. Mr. Brown also recalled the struggles they had had with the National Company, both to secure better terms and to purchase the exchange in Hull. The price asked, however, for this was about three times that for which they could have put down a new system, and hence his committee could not recommend the Corporation to purchase. They had laid down plant for 2,000 subscribers, and had already 1,800 on their books. Three-fourths of these agreed to pay £6. 6s., and a number of private house connections at £5 had been obtained. They had no subscribers on the party-line system. The company also now offer a £5 service to private houses, and he would remind those who took advantage of this rate that the Corporation had practically saved them £5 per year. He understood that Edinburgh, Liverpool, and other large towns were asking for this lower rate for private houses under the agreement of the National Telephone Company, which enforces them to treat all large towns equally.

The SHERIFF then proposed "The Mayor and Corporation," to which toast the MAYOR replied, upholding the action of the Council in starting telephone competition.

Alderman HOLDER proposed the toast of "The Engineer and Contractors." He said that the contractors were unlike any others he had met with, in that they had completed their work three months in front of time Messrs. Henley's had laid down the mains in the streets, for which 19 miles of excavation were required, at the rate of one mile per week. The people of Hull thus had the advantage of a working system quite three months before contracts were expected to be completed. Alderman Holder also spoke of Mr. A. R. Bennett in very appreciative terms. Although much had been written and said against Mr. Bennett personally and against his skill as a telephone engineer, they at Hull had every confidence in him as their consulting engineer from the first, and this confidence was justified by the work being carried out at considerably under estimated prices. They had also in their secret system a better telephone system than was estimated for in the first instance.

Mr. A. R. BENNETT, in reply, thanked Mr. Holden and those present for their kindness, and gave credit to the local staff under Mr. T. Holme, and to the contractors for the successful completion of the work.

Mr. MCMILLAN, of the Ericsson Bell Company, replied on behalf of the contractors.

The proceedings terminated with a vote of thanks to Councillor Brown as host.

NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(Continued from page 727.)

For crane work series motors are usually installed, and as these must be reversible, a special form of switch is necessary. In order to obtain a movement in either direction the current must be reversed in either the armature or the fields, but not in both: it is usual to reverse the direction of the flow through the armature only, and insert the starting switch between the end of the field winding and the armature terminal. While a switch with metallic resistance is often used for crane work, it is more generally found that a liquid switch is used for this purpose. The reason for this appears to be on account of the majority of cranes being used in shipbuilding yards, foundries, engineering works, etc., where, owing to the rough usage which all the equipment may be subject to, the liquid switch is the one more frequently met with for every type of motor.

A very good type of liquid switch is the one now made by Messrs. Steel, Peech, and Tozer, Limited, and which is diagrammatically illustrated in Figs. 12, 13, 14. From these figures it will be noted that the main contact is made for the armature circuit between a central ring and either an inner and outer ring, the central ring being divided into

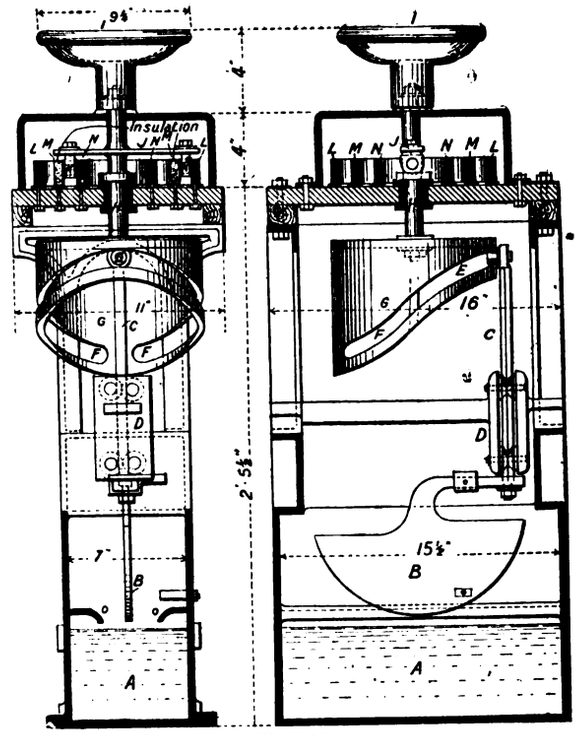

FIG. 12.

two portions so as to permit of a reverse motion being obtained. At the two points where the central ring is cut the space is filled up with an insulating material, and when the contact pieces are brought into this position the motor armature is entirely disconnected from the feeders. The motion of the contact pieces is controlled by a hand-wheel fixed to a vertical shaft; on this shaft is mounted a cylinder in which is cut a crescent-shaped groove in which works the roller fixed to the upper part of the guide rod of the resist-

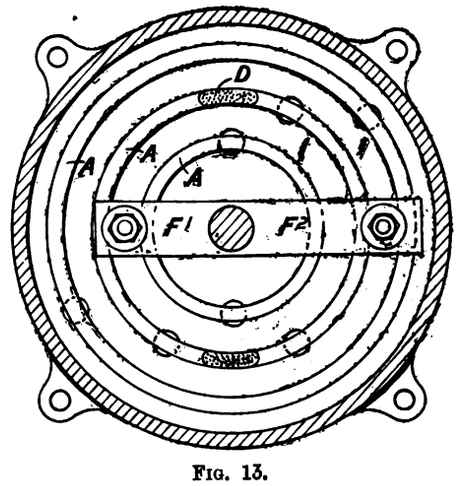

FIG. 13.

ance plate. The whole is so arranged that when the contact pieces are brought against the insulating piece of the middle ring the resistance plate is entirely out of the water, but as the contact pieces are moved in either direction the plate becomes immersed in the liquid. This arrangement is simple and effective, while at the same time it permits of a strong and well-protected switch being built suitable for withstanding the rough usage that switches too frequently receive in shipbuilding yards and engineering works generally. Up to the present this type of switch has only

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been made for operating series-wound motors, but there is nothing to prevent the switch being adapted for shunt or compound wound motors.

It is difficult to arrange a suitable automatic no-volt release in connection with a liquid switch, and the omission of this is the only fault that is apparent in the details of the above switch. This defect can only be overcome by inserting a no-volt circuit breaker in the motor leads; this naturally increases the cost, but greatly improves the installation, and the money so spent is well expended.

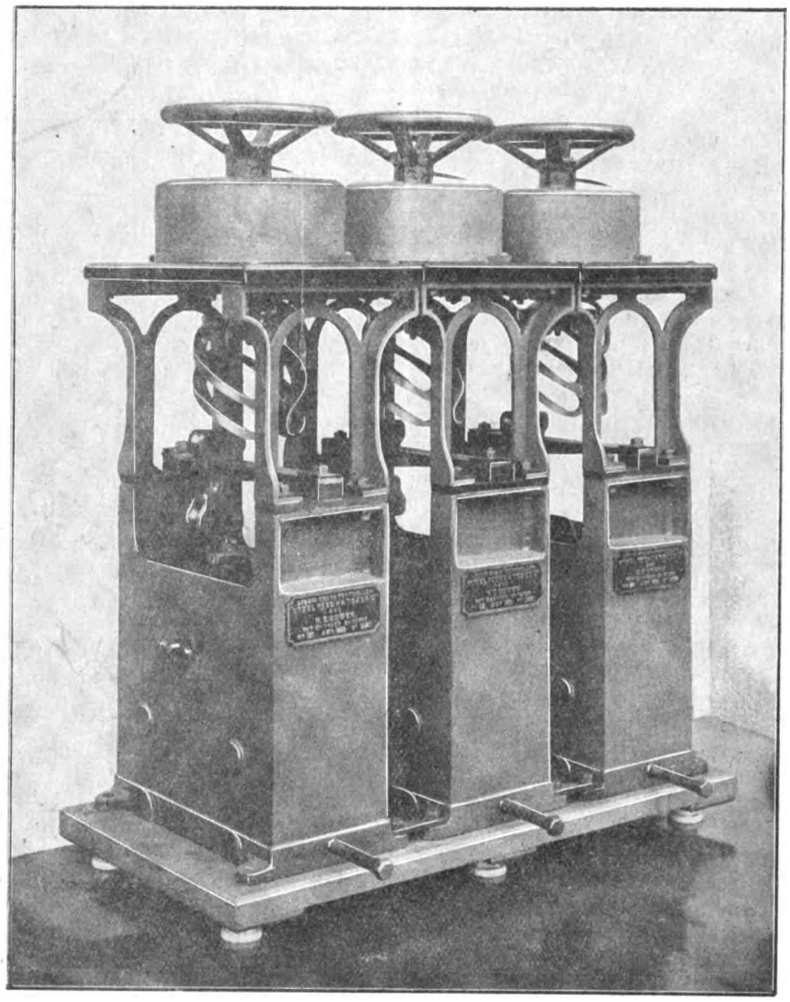

FIG. 14.

In dealing with the ordinary wire resistance starting switches, one of the points of greatest importance, whatever type of switch is used, is that of the durability of the resistance wire. If these short-circuit on themselves or to the frame, or if they burn out, continual trouble is experienced. The two points, then, that should receive the greatest attention with regard to the resistance wire are, first, the class of wire employed, and, secondly, the method of attachment. Innumerable materials, such as plain iron wire, galvanised iron, reostene, and other special alloys, have been employed by different makers, and it is difficult to say which metal has given the best results. Where the switches are to be fixed in a humid atmosphere, the iron wire rapidly rusts, and therefore in such cases it is advisable to use a metal, such as German silver, that does not oxidise rapidly; but when the switches are to be used in a dry atmosphere, the use of iron wire has been found to give very good results. It is generally considered that the object of the sand in which the wires are embedded in some makes of starting switches is to keep the resistance coils from short-circuiting either on themselves or on the frame. This is not, however, the case, and the real object

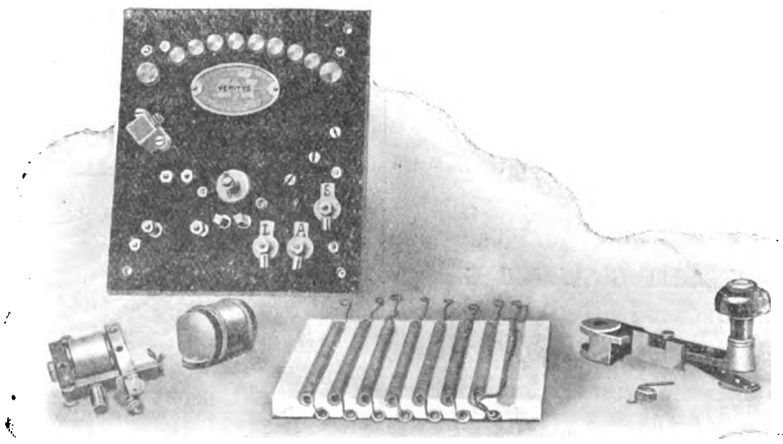

FIG. 15.

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of the sand is to absorb the heat generated in the wires. As a matter of fact, the sand affords little mechanical protection, as if there is any vibration the sand will give way, and also in the case of the wires tending to sag they will push the sand on one side. In Fig. 15 is illustrated a neat arrangement devised by Messrs. Veritys, Limited, to secure freedom from short-circuiting in their newer types of starting switches. It will be noted that the various coils are carried on the two sides of an independent fireproof support. This support is channelled out so that each coil lies in a separate groove, and is firmly held in its position. The firm claim that this method of construction provides perfect immunity from any chance of short-circuiting, while at the same time should any coil from any accidental cause break down it can be easily replaced, as there is not a single soldered joint used in the construction, but the various coils are fastened together by means of special connectors. The only other point that calls for attention is the fact that all the parts are removable from the front, and so can be replaced, if necessary, without taking the switch down from its position. The method of securing the coils, however, is good, and should give satisfactory results in practice.

To be continued.)

THE MEASUREMENT OF THE POTENTIAL OF THE ELECTRODES IN STATIONARY LIQUIDS. THE DETERMINATION OF CHANGES OF CONCENTRATION AT THE CATHODE DURING ELECTROLYSIS.*

BY HENRY J. S. SAND, PH.D., M.SC.

(Concluded from page 665.)

Alcoholic Solutions of Cuprous Chloride.

The next series of determinations was carried out with the object of testing whether the method was suitable for alcoholic solutions. The solution chosen was one of cuprous chloride in a mixture of hydrochloric acid, alcohol, and water, its composition being 1 grm. Cu_2Cl_2, 25 cubic centimetres strong hydrochloric acid, 45 cubic centimetres 95 per cent. alcohol, 30 cubic centimetres water. Owing to contact with the air, part of the cuprous chloride became oxidised to cupric chloride. The curves on Fig. 6 show the degree of coincidence obtained in successive experiments, three determinations having been carried out with the current density 1·054 $\frac{\text{milamps}}{\text{cm.}^2}$, and two with the current density 1·318 $\frac{\text{milamps.}}{\text{cm.}^2}$. The curves obtained are of interest, inasmuch as they show plainly that two successive processes take place: firstly, the reduction of the cupric chloride to cuprous chloride, which begins at potentials lower than those registered in the figure, and goes on to about 45 centivolts; and, secondly, the deposition of copper from the cuprous chloride beginning at about 45 centivolts and going on until the break in the curve is completed, when the potential becomes fairly constant at about 65 to 70 centivolts, and hydrogen comes off.

Acid Solutions of Nitrobenzene.

We now come to the discussion of curves obtained when the solution of an organic substance—namely, nitrobenzene—was reduced under varying conditions. Two solutions were experimented upon with different electrodes and current densities, other conditions remaining unchanged as nearly as possible. Stock solutions of accurately known composition were mixed in known proportion, the composition of the resulting liquids working out as follows:

1 litre acid solution used for experiments of Figs. 7, 8, 9, 10, contains	5 grm. nitrobenzene. 107 grm. H_2SO_4. 425 cc. ethylalcohol. Remainder water.
1 litre alkaline solution used for experiments of Fig. 11 contains	5 grm. nitrobenzene. 82 grm. NaOH 425 cc. ethylalcohol. Remainder water.

The anode for the experiments on acid solutions was, as as rule, one of copper in contact with a solution of 30 grm. cuprous chloride in 200 cubic centimetres strong hydrochloric acid and 100 cubic centimetres 95 per cent. alcohol. For the experiments on the alkaline solution the anode was mercury in contact with a solution of 100 grm. mercurous

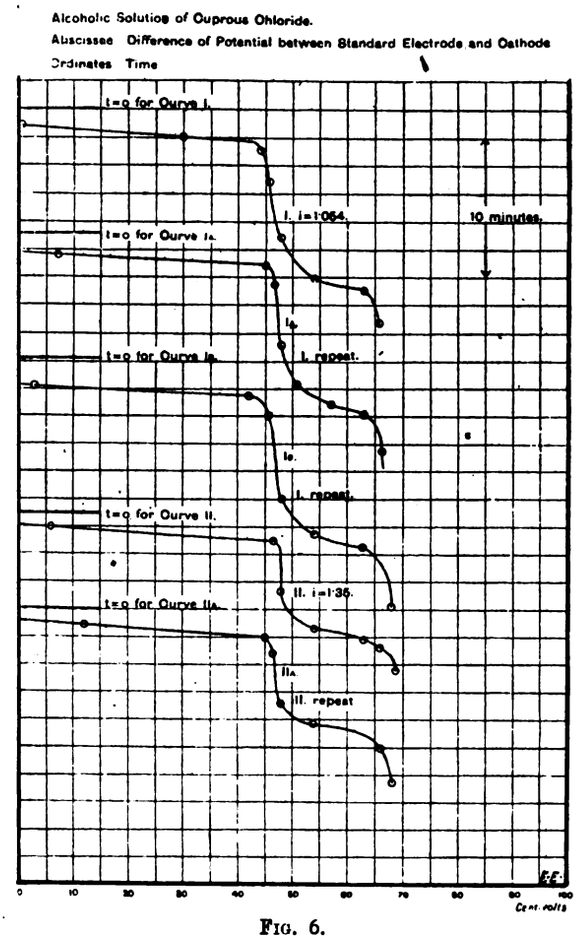

FIG. 6.

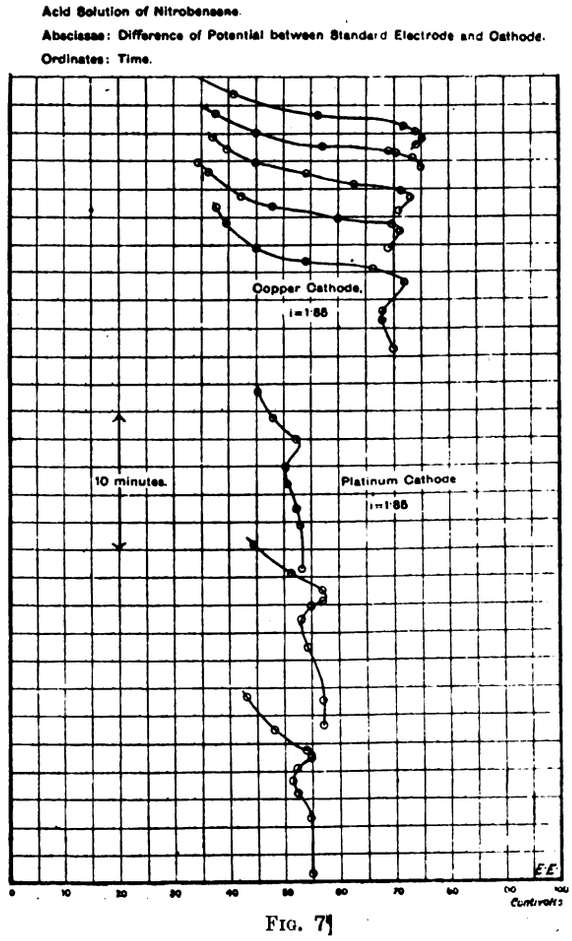

FIG. 7.

* Paper read before the Faraday Society, Oct. 25, 1904.

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nitrate and 35 cubic centimetres strong nitric acid in 500 cubic centimetres water, the solution interposed con-

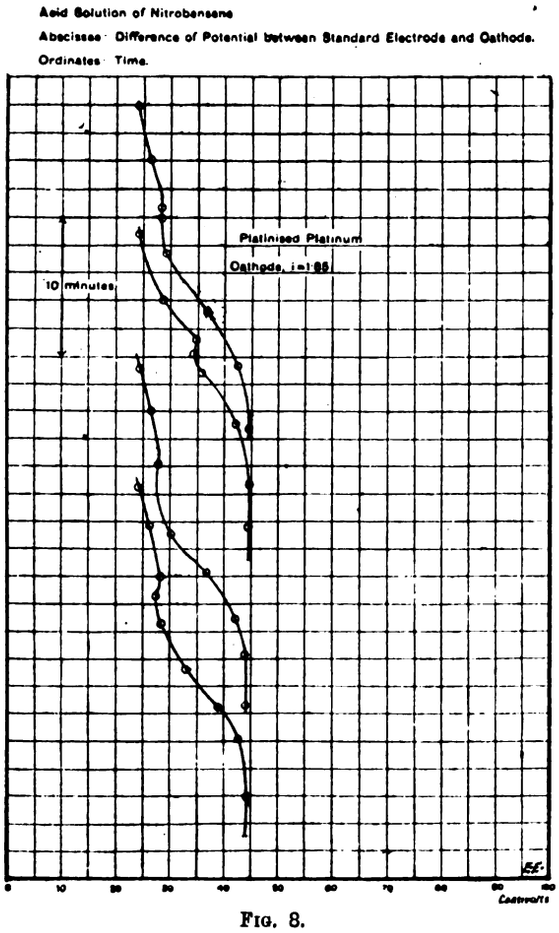

FIG. 8.

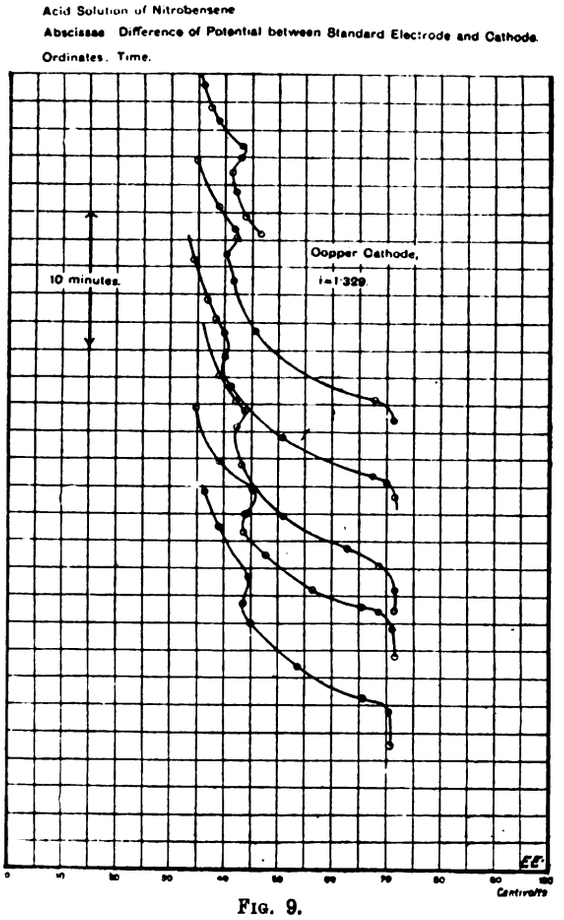

FIG. 9.

taining 125 grm. ammonium nitrate in 500 cubic centimetres.

The curves obtained show, firstly, the degree of coincidence yielded by a repetition of experiments, and, secondly, they exhibit both interesting similarities independent of the material of the electrode and characteristic differences due

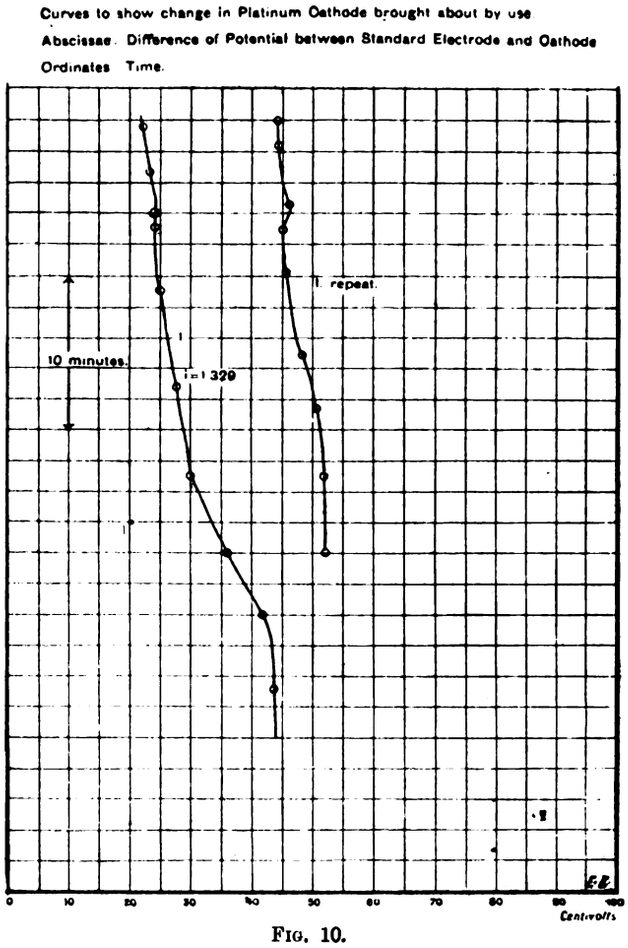

FIG. 10.

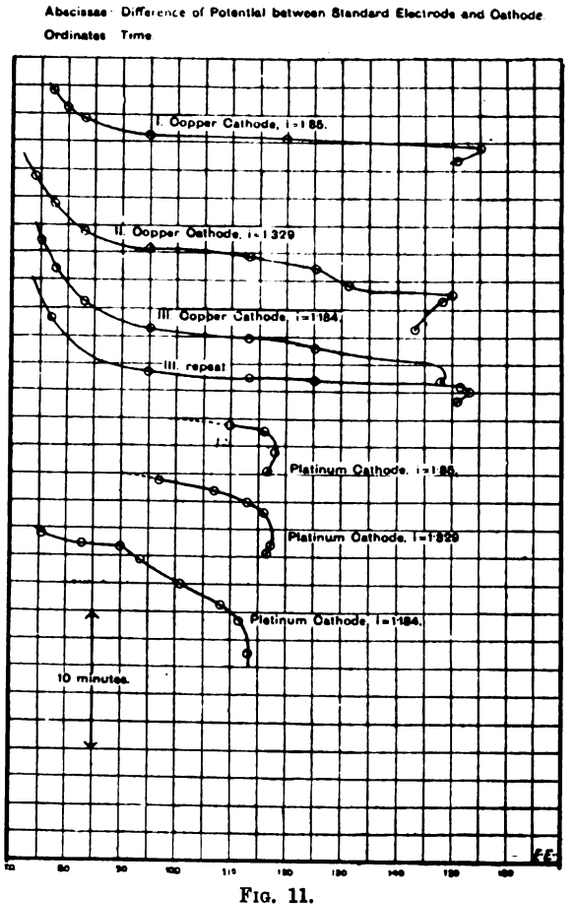

FIG. 11.

to it. The abscissæ again denote the experimentally found values of the potential of the standard electrode, the potential of the cathode being taken as zero. A small correction may be made for the difference of potential due

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to the resistance overcome by the current between the cathode and the junction, T, by taking the value 3½ ohms for this resistance in the case of the acid solution, and six ohms for the alkaline solution. All the curves representing the results of experiments on acid solutions exhibit first a rise of potential. After this it recedes, or becomes almost stationary, then increases once more, and finally becomes stationary again. Bubbles of hydrogen may now be observed on the cathode. It may, perhaps, be premature to attempt to explain definitely the first retrogression of potential in the curves. The most probable cause seems to be a temporary change in the nature of the electrode, resulting from electrolysis. Such changes have been recently shown to occur frequently by Russ, Luther, and Brislee, and others. As a rule, they tend to make cathodes more efficient—*i.e*, they enable them to accomplish reduction with the expenditure of a smaller amount of energy. The electrodes are also certainly permanently changed under certain conditions in such a manner that they become less efficient. This is very notable with the cathode of smooth platinum when small current densities are employed. If an electrode is used which has been freshly cleaned with ligroïn, boiling strong nitric acid, and boiling caustic soda solution, the potential of the standard electrode shows a comparatively low value throughout the experiment, the results being similar to those obtained with a cathode of platinum coated with platinum black. On repetition the cathode is, however, found to have become less efficient, the potential being considerably higher than in the first experiment. Further repetitions yield curves almost identical with the second, the potential, however, still becoming slightly higher. When the cathode is cleaned after this, as before the first experiment, it again yields a curve similar to the first. In Fig. 10 the first curve and one of its repetitions are shown.

Fig. 7 illustrates results obtained with a copper and a platinum cathode respectively. The experiments with the copper cathode were stopped after the first retrogression of potential. It will be seen that the latter occurs approximately at the same time in the experiments with the copper as in those with the platinum electrode. The difference between the actual values of the potentials is, however, very marked, the standard electrode at the beginning of the copper experiments showing a lower value than at the beginning of the platinum experiments. This corresponds to a greater efficiency—*i.e.*, a smaller expenditure of energy in the case of the copper than in that of the platinum electrode. In accordance, however, with the greater E.M.F. required for the liberation of hydrogen on a copper cathode than on one of platinum, the copper curves attain higher values of potential than the platinum curves at the end of the experiment. Fig. 9 represents experiments with a copper cathode carried out until evolution of hydrogen takes place. In Fig. 8 results are shown obtained with an electrode of platinum thickly coated with platinum black, the current density being the same as in the experiments of Fig. 7. The low values of the potential represent the most conspicuous feature of these experiments. As the electrode is not smooth, the time values are not comparable with those of Fig. 7.

Alkaline Solutions of Nitrobenzene.

Fig. 11 represents results obtained with the alkaline solution of nitrobenzene. As the solution at the cathode becomes heavier during electrolysis in an alkaline electrolyte, owing to an accumulation of alkali, the cathode was placed horizontally at the foot of the cell in these experiments (Fig. 2). At the points of maximum voltage hydrogen begins to be evolved. The differences between the experiments with copper and platinum electrodes are similar to those observed in acid solution. The time which elapses until hydrogen is evolved by a current of given density is considerably smaller than in acid solution. This points to the conclusion that the diffusion coefficient of nitrobenzene is considerably smaller in alkaline than in acid solution, and possibly also that the reduction does not proceed quite so far before hydrogen is evolved.

Example of Application of Results.

In conclusion, we have to show how experiments carried out according to the method described may be employed in order to arrive at an estimate whether results that have been obtained in electro-chemical investigations are due simply to concentration changes at the electrode that take place so rapidly that they cannot be neutralised by stirring, or whether they are really properties of the solution originally made up by the experimenter. As an example, we shall investigate whether concentration changes can have taken place during the experiments by Haber, referred to in the introduction, with sufficient rapidity to explain his results. We may approach such questions from two points of view. Firstly, we may make an arbitrary assumption regarding the time that must elapse until artificial stirring can completely renew the layer of liquid touching the electrode. For example, we might assume that such a renewal takes place completely after the lapse of one second, or of one minute, and then calculate what is the maximum change of concentration that can have taken place. Secondly, we may assume that owing to stirring the concentration of the electrolyte is always left unaltered at some definite distance, say $\frac{1}{10}$mm., from the electrode, and then calculate the maximum change of concentration that is conceivable on this assumption. Proceeding on the first plan we have the equation

$$C = C_0 - 2F\sqrt{\frac{t}{\pi k}} \quad . \quad . \quad . \quad . \quad (1)$$

in which C_0 is the original concentration of the substance electrolysed, C its concentration after the time t, k its diffusion coefficient, and F the amount removed by electrolysis at the electrode per unit of surface and time. From this equation we find the following value for the relative change of concentration at the electrode:

$$\frac{C_0 - C}{C_0} = \frac{2F}{C_0}\sqrt{\frac{t}{\pi k}} \quad . \quad . \quad . \quad . \quad (2)$$

Proceeding according to the second plan and indicating the distance from the electrode at which no change of concentration takes place by δ, we have the following relation according to Fick's diffusion law:

$$F = k\frac{C_0 - C}{\delta},$$

from which we obtain for the relative change of concentration at the electrode the value

$$\frac{C_0 - C}{C_0} = \frac{\delta F}{k C_0} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

When the current is employed solely for reduction we have

$$F = \frac{i}{96{,}540} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

concentrations being expressed in g.-equivalents or mg.-equivalents per cubic centimetre, and current densities in amperes per square centimetre or milliamperes per square centimetre respectively.

In order to eliminate k from these equations, we may calculate its value from the experiments we have described in the present paper. For this purpose we must assume that nitrobenzene has been completely removed from the electrode by reduction to azoxybenzene when hydrogen is evolved. We then find k by applying equations (1) and (4) to our experiments. We thus obtain

$$k = \left(\frac{2i'}{96{,}540\, C_0}\right)^2 \frac{t'}{\pi} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

quantities referring to our experiments being distinguished by dashes. The values for k derived from this equation are no doubt often vitiated by the fact that hydrogen may come off before complete reduction of the nitrobenzene has taken place, so that the values found for k are too small, and those for $\frac{C_0 - C}{C_0}$ too large. This does not matter seriously, however, as we only desire to find an upper limit for the latter quantity. Eliminating F and partly k from the equations (2), (3), (4), (5), we find the following relations:

$$\frac{C_0 - C}{C_0} = \frac{i}{i'}\frac{C_0}{C}\sqrt{\frac{t}{t'}} \quad . \quad . \quad . \quad . \quad (6)$$

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and $$\frac{C_0 - C}{C_0} = \frac{i}{96{,}540} \frac{\delta}{k C_0} \quad . \quad . \quad . \quad . \quad (7)$$

As an example, by which to test whether concentration changes played an important part in Haber's results, we take numbers from the paper recently published by him in conjunction with Russ. According to Table II., p. 279, when a current of density $\frac{4{\cdot}5}{1{\cdot}5 \times 10} \frac{\text{milamps.}}{\text{cm.}^2}$ was passed through a vigorously stirred alkaline solution of nitrobenzene of the concentration 0·8 $\frac{\text{mg.-equiv.}}{\text{cc.}}$, an absolute potential of 0·0737 volt was observed; whereas when the current had a density of $\frac{36}{1{\cdot}5 \times 10} \frac{\text{milamps.}}{\text{cm.}^2}$, the potential was 0·1171 volt, the difference being 0·0434 volt. Now, according to the Table VII*a*., when a current of the density $\frac{5}{1{\cdot}5 \times 10} \frac{\text{milamps.}}{\text{cm.}^2}$ was employed in a solution of the concentration 0·8 $\frac{\text{mg.-equiv.}}{\text{cc.}}$, the potential 0·0993 volt was recorded. In order to obtain a rise of potential of 0·0434 volt by reduction of the concentration of nitrobenzene, the current strength being left unchanged, we can infer by interpolation from numbers given in the same table that the concentration must be reduced to 0·115 $\frac{\text{mg.-equiv.}}{\text{cc.}}$—*i.e.*, to 14 per cent. of its former value. If the first experiments are to be explained as a result of local reduction of concentration at the cathode, such reduction must, therefore, amount to at least 86 per cent.

Now, in order to obtain an estimate of the magnitude of depletion at the cathode that actually took place, we refer to one of our experiments represented in Fig. 11. Taking, for example, Curve 4, we have $i' = 1{\cdot}184 \frac{\text{milamps}}{\text{cm.}^2}$ $t' = 460'$, $C'_0 = \frac{5 \times 3}{123} \frac{\text{mg.-equiv.}}{\text{cc.}}$. Employing equation (6), we find that if the liquid touching the cathode is renewed completely after every second by stirring, the lowering of concentration could never go below 1·4 per cent. I have shown formerly that under more unfavourable circumstances—viz., when the cathode was mercury contained in a cup—it is possible to prevent depletion, which would require 0·4 second if the liquid were stationary. It seems improbable, therefore, that the lowering of concentration in Haber's experiment went below the above value.

By employing equations (5) and (7) we find that if the concentration of the liquid be maintained continually at its original value by stirring at $\frac{1}{10}$mm. distance from the cathode, the utmost lowering that could take place would amount to 5¼ per cent. Brunner calculates the distance from the electrode to which he was able to keep the concentration unchanged in his experiments to have been $\frac{1}{80}$mm. to $\frac{1}{30}$mm., so that, adopting his values, we should conclude that the lowering of concentration did not amount to more than about 1½ per cent. Starting from other curves on Fig. 11, we obtain similar values. In any case the results show that we cannot assume changes of concentration amounting to 86 per cent. to have taken place in Haber's experiments, and that the variations of electrode potential with current density observed by him can therefore not be explained as the result of concentration changes at the cathode.

In carrying out the foregoing investigation the author has been assisted by grants from the Chemical and Royal Societies, for which he desires to express his indebtedness.

THE USE OF IRON IN ALTERNATE-CURRENT INSTRUMENTS.*

BY W. E. SUMPNER, D.SC., MEMBER.

It is probably no exaggeration to state that the amount of time, ingenuity, and skill devoted during the last 10 years to the improvement of alternate-current instruments has exceeded that spent in perfecting those for direct-current measurements during a period more than twice as long. Yet no one will maintain that the result is anything like so satisfactory in the former case as in the latter. It will, I hope, be interesting to spend some time this evening in considering the reasons for this, and what prospect there may be of a better result in the future.

The first idea that will no doubt occur is that alternate-current measurements are more complicated than those with steady currents, and that in consequence the tests are not likely to be so accurate. Now, I believe this view to be entirely wrong. Direct-current measurements, as the result of a development spreading over many years, are really much more numerous and varied, and are certainly quite as intricate in character as those practised in alternate-current working. It is not so much in the nature of the measurements to be made as in the character of the instruments available for the tests that the difference really lies. The result, I believe, is almost entirely due to the fact that for alternate currents there is no instrument at all comparable in sensitiveness with the galvanometers and voltmeters available for steady current work.

Now, perhaps this idea, though familiar to some, will take others by surprise. But if we proceed to consider how much all good direct-current tests depend upon sensitive galvanometers or voltmeters, we shall, I think, most of us be surprised. Take the three fundamental cases of the Wheatstone bridge, the potentiometer, and the voltameter. In each of these instances the accuracy of the test is directly dependent on the use of a delicate voltmeter to adjust to equality two voltages. In the first case the adjustment is made in order to measure a resistance in terms of a standard. In the second, by means of known resistances, a current or voltage is measured in terms of these resistances and the E.M.F. of a standard cell. In the third case, in which, say, a current balance is being standardised, although the voltameter measurement does not need a voltmeter, the adjustment of the current to a constant value is directly dependent on the use of such an instrument, and this adjustment is just as essential to accuracy as the correct measurement of the amount of chemical action. Measurements of insulation, magnetic induction, and capacity would hardly be possible without delicate galvanometers. Indeed, the sensitive voltmeter seems the one common essential to all accurate electrical testing.

It is of little practical use to speculate as to what would have been the progress of pure and applied electrical science if such instruments had not been available for direct-current testing. But it is hardly possible to overstate the important part they have had in bringing about this progress, and everyone will admit that the precision possible in the design of electrical apparatus, whether for direct or alternate currents, is almost entirely due to accurate measurements made with them. Most of the tests needed in connection with alternate-current machinery are still carried out by direct-current methods.

It is, of course, to the use of permanently magnetised steel that direct-current instruments owe their great sensitiveness. Whether of the fixed-coil or moving-coil types galvanometers may be described as single-current instruments in which the deflecting force is proportional directly to the current or voltage applied. Unfortunately, all alternate-current instruments have the characteristics of the double-current type, in which the deflecting force is proportional to the square of the current or voltage. This is obviously true of dynamometers, current balances, wattmeters, phasemeters, and electrostatic instruments. It is also true of induction instruments, whether the current induces magnetism as in moving-iron instruments, or eddy currents, as in the more recent induction meters. Hot-wire instruments have the same characteristic, since the heating effect varies as the product of volts and amperes. Instruments in which the deflecting force varies as the square of the applied voltage cannot be made sensitive for minute voltages owing to the rapid diminution of the force as the voltage decreases, and this constitutes the main reason why alternate-current instruments cannot be made to indicate low voltages.

Hot-wire instruments are as yet the most suitable for

* Inaugural address of the Chairman, delivered before the Birmingham Local Section of the Institution of Electrical Engineers.

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measuring small alternating voltages. Commercial instruments can be obtained reading from one volt down to about one-tenth of a volt. Prof. Threlfall has described an instrument before this Institution capable of measuring one-hundredth of a volt, and Prof. Fleming has shown a somewhat similar instrument to the Physical Society of London. Mr. Duddell has recently made an instrument which may be described as a combination of a hot-wire voltmeter with the radiomicrometer of Prof. Boys, the heat from the wire causing a thermo-electric current in a delicately suspended electric circuit placed in the field of a strong permanent magnet. With such an instrument, using as pointer a reflected ray of light, with the scale at 1m. distance, it is possible to get a deflection of more than 1cm. per *microwatt* spent in the hot wire. But such instruments, and especially the last, are more fitted for laboratory and research purposes than for ordinary testing.

An instrument may be made sensitive either by weakening the control or by increasing the forces causing the deflection. The strength of the control is a fair measure of the suitability of the meter for ordinary commercial work, since the weaker the control the more tenderly must the instrument be used, and the more liable are its indications to be affected by extraneous influences. The true measure of the sensitiveness (except for research purposes) is, therefore, the turning moment exerted per unit of current or voltage applied. Now, it is generally stated that a galvanometer of the fixed-coil or Thomson type is more sensitive than the moving-coil form of instrument; but this is merely due to the fact that the control used can be made, and is made, much weaker in the former than in the latter case. With equally strong control the permanent magnet form of instrument is much the more sensitive of the two, owing to the strength of the field applied to the coil conveying the current to be measured. In order to make alternate-current instruments as sensitive as the corresponding direct-current ones, strong magnetic fields must be produced. The permanent magnet is useless for alternate-current work unless satisfactory instruments of the vibration type can be devised, but the electromagnet, the most powerful form of magnet, still remains a possibility. Electromagnets are not used in galvanometers because existing instruments are sufficiently responsive, and thus only when extreme sensitiveness is needed—as, for instance, in the oscillograph—is anyone willing to put up with the inconvenience of supplying a subsidiary magnetising current and maintaining it of constant strength. The problem of producing sensitive alternate-current instruments resolves itself, therefore, into an enquiry into the conditions under which iron-cored electromagnets may be introduced into such instruments without involving errors due to differences of phase, frequency, wave-form, and other disturbing factors.

As an example of the need for more sensitive alternate-current instruments, I may instance the important problem of directly measuring an alternate current, or voltage, in terms of direct-current standards, such as a known resistance, and the E.M.F. of a standard cell. As yet the only standards available for alternate-current work are of a secondary character, and consist of expensively constructed instruments which have been standardised by direct-current measurements. Some years ago I tried to find a means of using the Crompton potentiometer for the direct measurement of an alternate-current voltage in terms of a standard cell. I soon saw how this could theoretically be done, but I have not succeeded in making or in finding an instrument sensitive enough to satisfactorily carry out the test. It may, however, be interesting, in connection with our subject to-night, to state the method. The problem consists in accurately balancing two voltages each of the order of a volt, the one produced by a steady current and the other by an alternating one. The current or voltage to be measured, whether direct or alternating, can be easily made to produce such voltages with the aid of shunts, or subdivided resistances, in the way commonly used with potentiometers. The direct voltage, D, is produced by the potentiometer, is adjustable by means of the sliding contact, and is accurately known. The alternating voltage should consist of two portions, A_1 and A_2, in series. The ratios of A_1 and A_2 to each other, and to the current or voltage to be tested, are supposed to be accurately known from the shunts or resistances employed. If now one of the terminals of the voltage D be connected to the junction of A_1 and A_2; if a voltmeter of the dynamometer type have its terminals connected to the extremities of the voltages A_1 and A_2; and if the free extremity of D be connected with the junction between the fixed and moving coils of the dynamometer, it will be seen that the voltages on the dynamometer coils are respectively $D + A$ and $D - A_2$.

Thus in Fig. 1 O is the middle terminal, and P Q the extreme terminals of the alternating voltage, $A_1 + A_2$. The direct voltage, D, is connected with the points O and R. The dynamometer coils, *c c*, are joined through suitable non-inductive resistances to the points P R and Q R. Under these circumstances the turning moment exerted on the moving coil is proportional to the product $(D + A_1)(D - A_2)$. This is true for any instant, and thus must be true for the mean. Since D is constant, A_1 and A_2 are alternating quantities, and $A_2 = k A_1$, where k is some known constant, it will be seen that the mean product is $D^2 - k A^2$, where A^2 is the mean value of A_1^2. The instrument, if sufficiently sensitive, will only give zero deflection when $D^2 = k A^2$, or, supposing $k = 1$, when $A = D$. This means that the alternating voltage, A, is measured directly

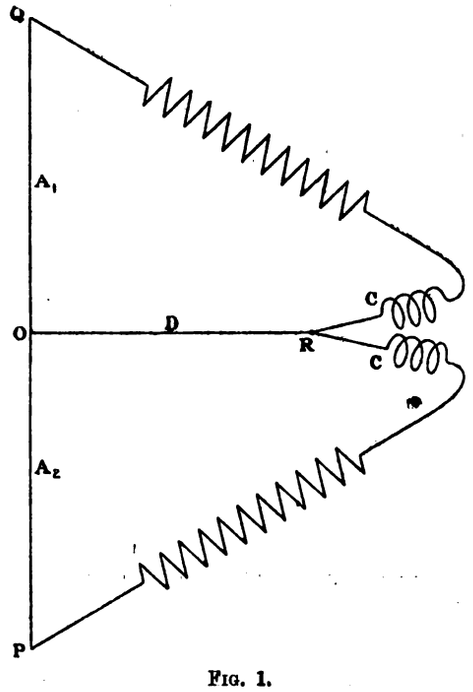

FIG. 1.

in terms of the standard cell, in a manner quite independent of frequency or wave-form. But the method, though perfect in theory, is impracticable, as is also the analogous method represented by interchanging the letters A and D in Fig. 1, in which case the direct-current voltage, D, is sub-divided instead of the alternating one. An instrument of sufficient sensitiveness could only be made by weakening the control to an extent rendering it unsuitable for common use, and the method only appears to be applicable by establishing a subsidiary voltage D, much greater than a volt, balancing it against the unknown alternating voltage, and measuring it immediately afterwards by the potentiometer in the ordinary way. Nevertheless, the mere invention of a sensitive dynamometer voltmeter would at once render the Crompton potentiometer, as now made, as suitable for the measurement of alternating currents and voltages as of the corresponding direct-current quantities for which it is so useful.

Now, before discussing how to use iron in alternating-current instruments, it must first be stated that this is already done in many cases, as in moving-iron indicators and in instruments of the eddy-current type. The latter now form an important class, and are either of the shielded pole type, the outcome of some pioneer experiments of Elihu Thomson, or of the rotary field type due originally to Ferraris. The rotating field instruments are particularly useful. They have the great advantage that the geometrical

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relations of the fixed and moving parts are not changed as the disc or cylinder turns, so that the indicating instruments possess regularly divided scales, and a range of deflection extending to nearly 360deg. Such instruments have many undoubted merits, but their calibration varies with frequency, and to a slight extent with wave-form. The wattmeters of this class are, indeed, not much more than good indicators. They are not the less useful on that account. They fulfil all the requirements of central-station use, but for accurate measurement something more is needed.

The first instrument to which I wish to direct your attention is the phasemeter, or power-factor indicator. These instruments may be made for either single or multiphase circuits. In the former case the calibration depends somewhat on the frequency, but only very slightly so in the latter. All such instruments consist of a fixed and moving set of coils, having a common diameter about which the moving system turns. The moving system is quite free to revolve. There is no control except that due to the interaction of the currents. Each system may comprise more than one coil, but as a rule the fixed system consists of a single coil through which the current passes, while the movable system consists of two coils inclined at some fixed angle to each other, and traversed by currents in different phases, obtained usually by tapping the multiphase mains, but, in the case of single-phase circuits, by providing two paths of different inductive properties for the pressure currents needed for the coils.

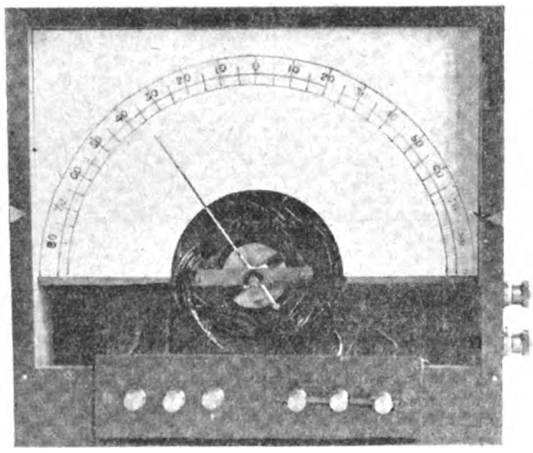

FIG. 2.—Phasemeter, or Power-Factor Indicator.

Now, in the theory of these instruments as hitherto given, the action of the current in the fixed coil on that of each of the moving coils is separately considered. Two moments are exerted, one on each moving coil, and the position of balance indicated by the pointer is such that these moments are equal and opposite. This position is independent of the amperes, or volts, since alteration in either of these equally affects the two moments, so that if these moments are balanced for, say, 20 amperes, they are equally balanced for 30 amperes. The position of balance can, therefore, only depend upon the phase differences between volts and amperes, and hence the deflection of the pointer can be calibrated to indicate phase.

But there is another way of looking at the action which is useful to consider, and which I think has not been previously noticed. The two-coil system traversed by currents in different phase produces a rotating field, and the interaction between this and the alternating (or rotating) field due to the current (or currents) in the other system of coils must be such that there is only one stable position of the moving system of coils for which the torque vanishes, and this position can only depend upon the phase differences involved in the two systems of currents. This is illustrated in rotary synchronisers such as that of Everett Edgcumbe, the rotor and stator of which are each wound so as to produce a rotating field by splitting a single-phase current into an inductive and a non-inductive branch. If two generators are joined up, one to the rotor and the other to the stator, the rotor revolves rapidly if the frequencies are different, but as these approach equality the rotation is slow, clockwise if one machine leads, counter clockwise if it lags; the position of the pointer indicates at each moment the phase difference of the two currents. If the two machines are coupled together so as to generate voltages in fixed phase relation, the pointer attached to the synchroniser takes up a fixed position in correspondence with this phase. The instrument thus becomes a phasemeter, and can be calibrated as such, but in its present form it is not suitable as a power-factor indicator.

Now, imagine a coil traversed by an alternating current placed in a rotating magnetic field of the same frequency, and free to turn about the axis of rotation of this field. The position taken up by the coil depends merely upon the phase of the current through the coil. If we assume uniformly revolving fields, and currents varying according to the sine law, the position will be such that at the instant the rotating field is parallel to the coil, the current in the latter is passing through its zero value. The angular deflection of the pointer from some fixed point on the scale measured in degrees, will be an exact measure of the phase of the current. If the currents are of irregular wave-form, and the rotating field is not uniform, this will not be precisely the case (see appendix), but there will in all cases be a fixed position of the coil for each phase, independent of the magnitudes of the currents in the different coils, and quite independent of the frequency, since this will affect currents and fields alike. The most efficient way of producing strong rotating fields is, of course, well known. It is exemplified in every induction motor. But it does not appear to have been noticed hitherto that phasemeters really act by means of rotating fields, and hence the means

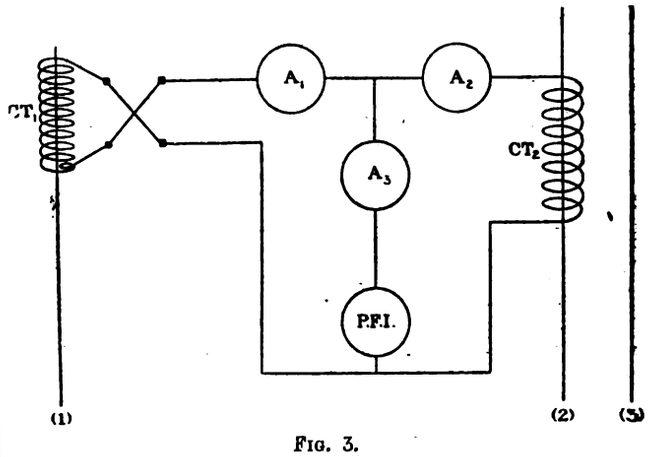

FIG. 3.

adopted in practice for producing such fields in commercial instruments are anything but the best available.

To illustrate this and other points I have had some instruments constructed in the technical school workshops, all designed for strong alternating magnetic fields. The first is the phasemeter illustrated in Fig. 2. The fixed coils are wound through circular ring stampings, just as in the stator of a three-phase motor. There are three coils, each of eight turns, wound with wire suitable for five or six amperes, with each coil brought to a separate pair of terminals. The portion corresponding with the rotor consists of a cylindrical block of circular stampings held in a fixed central position, and unwound. In the air-gap between the two is placed a pivoted coil similar to those used on moving-coil galvanometers, or voltmeters, but without control. It is capable of free motion about the axis of the instrument, and its position is indicated on the scale by an attached pointer. I have arranged some experiments which I think will convince you that this instrument is a very satisfactory indicator of phase or power factor. The position taken up by the pointer is quite definite under any given circumstances, and if the coil is moved out of its equilibrium position the forces tending to make it return are considerable, in spite of the fact that a very large non-inductive resistance is used in series with the pressure coil. This is only what is to be expected, since the strength of the field due to the fixed coils is about equal to that usual in permanent magnet direct-current instruments. Here, at all events, is one alternating-current instrument in which strong fields are employed without any of the disadvantages and errors supposed to be associated with the use of

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iron under such circumstances. Of course it would be possible to wind the fixed coils for pressure instead of current, either for direct connection to the mains or, if necessary, for the secondary of a step-down transformer. In many cases the moving coil would be put in series with the secondary of a current transformer. It is usual now with high-tension mains to have two current transformers, each primary being placed in one of the mains, and each secondary circuit, after passing through an ammeter, returning through a path common to both secondary circuits, and in which an ammeter and power-factor indicator are placed. The connections are shown diagrammatically in Fig. 3, in which A_1, A_2 A_3 represent the ammeters, (1), (2), and (3) indicate the mains, in the first two of which the primaries of the current transformers, C T_1 and C T_2, are placed, and the power-factor indicator is represented by P F I. Owing to the vector properties of alternating currents, if the current transformers are alike, the current measured by the ammeter A_3 will indicate the current in the third main, as shown by the vector diagram in Fig. 4. With such an arrangement it would be advantageous to use a reversing switch (short-circuiting during reversal) on the secondary of one of the transformers, say C T_1, as indicated in Fig. 3. By reversing this switch A_2 is unaltered, A_1 becomes A^1, equal but opposite in phase to A_1, and A_3 becomes A_3', about 70 per cent. greater than A_3 in magnitude, and strictly in quadrature with it, whatever the wave-form may be, provided only A_1 and A_2 are equal in magnitude. These relations are shown in the vector diagram (Fig. 4), in which, owing

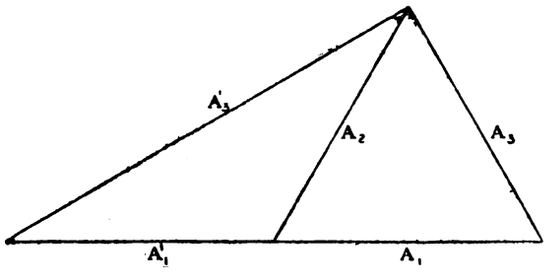

FIG. 4.

to the properties of a right-angled triangle A'_3 is perpendicular to A_3 if A_1, A_1', and A_2 are equal to each other, whatever may be the phase difference between A_1 and A_2 The advantage of this device arises from the fact that the power-factor indicator can be made to read on circuits of low power factor as well as on those of high power factor. As a rule, these instruments are calibrated between power factors 0·5 and 1·0, and are not available for low power-factor circuits. By using the reversing switch, the phase of the current passing through the instrument can be altered by 90 electrical degrees, so that the position corresponding with unity power factor is made to denote zero power factor, and by means of an additional calibration of the scale low power factors can be measured. If satisfactory power-factor indicators can be constructed, they will prove more serviceable than wattmeters on highly inductive circuits, since the latter instruments under such conditions are liable to large percentage errors, and their indications are low down on the scale.

(To be continued.)

PARLIAMENTARY POWERS.

The following additional applications for electric lighting provisional orders, tramway Bills, and other parliamentary powers are now being advertised in the *London Gazette* and elsewhere.

TRAMWAY AND LIGHT RAILWAY POWERS.

East Sussex Light Railway Company (extension of time); Bath Electric Tramways, Limited (light railways extension); Portmadoc, Beddgelert, and South Snowdon Railway Company (reconstruction and maintenance of light railways); Pudsey Corporation Tramways (construction of tramways); Bideford, Clovelly, and Hartland Light Railways (to incorporate a company); Colchester Corporation; Southampton Corporation; Tyneside Tramways and Tramroads Company; Leeds Corporation Tramways; Swansea Tramways Company; Hastings Tramways Company; Metropolitan Electric Tramways (Limited) Company (electrical powers); London Southern Tramways Company; Keighley Corporation Tramways; Tarporley and Mouldsworth Light Railways Company (construction of railway); Buenos Ayres Grand National Tramways Company, Limited (provisions as to amalgamation of company); Mexborough and Swinton Tramways Company (extension of time); Knutsford and Warrington Light Railway Company (construction and maintenance of light railways); Tanat Valley Light Railway Company (additional capital); Maidstone Corporation Light Railways (extensions); Coventry Electric Tramways Company (extension of time).

ELECTRIC LIGHTING ORDERS AND OTHER SUPPLY POWERS.

Central Electric Supply Company, Limited (supply to adjoining districts, etc., and erection of a generating station); Dover Corporation (electric lighting extension); Wimborne Urban District Council (electric lighting by the Metropolitan Electric Supply Company); Gravesend (electric lighting extensions to Northfleet); Shropshire and Worcestershire Electric Power Company (to extend the area of supply etc.); City of London Electric Lighting Company, Limited (extension of powers); Woolwich Borough Council (supply of electricity); Morley Corporation (further powers for supply of electricity); Marlborough (supply of electrical energy for all purposes within the borough and urban district by the Marlborough Electric Supply Company, Limited); Whitwood Urban District Council (electricity supply); Burslem Corporation (electric lighting extension); Southend-on-Sea Corporation (electricity supply extensions, etc.); Metropolitan Pneumatic Dispatch Company (construction, etc., of tubes, cables, and generation of electric power); Croydon Rural District Council (electric lighting); Ludlow Borough Council (storage and supply of electricity); Tewkesbury Borough Council (electric lighting); London County Council (supply of electrical fittings); Ware Urban District Council (electric lighting); Dorchester (electric lighting), by the Dorchester and District Electric Supply Company, Limited; Administrative County of London and District Electric Power Company (further powers); St. Albans Rural District Council (electric lighting); Whitworth Urban District Council (electric lighting); Durham (supply of electrical energy within the Rural District Council), by the Durham Electrical Power Distribution Company, Limited; North Metropolitan Electric Power Supply Company (powers to lay mains); East London and Lower Thames Electric Power Company (for the purpose of establishing electric works and supplying electric energy); Hemsworth Rural District Council (electric lighting); Portland Rural District Council (electricity supply); Brockenhurst and Milton (supply of electrical energy).

FORTHCOMING EVENTS.

FRIDAY, DEC. 2.

Junior Institution of Engineers.—At 8 p.m., "Some Points of Interest in the Construction of Torpedo-Boats," by Mr. H. E. Yarrow.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "Midland Railway, West Riding Lines: The Construction of Contract No. 1," by Mr. R. T. McCallum.

SATURDAY, DEC. 3.

Institution of Junior Engineers.—Visit to the London Coliseum to inspect its features of engineering interest.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to the Corporation sub-stations.

MONDAY, DEC. 5.

Society of Engineers.—"Condensing Plant," by Mr. W. E. Storey.

TUESDAY, DEC. 6.

Institution of Civil Engineers.—At 8 p.m., further discussion on Mr. J. F. C. Snell's paper, "Distribution of Electrical Energy"; "On the Construction of a Concrete Railway Viaduct," by Mr. A. Wood-Hill and Mr. E. D. Pain.

WEDNESDAY, DEC. 7.

Society of Arts.—At 8 p.m., "The International Exhibition at St. Louis, U.S.A.," by Mr. W. F. Reid

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., "The Gordon Electric Light Installation at Paddington, 1884-1904," by Mr. M. G. Tweedie.

THURSDAY, DEC. 8.

Society of Arts.—At 4.30 p.m., "Burma," by Sir Frederic W. R. Fryer, late Lieutenant-Governor of Burma.

Institution of Electrical Engineers.—At 8 p.m., "Hydrodynamical and Electromagnetic Investigations regarding the Magnetic-Flux Distribution in Toothed-Core Armatures," by Prof. H. S. Hele-Shaw, A. Hay, and P. H. Powell (conclusion of discussion); "Studies in Magnetic Testing," by Mr. G. F. C. Searle.

Institution of Electrical Engineers (Students' Section).—At 2 p.m., visit to the Robertson Electric Lamp Works, Brook Green, Hammersmith, W.

FRIDAY, DEC. 9.

Electro-Harmonic Society.—At 8 p.m., smoking concert.

SATURDAY, DEC. 10.

Junior Institution of Engineers.—At 3 p.m., visit to the International Gas Exhibition at Earl's Court.

Corps of Electrical Engineers (R.V.)—At 7.30 p.m., annual mess dinner at Anderton's Hotel.

Glasgow Technical College.—At 7.30 p.m., "Electro-Metallurgy—Some Notes on its Present Position," by Mr. J. D. Mackenzie.

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TO CORRESPONDENTS.

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THE METRIC FALLACY.

Quite recently we directed attention to the work of the British Weights and Measures Association, whose object is "the defence, standardising, and simplifying of British weights and measures." Within the past few days we have received from America a volume of some two hundred and thirty pages discussing the metric fallacy. The battle is joined. The mantle of the late Sir Frederick Bramwell has not been placed upon the shoulders of a successor. He laughed to scorn the attempts made to foist the metric system compulsorily upon this country, and he maintained that on the whole the existing system of British weights and measures was superior to the much-belauded metric system; but he understood that any innovation was likely to succeed, because innovators are talkative, energetic, and hang together, while defenders are inclined to pooh-pooh the dangers of the situation. We confess to cynicism, and the glamour of the arguments of a hundred and one professors and students do not outweigh the experience of a score of successful practical men. The aim of the professor is simplification of calculation of set hypothetical questions, the aim of the practical man is simplification of work, and getting of business. Text-book questions and examination questions are one thing, practical questions are quite different. Enthusiastic supporters of the metric system have tabulated the countries on the earth's surface that accept that system, and have left those who read or heard their words to infer that in these countries than the metric system there was none other. As a matter of fact, there is *no* country upon the face of the earth that has adopted the metric system for all, and probably not for the majority of purposes, where a system is required—not even France, the birthplace of the suggestion. The author of the "Metric Fallacy" has these very pertinent or impertinent remarks, according as the reader thinks for himself or follows his leader, on the subject. He says: "Should the reader be surprised at the facts regarding the limited use of the metric system herein given, he should remember that *no proof of anything to the contrary has ever been offered* (the italics are his). Whenever the metric advocates have learned that a government has passed a law favourable to the system, they have straightway conveniently assumed that it has become the common system in trade and commerce. They have not enquired into the working of these laws, nor into their scope or nature. Their logic has been: 'Such a country has passed a metric system law, therefore the people of the country have dropped their old units and taken up the new. Their stories of the imposing numbers of hundreds of millions of people who use the system have no other basis than this They have simply added the figures for the population of those countries which have passed some kind of a metric law, including those in which the laws are simply permissive and those in which the system has been adopted for government purposes alone. If the facts which are given in these pages turn the case to ridicule, they have nothing to thank but their own credulous willingness to believe anything favourable to their system, and to their free use of their own imagination without regard to facts." In this country we have been deafened with the cry, "We lose trade because we don't compulsorily accept the metric system." By trade is meant external trade. Surely America is competing for this same external trade, and this is what the American author says: "I shall show that our foreign customers do not care one picayune whether we adopt it or not, and I shall prove it by a flood of evidence." And by all that is true he does show it. He proves up to the hilt, to all unbiassed people, that the

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statements usually made in regard to the metric system "have no foundation in fact, and no foundation of any kind except simple assumption combined with credulous willingness to believe anything whatever favourable to the system." He goes on to say, "With their system of weights and measures as a foundation, the English-speaking peoples have built up the greatest commercial and industrial structure the world has known. This system they are asked to abandon for the benefit of others at a cost that is beyond estimate, and for compensating advantages that to themselves are wholly trivial and imaginary." If these views of the American author—supported as they are by the new association at home we have referred to—are approximately correct, why is there an outcry for change? We believe it is really a psychological question. Once more the Latin races against the Anglo-Saxon; once more lightness, alertness, flexibility as against solidity and phlegmatism. The native Argentine or Chilian no more cared how his engine or railway gauge was measured than he cared for the man in the moon; but the metric supporter was there, and the system was adopted as any other system would have been adopted if put forward with the same *verve* and pertinacity. Where the Latin races have prevailed politically or otherwise we get the system, but of the forty-three countries which have in name accepted the system, none really uses it to the exclusion of all else—in fact, wherever you really examine a large part, if not the major part, of business is conducted on other systems, and the use of the metric system is largely confined to text-book literature and the hectoring lectures of the pure enthusiast. When a practical man adopts it, you may be sure that there are other underlying reasons for his course than general utility.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HACKNEY AND THE ELECTRIC LIGHT.—MAXIMUM DEMAND SYSTEM OF CHARGING.

SIR,—A large number of ratepayers seem to experience some difficulty in finding out for themselves the average price which they will have to pay for electrical energy under the maximum demand system. The charges are as follows:

For Lighting.—For any quantity of electrical energy used each quarter not exceeding the equivalent of one hour's supply per day at the maximum demand, 7d. per unit; for any quantity used each quarter beyond, 1d. per unit.

For Power, Heating, and Cooking.—For any quantity of electrical energy used each quarter not exceeding the equivalent of one hour's supply per day at the maximum demand, 3d. per unit; for any quantity used each quarter beyond, 1d. per unit.

Under this scale the average rates for the different periods of use will be as follows:

TABLE OF AVERAGE PRICES.

Hours of use of maximum demand per day.	Average price per unit — For lighting.	For power.
1 hour	7·00d.	3·00d.
2 hours	4·00d.	2·00d.
3 ,,	3·00d.	1·67d.
4 ,,	2·50d.	1·50d.
5 ,,	2·20d.	1·40d.
6 ,,	2·00d.	1·33d.
7 ,,	1·85d.	1·29d.
8 ,,	1·75d.	1·25d.
9 ,,	1·67d.	1·22d.
10 ,,	1·60d.	1·20d.
24 ,,	1·25d.	1·08d.

The following is a simple method by which intending consumers or present consumers of electrical energy can ascertain for themselves what is likely to be the average price per unit which they will have to pay for their supply.

For Intending Consumers.—If you are using gas, light up the greatest number of burners you ever have in use at one time, and by the meter ascertain carefully how many cubic feet of gas are consumed per hour. Divide the year's consumption expressed in cubic feet by this figure and by 365. The result will be the average number of hours of use of the maximum demand per day throughout the year. Then refer to the foregoing table of average prices, and opposite the number of hours in the first column you will find in the second column the average rate per unit for electricity for lighting, and the average rate for power, etc., in the third column. For example: Suppose that (1) the consumption of gas with the greatest number of lamps ordinarily used, all alight is 50 cubic feet in one hour; (2) the year's consumption of gas is 54,750 cubic feet. Then, 54,750 cubic feet divided by 50 = 1,095 hours of use of maximum demand during the year. Dividing this figure by 365 days, that being the average daily use of the maximum demand = three hours. And for three hours, the table of prices shows that the average price for electricity for lighting is 3d. per unit, and for power, etc., 1·67d. per unit.

For Present Consumers.—Switch on the greatest number of lamps you require to use at any one time and by the meter ascertain carefully how many units are used in one hour. Divide the year's consumption in units by this figure and by 365. The result is the average number of hours' use of the maximum demand per day. Then refer to the table of average prices, and opposite the number of hours in the first column you will find in the second column the average rate per unit for electricity for lighting and the average rate for power in the third column. Expressed arithematically, the average number of hours' use per day of the maximum demand equals the consumption in units per annum, divided by the combined factors of the number of units used per hour when maximum number of lamps are in use and the number of days in the year. For example: Suppose that the (1) number of lamps switched on = 30 of 16 c.p.; (2) units used in one hour = two units; (3) year's consumption of electricity = 2,920 units; then 2,920 divided by 2 = 1,460, which divided by 365 = four hours, that being the average daily use of the maximum demand; and, for four hours, the table of prices shows that the average price of electricity is 2½d. per unit for lighting and 1½d. per unit for power. If the maximum number of lamps in use varies from quarter to quarter, treat each quarter separately, using in the equations figures of consumption per quarter and 91 in place of 365.—Yours, etc.,

L. L. ROBINSON, Borough Electrical Engineer, Hackney.

THE PATRIOTISM OF BRER FOX.

"De beastesses down yonder," said Uncle Remus, "was wantin' a lot er perwishuns, en dey asked Brer Tarrypin ter buy fer dem, fer ter see dat dey wasn't cheated. W'en Brer Tarrypin come fer ter look into de matter, he find dat de perwishuns bought befo' fum Brer Rabbit was better den de perwishuns bought fum Brer Wolf. So Brer Tarrypin he advertise in de papers fer perwishuns sold by Brer Rabbit, en den he sot down en waited fer de replies.

"Bimeby Brer Fox come smellin' 'roun' Brer Rabbit's chimbley-corner.

"'Who dar?' sez Brer Rabbit, sezee.

"'Fren',' sez Brer Fox.

"'How you find yo'se'f deze days, Brer Fox?' sez Brer Rabbit, sezee.

"'Lounjun 'roun' en suffer'n,' sez Brer Fox, sezee.

"'W'at ail you, Brer Fox?' sez Brer Rabbit, sezee.

"'Lor'! Brer Rabbit, you dunner w'at trouble is,' sez Brer Fox, sezee. 'I wanter put in fer de perwishuns, en Brer Tarrypin sez I've got ter buy fum you,' sez Brer Fox, sezee.

"Now Brer Rabbit knew dat Brer Fox was mighty familious wid Brer Wolf en always bought fum him, so he lit a seegar and sez: 'I'm oblije' ter you, Brer Fox, fer de compliment, en I sympafise wid you. You look berry bad,' sez Brer Rabbit, sezee, 'en I should advise you fer ter go home en take ter yo' bed.'

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"'It aint so bad as dat,' say Brer Fox, sezee, 'but I s'pose I must buy yo' stuff.'

"'You needn't 'less you wanter,' sez Brer Rabbit, sezee.

"'I'll tell you w'at, Brer Rabbit,' sez Brer Fox, sezee. 'I know dat yo' perwishuns come fum Germany, but if yo'll gib me pref'renshul terms I'll buy fum you. But if you ain't gwineter, I'll go ter Brer Wolf.'

"Den Brer Rabbit up en tell Brer Fox how 'twuz, en he 'low'd, Brer Rabbit did, dat Brer Fox was de lowdownest w'atsizname w'at he ever run up wid. En Brer Rabbit tol' Brer Fox ter go ter his fren' Brer Wolf, en den he showed Brer Fox outer de front-po'ch.

"W'en Brer Fox got some way off he holler out: 'Brer Rabbit, yer'll hear er diz bizness befo' you've done, en I'll tell all de udder animils.'

"But Brer Rabbit he lay low. Den Brer Fox he went ter Brer Wolf en he sez, sezee: 'Brer Wolf, yer perwishuns ain't unlike Brer Rabbit's, en fer ol' fren'ship's sake I'll buy fum you dis once if yo'll gib me de ushul pref'renshul terms.'

"Brer Wolf 'low'd he do anythin' fer ter settle Brer Rabbit's hash, en Brer Fox think ter hisse'f dis looks mighty nice game. So den he lope off home, en he rubbed his han's thinkin' er how Brer Rabbit ud feel sick

"En Brer Rabbit he lay low. W'en de beastesses en Brer Tarrypin examine de offers, dey gave de order fer Mr. Tukkey Buzzard 'cose he'd give dem w'at dey ask for; en Brer Fox he done got nuffin 'cose he give dem w'at dey didn't want.

"W'en Brer Fox heerd er dat he kick up a monstus racket, en he fa'rly to' up de groun', he did, en he jump so high en so quick dat he mighty nigh snatch his own tail off. Den he tied a wet han'kerchief roun' his head, en thought fer two days. En bimeby he wrote ter de papers, en he sez, sezee: 'De action er de beastesses is impatriotic,' sezee. 'Dey give de order ter Mr. Tukkey Buzzard fer German perwishuns, en here am I tryin' fer ter improve de trade er de country,' sezee, 'en sacrificin' part er me profit. I call der doin's monstus bad, w'en me en de udder animils is payin' rates,' sezee, 'fer ter keep sech pesterin' people es Brer Rabbit outer de country. I sign mese'f "Patriotic Fox," sez Brer Fox, sezee.'

"Is that all?" asked the little boy.

"Well, no," replied Uncle Remus, "de udder animils thought Brer Fox was patriotic en mighty badly treated, but yo' see, sonny, dat his patriotism was jest worth de pref'renshul terms he got fum Brer Wolf."

[This correspondence seems to have gone far enough. Everyone has had his say, and except that the muddle of (1) architect specifying, (2) admitting that alternative tenders should not be out of court, (3) guardians accepting without examination of tenders by architect, be cleared up, the whole transaction remains in the category of peculiar methods of local dealing with professional men and tenders. ED., *E. E.*]

APPOINTMENTS VACANT.

Pupil in company's light and power station. See advertisement in last issue.

Senior Operator, Glasgow Telephone Department. Applications by Dec. 5. See advertisement iu last issue.

Engineering Apprentice, Gilbert Little and Sons, Limited, Smethwick. See advertisement in last issue.

Draughtsman, Electrical Department of the Admiralty. Applications by Dec. 5. See advertisement in last issue.

Switchboard Electrician, Glasgow Telephone Department. Applications by Dec. 5. See advertisement in last issue.

Tramways Manager, Newcastle Corporation. Proposed salary to commence at £700 per annum, and to be raised by £50 the following year, ultimately to reach £800.

Draughtsman (temporary), Swindon Corporation. Wages, 30s. per week. See advertisement.

Tramway Extension.—To-morrow (Saturday) the Metropolitan Electric Tramways, Limited, will open for public traffic another extension of their electric tramways. The new line, which is about five miles long and has double track throughout, runs from Cricklewood to Edgware. The electricity for working this line will be supplied from the large generating station of the North Metropolitan Electric Power Supply Company at Willesden.

THE CABLE ESTIMATING CLERK'S COMPLAINT.

A DIRGE IN ONE SPASM BUT MANY METRES.

Prologue.

Our lot is not a happy one;
Few are the days of bliss—
But nights of woe, till tenders go
We hardly ever miss.
When after full eight hours of work,
At half-past five or so,
Thinking of home and cheerful tome,
We slowly rise to go—
Alas! the evening's post brings in
A letter, short and clear;
From someone who, by all that's blue,
Has signed himself, with cheerful vim,
"Consulting Engineer."

Heaven bless the man, whose letter ran:
"Please work me out at once,
Five lighting schemes, in detail priced,
From the enclosèd plan.
The first for mains run overhead
On wooden poles stuck up in holes.
The second scheme aloft as well,
But poles of steel like Spencer's sell.
The third for cable armoured laid in earth.
The fourth a solid system: this I've heard
Is very good with troughs of wood,
For which I'd take your word.
The fifth for cables, covered o'er with lead
Drawn into conduits on a concrete bed.
And p'rhaps you also wouldn't mind
Quoting for various insulations,
Paper, rubber—any other kind
Used with electric lighting stations.
And if you wish for business with your firm,
Be sure your offers reach me by return."

And that is all from this dear man:
So after making a few choice remarks
And ordering in our tea and bed,
We ope the plan, and this we scan
To get some sort of information.
This plan, in size, I should surmise,
Is rather larger than a postage stamp—
No name of town, which you will own
Is rather vague; it may be Hague
Or Cairo, Chowbent or Boulogne;
Fez, Philippi, or Featherstone:
No streets are named, no scale is given:
It may be earth, it may be heaven;
The scale may be sixteen to seven,
Or ten to fifteen bar eleven:
One inch to mile, one mile to inch,
Perchance we'd guess it at a pinch.

We hate to be beaten by trifles like these,
We try every way up till our brain 'gins to freeze—
We *might* even guess the maximum load—
Or the streets where the "leets"
Will be wanted—or even the road
Where the station will stand;
Perhaps *there* near the river, or on this waste land,
Or anywhere, nowhere—O! let it be d——d.

So, being but mortal, we trot home to bed,
And next day to this man who is thick in the head
We write a nice letter of thanks for his plan,
And if he'll send on a few details omitted
We'll send in our tenders as quick as we can,
And do all his work with the greatest of pleasure;
In fact, it's a privilege and joy beyond measure.
And so on, and so on, etcetera, *ad lib.*—
(Let us hope we shall be forgiven the fib.)

* * * * *

Epilogue.

O Tempora!
O Mores!!
O Heck!!! DUPLICATOR.

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HYDRODYNAMICAL AND ELECTROMAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.*

BY PROF. H. S. HELE-SHAW, F.R.S., LL.D., ALFRED HAY, D.SC., AND P. H. POWELL, M.SC., M ENG

(*Concluded from page 792.*)

RESULTS OF BALLISTIC EXPERIMENTS.

The magnetic flux through the top, the middle, and the bottom of the tooth was determined for five different values

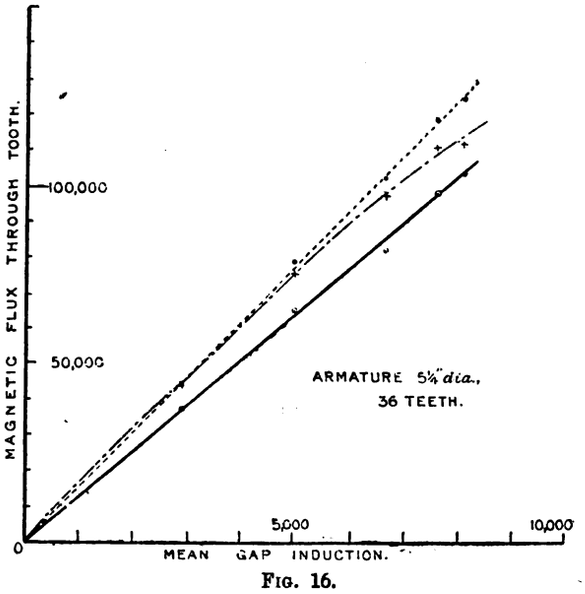

FIG. 16.

of the mean gap induction, ranging from about 3,000 to about 9,000 C.G.S. lines per square centimetre, for each of the five armature cores experimented upon. The results obtained are given in Table III., and are graphically exhibited in Figs. 16-20, the curves there shown having the mean gap induction for abscissæ and the magnetic fluxes through the various cross-sections of the tooth for ordinates. The full-line curve in each case refers to the total flux through the top of the tooth, the dotted curve to the flux

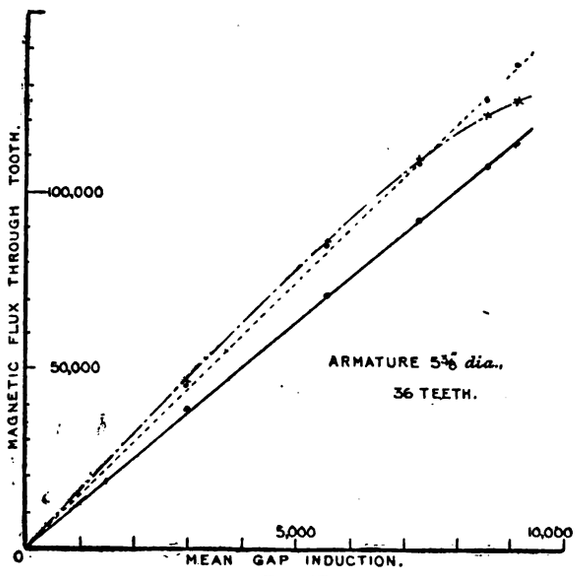

FIG. 17.

through the middle of the tooth, and the chain-dotted curve to the flux through the base of the tooth. The three readings marked with an asterisk in Table III. are open to some doubt, and are almost certainly too low; unfortunately, the core had been dismantled before the discrepancy was noticed, and the readings could not be repeated. A glance at the stream-line diagrams shows that the total flux through a cross-section of the tooth some distance below the surface of the armature is considerably greater than the flux through the top of the tooth. This is fully borne out by the ballistic measurements, which show clearly the steady increase in the magnetic flux as we proceed down

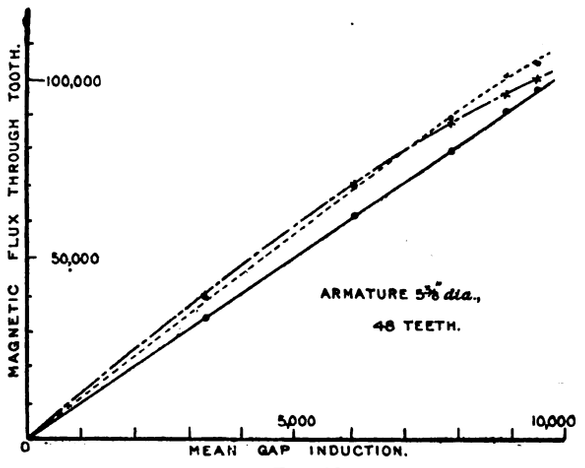

FIG. 18.

the tooth—so long, at any rate, as the induction at the base of the tooth does not exceed about 20,000. When the induction is pushed beyond this limit, another effect, not indicated by the stream-line diagrams (in which the permeability is constant), comes into play. The flux, after reaching a maximum value at a certain depth, begins to decrease, lines of induction leaving the flank of the tooth and crowding into the slot. This effect is very strongly

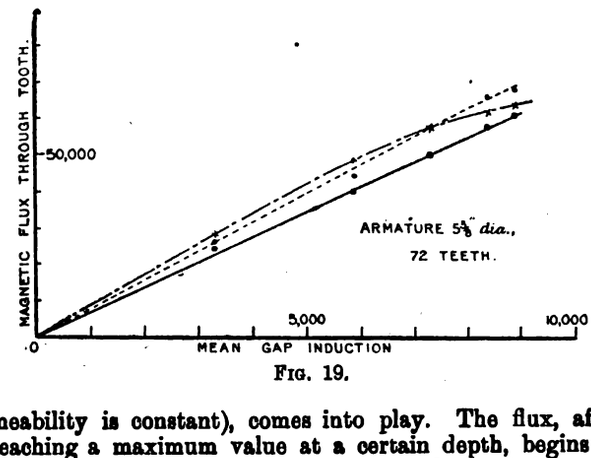

FIG. 19.

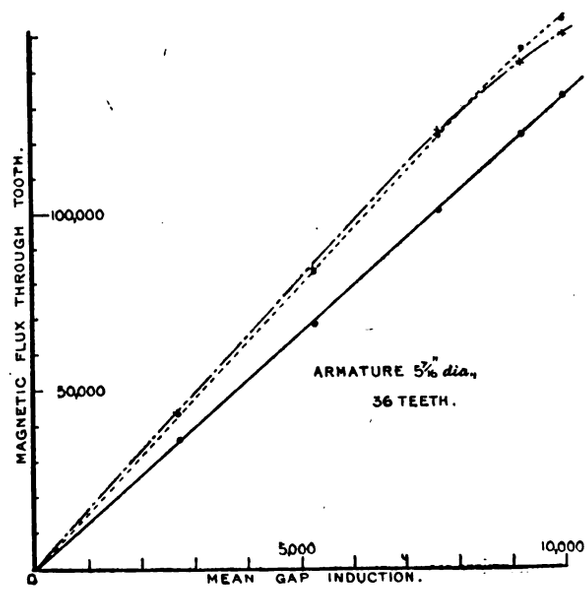

FIG. 20.

marked for all the higher values of the gap induction, and is indicated by the crossing of the curves in Figs. 16-20.

So long as the air-gap remains of constant length, and the ratio of width of slot to width of tooth is not materially altered, no appreciable change in the flux distribution along

* Paper read before the Institution of Electrical Engineers.

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a tooth is produced by varying the number of teeth—*i.e.*, the width of tooth. If, however, the air-gap is steadily increased, then, as an examination of Figs. 16-20 shows, the depth at which, for a given gap induction, the flux reaches a maximum value increases with increase of air-gap.

TABLE III.

—	Mean gap induction	Total magnetic flux. Top of tooth.	Middle of tooth.	Base of tooth	Magnetic induction Top of tooth	Middle of tooth	Base of tooth
Armature 5½in. in diameter, 36 teeth.	2,890	37 000	44,400	*43,800	4,790	7,040	8 570
	5,010	65,800	79,100	*75,900	8,520	12,600	14,850
	6,650	81,900	102,500	*97,400	10,600	16,300	19 060
	7,610	98,500	118 900	111,400	12,750	18,870	21,800
	8,110	103,200	125 000	112,300	13,370	19 850	21,980
Armature 5⅝in. in diameter, 36 teeth.	2,950	38,900	45 200	46,300	5,070	7,120	8,920
	5 540	71,200	84,600	86,000	9,280	13,400	16 600
	7,240	92 200	108 500	109,400	12,250	17,100	20,940
	8,550	107,800	126 400	121,800	14,060	19,900	23 500
	9,120	113,800	136 200	126,000	14,800	21,500	24,300
Armature 5⅝in. in diameter, 48 teeth.	3,290	33,200	35,100	39,600	5 350	7,440	8,700
	6,020	61,800	69,300	70,000	9,950	13.200	15 350
	7 860	79,900	89,500	87,600	12,800	17,000	19,200
	8,880	91,000	101,900	96,200	14,700	19 400	21,100
	9,440	97,500	105,400	101,000	15,700	20,000	22,140
Armature 5⅝in. in diameter, 72 teeth.	3,280	24,300	26,800	28 600	6,070	8 130	10,560
	5 810	40,300	44,900	46,000	10,080	13 600	17,000
	7,270	50,900	57,800	57,300	12,700	17,500	21,160
	8,380	58,400	66,200	62,300	14,600	20 100	23,000
	8,870	61,300	68,900	64,400	15,300	20,900	23,800
Armature 5⅞in. in diameter, 36 teeth.	2,680	36 100	43,400	43,500	4,280	6,020	7,450
	5,260	68,400	83,100	83,700	8,100	11,540	14,350
	7,630	100,700	122,000	122,700	11,900	16 950	21,000
	9 200	122,400	145,800	142,200	14 500	20,200	24,400
	10,000	133,300	154,100	150,200	15,800	21,400	25,700

For the range of gap induction used, the curves connecting the total flux through the top and middle cross-sections of the tooth with the mean air-gap induction are almost indistinguishable from straight lines, which necessarily pass through the origin. Such, however, is no longer the case for the curves relating to the base of the tooth, the initial portion only of which is straight. It is, of course, obvious that if it had been possible to push the induction far enough, the curves for the top and middle of the tooth would have commenced bending towards the horizontal axis in a manner similar to that of the curve for the base of the tooth—in fact, this tendency is clearly marked in the case of the dotted curves of Figs. 18 and 20.

CONCLUSION.

The experiments described in the present paper occupied the greater part of two years, and the expense of constructing the apparatus and photographing the stream-line slides was defrayed out of a research grant made by the Royal Society. We are indebted to Prof. E. W. Marchant, D.Sc., and several of his students for valuable assistance in connection with the somewhat laborious experiments which form the subject of our paper.

FROM AMSTERDAM TO ZANDVOORT BY LIGHT RAILWAY.

We have great pleasure in recording the successful completion by Messrs. J. G. White and Co., Limited, of a system of light railways between Amsterdam and Haarlem. Apart from the engineering difficulties which have attended the construction of this line, due to the treacherous nature of Holland's sandy soil, in conjunction with the Government's requirements as to the level of the track, the undertaking presents some interesting features. Altogether unusual facilities have, for instance, been provided by the Amsterdam municipality to enable the light railway company's cars to run right into the centre of the town. It was not a question of through running in the ordinary sense, because the gauge of the Corporation tramways differs from that adopted by the company, thus making a simple physical junction between the two systems impossible. The obvious way out of the difficulty was to lay a third rail over a section of the tramway track in Amsterdam, and this work was undertaken by the Corporation contemporaneously with the conversion of their whole system for electric traction. Outside Amsterdam the company's lines leave the public highway and proceed across sparsely-populated country to Haarlem, where a junction is made with the single-track light railway to Zandvoort, belonging to an associated company. Thus the residents of Amsterdam are placed within direct reach of a charming health resort on the open coast, about 17 miles distant. The success of the enterprise depends almost entirely upon the development of a large summer traffic. Assuming the average Dutchman to be as fond of a glimpse of the open sea as the average Englishman, there can be little doubt about this development. Even if a Dutchman's instinct does not turn him seaward, the reputed objectionable state of the Amsterdam canals during hot weather should certainly drive him. Perhaps a little judicious stirring of these canals might serve to stimulate a desire for fresh air when receipts are unsatisfactory. But apart from an estimate of returns on this basis, the undertaking has many points in its favour. First and foremost, it is a light railway in the fullest sense of the term—that is to say, it enjoys for the most part an exclusive right of way, thus making the maintenance of a high average speed not only legal but possible. Moreover, the track possesses very few curves, and is absolutely level throughout. We are indebted to Messrs. J. G. White and Co., Limited, for an opportunity to inspect the undertaking last week, when every facility was given us to see exactly how the work has been carried out. Here, it may be mentioned that the firm in question have been connected with the scheme as contractors and engineers for the whole. In regard to the generating plant installed, the best features of English practice have been introduced, notably in the case of the main engines, which are of the high-speed type by Belliss and Morcom. At the same time, the general design does not suggest an English scheme transferred to Holland. On the contrary, there is evidence of extreme care having been taken to adapt the scheme to local conditions, especially in regard to the track work and rolling-stock. We do not remember having ever travelled with greater comfort than on this railway, which fact speaks well for the capability of an English firm to do good work when given a free hand in a foreign country, especially as in this case the difficulties involved were exceptional.

Bearing in mind experience nearer home, our readers will not be surprised to learn that this promising undertaking is due to American enterprise, Messrs. J. G. White having acted as agents for an American syndicate in selecting the field for the venture. In addition to the land required for the permanent way, the company have acquired large tracts of adjoining country with a view to leasing the same in plots for building purposes as Amsterdam extends. So far as the capital invested is concerned, only the debenture stock is held in Holland.

In a subsequent issue we hope to give a full illustrated description of the undertaking, together with our impressions of some of the more interesting engineering features.

We may add here that, apart from its main object, our recent visit to Amsterdam will long remain to us as a pleasant episode—thanks chiefly to Mr. A. N. Connett and Mr. Murphy, of Messrs. J. G. White and Co., whose care for our creature comforts was unflagging. To these gentlemen we are greatly indebted for an instructive and, at the same time, extremely pleasant trip.

PERSONAL.

Mr. H. A Fleet has been appointed station superintendent to the Yorkshire Electric Power Company, and has resigned the corresponding position held by him at the power station of the Mersey Railway Company.

We understand that Mr. Harris, assistant engineer to the Edinburgh and District Tramways Company, Limited, has succeeded Mr. Colam as principal engineer.

Mr. J. R. W. Grainge, shift engineer at Battersea, has resigned.

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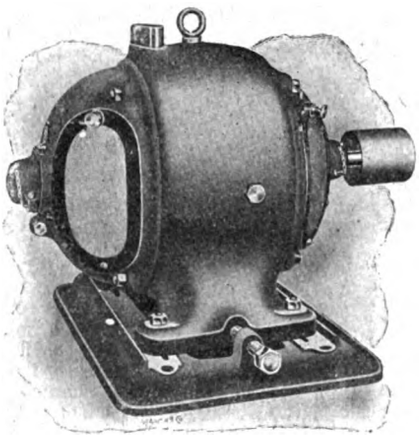
TRADE NOTICES AND NOVELTIES.

R. E. Type Motors.

The Rhodes Electrical Manufacturing Company, Limited, of 70 and 71, Bishopsgate-street Within, London, E.C., and Bradford, have just issued a new list of their R. E. type continuous-current motors, giving particulars of the output of the machines at different speeds, together with prices and approximate shipping measurements in a form convenient for reference.



These motors are made in standard sizes, ranging from ½ h.p. to 60 h.p., each size being listed for two voltages—namely, 230 volts and 460 volts. The accompanying illustration shows the general design of an R. E. type motor, fitted with new pattern end shields and perforated enclosing covers.

"Ediswan" Novelties.

The accompanying illustration (Fig. 1) shows a high-voltage switch plug, specially designed and introduced by the Edison and Swan United Electric Light Company, Limited, Queen-street, London, E.C., to meet the demand for a switch-controlled wall socket involving only one operation. This switch

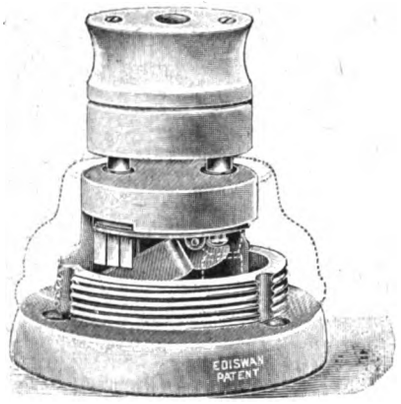


FIG. 1.—"Ediswan" H.V. Switch Plug.

plug consists essentially of a quick-break, double-contact switch, which is closed by the insertion of and opened by the withdrawal of the plug. The latter is made with a special shaped prong, which pushes over a cam on the switch spindle when

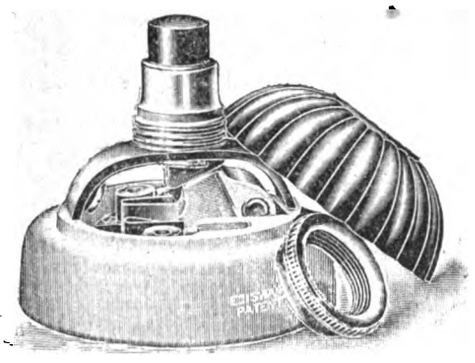


FIG. 2. "Ediswan" Button Switch.

making the circuit, and engages a detent on this cam when breaking the circuit, the action being entirely automatic. The circuit is only made when the plug is right home, hence there can be no live contacts on the socket.

Fig. 2 illustrates the "Ediswan" "button" switch, which marks a new departure in point switches. Hitherto the only switches working on this principle have required two separate pushes, one for closing and the other for opening the circuit. With the "button" switch, however, the cycle of operations is effected by means of a single push. Besides having all the good features of the well-known "wedge" tumbler switch, the movement of which it retains, the "button" switch, it is claimed, possesses the following among other additional advantages: independent break, freedom from liability to arc, better insulation of the operator from shock, and neater appearance, especially in regard to the patterns supplied for flush work.

Nernst Lamps.

The latest pamphlet issued by the Electrical Company, Limited, 121-125, Charing Cross-road, W.C., contains some interesting views of Nernst lamps installed by them in the Edinburgh Museum, Houses of Parliament, restaurants, railway stations, etc. In one very large establishment, we understand, no less than 10,000 of these lamps are in use. The latter portion of the pamphlet deals more particularly with the use of the lamps for street-lighting, views of the installations in Barnes, Maidstone, and Gravesend being given; while the last two pages are devoted to the Express and Multiple types, both of which have been illustrated in these columns.

Catalogues, etc., Received.

THE ELECTRICAL COMPANY, LIMITED, 121-125, Charing Cross-road, W.C.—Leaflet No. 99: cut-outs for high voltage, illustrated. Leaflet No. 100: casing and capping, illustrated. Leaflet No. 109: lampholders for Nernst lamps, illustrated.

POPLAR ELECTRICITY ACCOUNTS.

From the accounts of the Poplar electricity department for the year ended March 31, 1904, it appears that the total expenditure on capital account to that date amounted to £194,300, of which £2,493 had been repaid. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	8,119	17	8
Distribution of electricity	980	6	11
Attending and repairs to public lamps	2,079	17	7
Rents, rates, and taxes	998	6	10
Management expenses, salaries, etc.	2,338	1	10
Special charges, insurances, etc.	154	15	10
	14,671	6	8
Amount carried to net revenue account	10,787	5	11
	£25,458	12	7

Cr. Income.	£	s.	d.
By sale of current for lighting and power	15,727	5	4
Public lighting	2,931	14	9
Meter rents, test fees, etc.	499	13	6
	£25,458	12	7

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	185,454	9	9
Sundry creditors	6,998	6	3
Net revenue account	6,892	13	5
Cash due to bankers	5,054	7	4
	£204,399	16	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	191,807	6	1
Stores on hand	3,945	1	3
Sundry debtors for current supplied	7,843	8	5
Other debtors	797	14	5
Petty cash and postage	6	6	7
	£204,399	16	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		2,466,098
Quantity sold { Public lamps 678,840 / Private consumers by meter 1,527,557 }		2,206,397
Quantity used on works		170,229
Total quantity used		2,376,396
Units expended in distribution		89,702
Percentage of current used to generated		89·77
Total maximum supply demanded in 32-watt lamps		38,250

Number of public lamps: 320 arcs, 1,649 8-c.p. incandescents.

India.—The Secretary of State for India has sanctioned the creation of the post of electrical adviser to the Government of India.

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PHYSICAL SOCIETY.

At the meeting of the above society on Nov. 11, Dr. R. T. Glazebrooke, F.R.S., president, in the chair,

A paper on the "**Investigation of the Variations of Magnetic Hysteresis with Frequency,**" by **Prof. T. R. Lyle**, was read by Prof. Trouton. The experiments were made on two rings of laminated annealed iron, in one of which the radial breadth of the iron was considerable relative to its mean radius. These rings were magnetised by alternating currents of different strengths and periods. Both the magnetising-current wave and the magnetic-flux wave were quantitatively determined by a wave-tracer (described by the author in the *Phil. Mag.*, November, 1903), and the wave-forms so obtained subjected to harmonic analysis. The experiments were divided into series, in which the period and wave-form of the magnetising current were kept as nearly constant as possible throughout any one series, while its strength was varied. The analytic expressions for the associated current and flux waves for a few series are given in tabular form. From the analytic expressions for each pair of associated waves it was found that when the magnetising current was approximately sinusoidal, the total iron loss (I) was, within certain limits of the induction, given by a formula $I=(a+bn)B^{1\cdot67}$, where n is the number of periods per second, B the "effective induction," and a and b are constants. When from the total iron loss per cubic centimetre per cycle the sum of the statical hysteresis and the value that theory assigns to eddy-current loss was subtracted, a considerable quantity remained, which increased both when the frequency and the flux density increased. This quantity, called by Fleming the kinetic hysteresis, has been obtained for each experiment. An interesting case of transformation, and what is called refluxion of energy, is drawn attention to and discussed. If the E.M.F. impressed on the magnetising circuit on the iron ring be sinusoidal, the flux wave produced contains third, fifth, etc., harmonics. These higher flux harmonics induce currents in the magnetising circuit which are dissipated as heat in it. Thus we have a transformation of electrical energy due to alternating currents of frequency n to energy of currents whose frequencies are $3n$, $5n$, etc., which is reflected back into the magnetising circuit. This the author believes is a hitherto unnoticed source of transformer loss.

Dr. J. A. Fleming said the paper appeared to contain many points of interest. The result given by the author that the total iron losses varied as the 1·57 power of the induction density, agreed with practice. There was, however, no hard-and-fast law for the calculation of the iron losses, but the number 1·6 was useful as a guide. In many cases the loss varied according to an exponent considerably less than 1·6. He pointed out that this exponent was practically the same for all magnetic metals, and said it would be interesting to know if the law would be true in the case of a Ewing model of a magnet. The paper clearly showed that transformer losses should be determined by measuring the watts. The experimental determination of the statical hysteresis was not of practical importance; what was wanted was the real loss which varied with the frequency. We should be able to calculate the loss at any induction and frequency from the known loss at any particular induction and frequency.

Mr. A. Campbell drew attention to the work of an earlier investigator on the same subject. Max Wien, in a paper on "Magnetisation by Alternating Currents" (*Wied. Ann.* (13), August, 1898), gives results of an investigation on the change in flux density and hysteresis loss due to variation in frequency of the magnetising alternating current. His chief method of measurement was based on Maxwell's method of comparing two self-inductances. One of the inductive coils so compared was the winding of the iron ring under test, the source of voltage being alternating (128 to 520 ⁓ per second), and the indicating instrument a tuned optical telephone or vibration galvanometer. The bridge measurements (starting with direct current) gave the "effective" resistance and self-inductance of the ring winding, and from these (with the dimensions, etc.) were deduced the values of B and the hysteresis loss due to the fundamental component of the alternating flux, allowance for eddy currents having been made. A number of conclusions are drawn from the results; amongst others, that increase of frequency decreases B for a given value of H, and increases the hysteresis loss for a given value of B. This appears to indicate that with quickly alternating fields B lags behind H. It is interesting to notice that for one of the rings tested the "kinetic hysteresis" found for $n = 128$ is of somewhat the same order of magnitude as that given by the rings of Prof. Lyle at lower frequencies.

Dr. D. K. Morris, in a letter to the secretary, said that much experimental work on the subject of the paper had been recently carried out, chiefly by Mr. R. P. Hulse, in the University of Birmingham; and it always appeared that with good transformer iron, the increase of hysteresis with frequency was *less* than that found by Prof. Lyle. These experiments were made with ring magnets built up of stampings, properly insulated from one another, and having a small difference only between internal and external radius. Another method of experimenting was the following: If the no-load loss of a transformer be measured at different frequencies, the voltage being so adjusted as to give constant flux density, then by dividing each measurement by the frequency and plotting the quotients against the frequency, a straight line is obtained from whose inclination the eddy-current constant can be obtained, on the assumption that hysteresis does not vary with the frequency. The author quotes $\frac{\pi^2}{6}=1\cdot645$ as this constant (that figure, namely, which when multiplied by the [thickness of stamping]^2, by the [induction density]^2 and the [frequency]^2, and divided by the specific resistance of the stampings, will give the eddy-current loss). Different methods of arriving at it as previously given, show that it certainly lies between 1·2 and 2·0. Measurements on transformers by the above method give figures between 4 and 5 as far as Dr. Morris's experience goes. It would be interesting to know if any other Fellow had made similar measurements. This means that that portion of the loss which does not simply increase proportionally with the frequency is more than double that which is ordinarily explained by eddy currents. Such measurements have been made for a maximum flux density from B = 2,600 to B = 5,000 lines per square centimetre, and the results are in close agreement with those of Prof. Lyle. Dr. Morris has usually attributed the excess eddy-current loss to current flowing from plate to plate. Such currents certainly did not occur in the author's experiments. Sometimes the discrepancy between observed and calculated eddy currents is due in part to the existence of higher harmonics in the flux wave for which the relatively large allowance has not been made. But if it is not due to either of these causes, it certainly would seem to indicate "kinetic hysteresis." Prof. Lyle asserts that "if the E.M.F. wave impressed on the magnetising winding is sinusoidal, the flux wave will contain third harmonics," etc. It is quite true that the magnetising *current* contains such harmonics, but unless the resistance of the magnetising winding is very high, these harmonics will not appear appreciably either in the back voltage or the corresponding flux. The practical significance of the "reflected energy" referred to is, therefore, very slight.

Mr. T. H. Blakesley said that 10 or 12 years ago he read a paper before the society describing experiments which pointed to the existence of kinetic hysteresis. The present paper substantiated what he said then.

A paper "**On the Practical Determination of the Mean Spherical Candle-Power of Incandescent and Arc Lamps,**" by **Mr. G. B. Dyke**, was read by the author. Mr. Dyke points out the need of an improved method of expressing the efficiency of incandescent lamps, and adopts the suggestion of Dr. Fleming of expressing the whole flux of light in lumens per watt. The expression of the efficiency in this manner involves the determination of the mean spherical candle-power (M.S.C.P.), and the paper describes a method of doing this. The objects of the paper are (1) to obtain curves showing the variations of candle-power of incandescent lamps in a horizontal plane; (2) to obtain reduction factors by which the mean horizontal candle-power (M.H.C.P.) may be calculated from the maximum horizontal candle-power (C.P.); and (3) to obtain reduction factors for deducing the M.S.C.P. from the M.H.C.P. and from the C.P. A self-contained motor-driven lampholder is described which rotates the lamp about a vertical axis at from 230 to 300 revolutions per minute. The M.H.C.P. was determined by spinning the lamps, and by taking C.P.S in different azimuths by a step-to-step method. The results agreed within the limits of experimental error, thus showing that the filaments were not sensibly distorted during rotation. An integrating photometer was used to determine the ratio (M.S.C.P.)/(M.H.C.P.). The instrument is of the type suggested by Mr. C. P. Matthews, and consists of several pairs of mirrors placed around the circumference of a semicircle, and so arranged that light emitted from a source placed at the centre of the system is incident upon the photometer screen, also situate at the centre, at the same angle with the vertical as it made on emission from the centre. It is shown how the ratio (M.S.C.P.)/(M.H C.P.) can be determined by observing one distance after obtaining a photometric balance. The effects of any departure from Lambert's cosine law, and of varying reflection coefficients of the mirrors, were investigated and allowed for. It was also found impossible to reduce the size of the apparatus by interposing ground-glass screens because of the varying absorption of ground glass for light of different colours. Nine types of incandescent lamp were experimented upon, and the high peaks and depressions on the curves of horizontal intensity were ascribed respectively to a mirror action of the bulb and to portions of the filaments obstructing the light from other portions. Values of the ratios (M.H.C.P.)/(C.P.), (M.S.C.P.)/(C.P.), and (M.S.C.P.)/(M.H.C.P.) have been obtained, and for lamps of the same type of filament it is found that the ratio (M.S.C.P.)/(M.H.C.P.) is remarkably constant. The author therefore suggests the determination of the M.H.C.P. by means of a rotator, and then, with the aid of a reduction factor, determined once and for all for a particular type of filament by an integrating photometer, the deduction of the M.S.C.P. Preliminary experiments upon arc lamps seem to show that a similar method may be adopted for the determination of their M.S.C.P.

Dr. J. A. Fleming congratulated the author, and referred to the peculiar difficulties under which the research had been conducted at University College. Two features of the integrating photometer used were the possibility of compensating departures from the cosine law by the setting of the mirrors and the determination of the M.S.C.P. from one reading. It was now as easy to obtain a value for the M.S.C.P. as to obtain a useless measure of the horizontal intensity in any particular direction. The variation in the reflecting powers of the mirrors due to dust and dirt could also be eliminated.

Mr. Patterson gave an account of similar experiments which were being carried out at the National Physical Laboratory. Referring to the fact that the author had taken for his zero position in determining the ordinary C.P. of a lamp that in which the mean plane of the filament was at right angles to the axis of the photometric bench, he pointed out that this position was unsatisfactory because of the prevalence of streaks and shadows on the screen. The M.H.C.P., and not the C.P. in any particular direction, was the only unit now in use. The results of the author were in close agreement with those obtained at the National Physical Laboratory.

Mr. W. Duddell pointed out that if the peaks in the curves of horizontal intensity were due to reflection from the bulb, one would expect that their position would vary with the distance between the lamp and screen. He asked the author if he had noticed any such variation. The integrating photometer described in the paper was very cumbersome, and he would like to know in what respects it was superior to Blondel's lumenmeter.

Dr. C. Chree remarked that it would be interesting mathematically to express the illumination in a series of spherical harmonics.

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The **Chairman** expressed his interest in the fact that some of the results of the author had been confirmed by Mr. Patterson at the National Physical Laboratory. He had recently been in America, and found that the integrating photometer was in use for measurements upon arc lamps, but that incandescent lamps were measured with a rotator, no particular regard being paid to the M.S.C.P. With regard to the observations of Dr. Chree, he said that Mr. Patterson could give him sufficient data to carry out the calculations.

The **Author**, in reply to Mr. Duddell, said that although he had not varied the distance between the lamp and the screen, he had taken photographs of the "blaze" of the lamp at different distances, and found that it was always the same.

Exhibition of Apparatus by **Mr. R. W. Paul.**—The construction of highly sensitive pivoted electrical instruments has been rendered difficult by the fact that delicate pivots will not admit of transporting without injury. A number of galvanometers were shown in which the design was based upon the use of a moving coil, supported on one pivot in a powerful and uniform magnetic field, and controlled by a spring. The adoption of one, in place of the usual two pivots, renders it feasible to raise the coil when the instrument is out of use, and thus secure the pivot from risk of injury. By taking advantage of this, and the incidental reduction of pivot friction, a practical instrument has been made approaching in sensibility to that of a reflecting galvanometer. Some of the instruments exhibited gave a full scale reading of 100 divisions for two millivolts or for 60 microamperes. Combined with shunts and resistances other forms gave direct reading insulation measurements to 2,500 megohms, pressures to 500 volts, and currents to 25 milliamperes in the one apparatus. Demonstrations were given of the suitability of the galvanometers for pyrometer use. The galvanometers are so designed that accurate levelling is unnecessary. A simple, non-reflecting, suspended-coil galvanometer for the student's use, with a sensibility of one division per microampere, was also exhibited. A new design of lantern, adapted for science lectures, and for use with three Nernst filaments arranged closely together, was shown in action. It is capable of being instantly changed from horizontal to vertical projection, can be fitted with a reversing prism, and has a wide adjustment for focussing. Another exhibit was an Ayrton-Mather reflecting electrostatic voltmeter with a magnetic damping device. The instrument shown had a sensibility of 500mm. at 1m. for 30 volts, but similar instruments are made to give this deflection with pressures as low as eight volts.

At the meeting on Nov. 25, Dr. R. T. Glazebrooke, F.R.S., president, in the chair,

A paper on **"The Measurement of Small Differences of Phase"** was read by **Dr. W. E. Sumpner.** Hitherto, in order to measure the differences of phase between alternating-current quantities, it has been necessary to use some method involving the simultaneous reading of three deflectional instruments, such as the wattmeter method, or the three-voltmeter method either in its original or in some modified form. These methods cannot be successfully applied when the phase differences to be determined are small. The author describes new voltmeter methods which may be used for the purpose, and gives the results of a number of measurements on alternating-current plant. Difficulties arising in the measurement of very small alternating-current voltages are overcome by rectifying the voltages so as to utilise sensitive direct-current instruments. The paper gives the result of some tests on two transformers of 3 kw. capacity intended to work between voltages of 100 and 1,000, and with currents of 100 cycles per second. One transformer was used to step up the volts from V_1 to V_2 the other to step down from V_2 to V_3. It was found that the phase difference between V_1 and V_3 for a non-inductive load increases regularly with the current. For an inductive load there is a sharply defined minimum at low power factor. The author suggested that points on one side of the minimum corresponded to a lag, and points on the other side to a lead of the current on the voltage in the primary circuit.

Dr. A. Hay congratulated the author, and said that the determination of power factors was a matter of importance. He had found that alternators tested with water resistances gave better results than when tested with lamps. The phase differences between the volts and the amperes in the water resistances were generally greater than those indicated by Dr. Sumpner. He asked the author what current density he used, and pointed out that the result would depend upon the current density at the electrodes. A minimum phase difference could be obtained by loading up the secondary of an ordinary transformer, and was due to an increase in the power factor up to a certain point and then a decrease. We were dealing with lag in both cases.

Mr. A. Campbell said that some years ago (Institution of Electrical Engineers, April, 1901) he published a description of the method of measuring a phase difference, close to 180deg., between two independent voltages by the first method mentioned by Dr. Sumpner—viz., by shunting the larger by a high resistance, picking off from it a part as nearly as possible equal to the other, and measuring the difference resultant. A test on a small transformer gave a phase difference of about (180°−0°·15). Dr. Sumpner, however, has considerably improved the method; he ensures the sufficient equality of the components by adjusting until the resultant is a minimum—a simple and beautiful device. In his discussion of the three-voltmeter method, Dr. Sumpner assumes that three instruments are necessary. Mr. Campbell has found that in many cases a single instrument with a quick change-over switch is quite sufficient, provided a number of readings are taken in rotation and averages obtained. With respect to Dr. Sumpner's method of measuring small alternating voltages by rectifying them, although it might give good results when the wave form was known, he thought that in the very cases where such measurements were wanted the wave form was not known. Small differences of "power" phase may be as much due to small difference in wave form as to small displacements of similar waves; thus the "difference" resultant is probably nearly always of very uncertain wave form.

Mr. T. H. Blakesley expressed his interest in the paper, and said that many years ago he had made use of commutation in order to work with direct-current instruments. He had used a high-resistance galvanometer, and found that not only the self-induction but also the capacity of the coils had to be eliminated.

Mr. W. Duddell supported Mr. Campbell in his contention that small differences of "power" phase might be due to small differences in wave form. He had used water resistances in testing large alternators, but had never found any phase difference between the voltage and the current. He had usually worked with high voltages, so that condenser effects due to polarisation (of the order of one volt) would have little effect.

Dr. C. V. Drysdale said he had given a good deal of attention to the measurement of small phase differences, and had found it advantageous to measure the sine of the phase difference instead of the cosine. This could be accomplished by putting a condenser in series with the pressure circuit of a wattmeter so as to produce a phase displacement of nearly 90deg. In these circumstance he had previously shown that with ordinary conditions the watts were equal to the wattmeter reading plus a constant multiplied by the sine of the angle of phase difference. When, as was usually the case, sin θ was nearly equal to unity, it was only necessary to add a constant to the wattmeter reading.

Dr. W. E. Sumpner, in reply to Prof. Hay, said he had worked with low current densities, and was unable to say what would happen if the current density was increased. With regard to rectification, he was aware of the effect of the shape of the wave. He had made experiments with currents of very different wave forms, and in his opinion only about 20 per cent. of the observed results could be due to any alteration in the form of the wave. His methods were suggested as a means of getting an *approximate* value of very small phase differences, which could not be determined in other ways. The difficulties referred to by Mr. Blakesley were not encountered, as he had worked with a moving-coil galvanometer of small capacity and self-induction. He was afraid that the observations of Dr. Drysdale raised questions which it would take too long to discuss at the present meeting.

LEGAL INTELLIGENCE.

PROPOSED FLOTATION OF AN ELECTRICAL INVENTION.

The case of Edwards and Brown *v.* Anderson and Hammond came before Mr. Justice Kekewich on Tuesday, the plaintiffs claiming £93, balance of account for services rendered under an agreement which plaintiffs alleged was made by the defendants.

Mr. McCall, K.C., said the plaintiffs had discovered an improved method of making conduits for electrical wires. In order to develop and work the patent and, if possible, form a company to work the invention, the plaintiffs were introduced to the defendant Hammond, who was secretary to several companies. Mr. Hammond suggested to the plaintiffs, who were quite unacquainted with the process of forming companies, that they should leave with him particulars of their invention, and that he would find someone who would go into the matter with him and form a company to work it. Plaintiffs were subsequently introduced to the defendant Anderson by Hammond, and were told that that gentleman would assist in finding the capital and promoting a company. Plaintiffs were induced to leave their employment, on the promise of the defendants that they would pay them their wages until the syndicate or the company came into existence, and it was on that contract that the plaintiffs claimed. From time to time the plaintiffs received some money from the defendant Hammond.

Evidence was given by the principals on both sides.

His Lordship, in giving judgment, held that the plaintiffs had not proved their case sufficiently, although he believed them to be truthful witnesses. He did not believe a word of the defendant Hammond's evidence. If, therefore, the evidence of the two plaintiffs had been up to the mark, he would have had no hesitation in giving judgment in their favour. As, however, the plaintiffs' case was not sufficiently verified, the case must be dismissed.

ACETYLENE GAS PATENT.

In the House of Lords on Tuesday, the Lord Chancellor and Lords Davey and Robertson had before them the matter of the Acetylene Illuminating Company, Limited, and the Willson Laboratory Company (appellants) *v.* United Alkali Company, Limited (respondent). This was an appeal by the Acetylene Illuminating Company, Limited, of 3, Victoria-street, S.W., and the Willson Laboratory Company (incorporated under the laws of the State of West Virginia, trading at 3, Beekman-street, New York, U.S.A.), against a judgment entered for the United Alkali Company when the action was tried before Mr. Justice Buckley and affirmed on appeal. In the action the Acetylene and the Willson Companies sought a declaration to restrain infringement by the United Alkali Company of letters patent No. 16,705 of 1894 granted to Thomas Leopold Willson. The patent related to an alleged invention of a new process for the manufacture of crystalline carbide of calcium, a chemical combination used chiefly for producing acetylene gas, which is obtained by the action of water upon calcium carbide. Mr. Justice Buckley held that the United Alkali Company had not infringed, on the ground that, in his judgment, the patentee had restricted himself to an arc furnace, whereas the United Alkali Company had used an incandescent furnace. In the Court of Appeal their lordships held that the patent was invalid for want of subject-

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matter and on the ground of anticipation. The question, therefore, of whether there had been infringement was immaterial, and they did not decide it. Hence the appeal to the House of Lords.

In giving judgment, the **Lord Chancellor** said the appellants had failed to show that the invention was proper subject-matter for a patent. He had no hesitation in coming to the conclusion that the patent was invalid, because that was the view, and the only view, that had been taken of it by the judges in the courts below. Mr. Moulton had made a gallant struggle to establish that the utility and commercial value of the invention was such that although it only applied a known process of obtaining calcium carbide, it for the first time rendered that knowledge of commercial value, and, therefore, the invention ought to be protected. If that learned counsel had established what he so strenuously attempted to prove, he would have been entitled as the law stood to their judgment on that point. But he had not succeeded in his attempt.

Lords Davey and Robertson entirely concurring, the appeal was dismissed.

ELECTRIC TRAMCAR ACCIDENT.

At the Manchester Assizes, before Mr. Justice Phillimore and a common jury, the case of Edwards *v.* the Corporation of Manchester came on for hearing, in which the plaintiff claimed damages for an accident which happened to her whilst travelling in one of the Corporation's cars.

It was stated on the part of the plaintiff that at the time of the accident she was an inside passenger on a car which was proceeding in the Ardwick direction, and, as was her usual practice, intended to get down at Tipping-street. She told the guard this, she said, when she paid her fare. But when the car reached Tipping-street the guard was taking fares from the outside passengers. The car, nevertheless, stopped, and one or two gentlemen got out. The plaintiff got down to the bottom step, and, according to her account, had one foot on the roadway when the car made a sudden movement forward, and she fell. At first she felt no injury beyond the effects of a severe shake, but in a few days internal pain developed, and her medical attendant found that she was suffering from hernia, which, as she was about 65 years of age, he said, was likely to be chronic.

The question for the jury was whether there had been negligence on the part of the conductor, and, if so, whether this conduced to the plaintiff's injury. For the Corporation negligence was denied, and it was pleaded that the plaintiff had been guilty of contributory negligence in leaving the car whilst it was in motion. The conductor denied that he gave the signal for the car to start, and it was suggested that a passenger who left it immediately before the plaintiff got out did so improperly, or without noticing that she also was preparing to leave at the Tipping-street stopping place.

In the end the jury found for the plaintiff, damages £200; and his Lordship gave judgment for that amount.

CAPTIVE FLYING MACHINES.

Mr. H. Terrell, K.C., applied to the Chancery Division for an order for the compulsory winding-up of Sir Hiram Maxim's Electrical Engineering Company, Limited.

Counsel said the company, which was incorporated in 1899, contracted with the petitioner (Mr. C. Remmer) to erect at Southport certain parts of one of Sir Hiram Maxim's captive flying machines. He did the work and became entitled to payment of £1,576. He was given a cheque for £100 and bills for £964. The first bill became due in October of last year and was dishonoured. Mr. Hardy, managing director was appointed receiver on behalf of the debenture holders, and was afterwards made liquidator in a voluntary liquidation. Counsel asked, however, that a compulsory order might be made.

Mr. Eve, K.C., for the company, described the petition as idle and flimsy.

Mr. Justice Warrington thought the voluntary liquidation should be superseded by a compulsory order, and granted the application.

ALLEGED ELECTRIC SHOCK.

At the Manchester Assizes last week, before Mr. Justice Walton, Mr. W. S. Boor sought to recover damages from the Salford Corporation for personal injuries alleged to be due to an electric shock caused by the negligent management of the defendants' tramcars.

Mr. Shee, K.C., stated that the plaintiff boarded one of the defendants' cars while other passengers were getting in and out. With his left hand he grasped the canopy pole. Then the conductor touched the electric button as a signal to the motorman, and, turning to the plaintiff, he said something which the plaintiff took to be an intimation to take his seat. At that moment—the plaintiff having his hand still on the pole—the car began to move, and he received a violent electric shock. His body was "pulled up" or twisted, and he was unable either to release his hand or to move his left foot, which rested upon the step. The pain in his left leg was terrible. The guard and a gentleman who was seated inside the car went to his assistance, and he proceeded as far as the cattle market, but had to return home almost immediately in a cab. When seen by a medical gentleman (Dr. Dabbs) his left knee was swollen, and the conclusion arrived at was that there had been a rupture of the ligament. This was confirmed by an application of the X-rays. The shock had been sufficiently violent to produce this injury. The plaintiff remained under treatment, unable to leave his bed, for many weeks, and it was not until April 24 that he could proceed to Southport for change of air. There was every reason to think he would go on improving, but he was still an invalid. Amongst the out-of-pocket expenses which went to make up the claim were: doctors' bills, £40; physicians' fees, six guineas; X-rays and surgical appliances, £3; cost of nursing, £18. 15s.; five weeks' stay at Southport, £40; and loss of business for 21 weeks, £220. The total amount of these expenses came to over £900. Counsel added that he understood the defendants were going to say that the plaintiff was not injured by an electric shock at all, but by knocking himself against the rail or against the step when getting into the car. There could be no dispute, however, that electric shocks could be sustained through insufficient insulation, resulting in the leakage of electricity. This would be more likely to happen on a wet day, such as was the case when the accident occurred.

After evidence had been taken as to fact, a number of electrical and medical witnesses were called for the plaintiff.

Mr. Sanderson then opened the case for the Corporation, and said the latter did not insure passengers against all risks, nor did they warrant their cars to be free from all defects and absolutely safe. Their only liability in a case like this was that they should take reasonable care, having regard to all the circumstances. If the jury found that reasonable care had been taken, the defendants were not liable. The trams were run for the public benefit, and it would be a very serious thing if, when a corporation had used every possible precaution to ensure the safety of their passengers, they were to be penalised for accidents like this. The car in question was made in 1902, and was electrically equipped by the British Westinghouse Company, all the Board of Trade requirements being complied with. Before being brought into use it underwent the fullest and most complete tests. As to the plaintiff's injury, the defendant's explanation was that in trying to reach the platform of the car he slipped, and whether the injury was the result of a direct blow or in trying to recover himself was immaterial. It was while he was in the act of getting upon the platform that he cried out—that was to say, before the car moved. Counsel thought that after hearing witnesses the jury would say that it was practically impossible for the plaintiff to have got a shock in the way he had described. The car, as soon as the accident reached the cars of the Corporation, was exhaustively tested, and no leakage whatever could be detected about it. It was working to-day in the same condition as at the time of the accident.

Several well-known technical experts gave evidence on behalf of the defendants.

His Lordship, in summing up, said that the question was whether there had been negligence on the part of the defendants.

The jury, after a brief consultation, decided in the negative, and the action was therefore dismissed.

EMPLOYERS' LIABILITY ACT.

At the Brompton County Court Albert Fisher, a fitter's labourer, brought an action, under the Employers' Liability Act, against the Underground Electric Railways Company of London, Limited, Lot's-road, Chelsea, S.W., claiming damages in respect of personal injuries said to have been sustained owing to negligence on the part of the defendants or their servants.

Plaintiff's Counsel said that his client, who was in the employ of the defendants at their works at Lot's-road, was assisting in raising a heavy iron pipe from the ground on to a large staging. This staging consisted of iron columns, across which were scaffold poles, and across these were planks upon which the men stood. When the pipe was raised a little higher than the platform, a man in charge of the job called the plaintiff from the ground on to the platform. Suddenly the rope or sling by which the pipe was raised broke or gave way. The pipe fell on the staging, which collapsed. The men, including the plaintiff, fell some 30ft. or 40ft., the plaintiff sustaining serious injuries. Counsel contended that the staging was deficient, and particularly that the rope was defective. The defence filed by the other side was that the plaintiff had "exercised his option" by receiving half wages under the Workmen's Compensation Act. The plaintiff, however, had, while in hospital, signed a document agreeing to accept compensation under the Workmen's Compensation Act under the impression that he was merely signing a receipt for a temporary allowance.

The plaintiff supported his counsel's statements, and corroborative evidence was given.

For the defence evidence was called to prove that the plaintiff distinctly understood he was being compensated under the Workmen's Compensation Act.

The jury returned a verdict in favour of the plaintiff, assessing the damages at £81. 16s.

SHEFFIELD ELECTRICITY WORKS.

At the Sheffield County Court last week Joseph Bolton, herbalist, sued the Corporation of Sheffield for £2. 10s. on account of damages sustained by him owing to their allowing an emission of fine dust from the chimney of their electric power station in such quantities as to be nuisance in law, such fine dust falling upon the plaintiff's goods and damaging them.

Mr. Muir Wilson, in opening the plaintiff's case, said that the injury complained of was particular and beyond that suffered by the general public. On June 14 plaintiff had his stall in the Sheaf Market, on which his goods were exposed to view. From two o'clock until five there was a continuous emission of very fine grit from the chimney of the electric power station. Whether it arose from improper fuel or not, he could not say. It spoiled him six varieties of herbs and some pills. It was impossible to cover these articles up, as that would have spoilt the sale. He drew the attention of the market collector to the matter. On Aug. 9 there was a repetition of the emissions.

For the defence it was stated that every precautionary measure known to science had been taken.

Evidence was given on both sides as to question of fact, and the defendants called witnesses upon technical points.

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His Honour, in giving judgment, said at the close of plaintiff's case he had very grave doubts whether the plaintiff had made out a case, but he was glad he had not interfered, because the case had now been gone into very thoroughly, and they had had a large body of evidence upon it. The argument addressed to him on behalf of the plaintiff was entirely based on the assumption that the grit complained of had come from the chimneys at the power station. That was an assumption which had not been borne out by a single witness. The statement of the young man who, in giving evidence on behalf of the plaintiff, spoke of "showers of grit" was an exaggeration, to say the least of it. The plaintiff's case was entirely disproved, and instead of nonsuiting, as he should have been inclined to do on the previous day, he found that the defendants had made out their case completely to his satisfaction, and there would be judgment for the defendants. As to costs, he would point out that there were 25 other chimneys in the neighbourhood, every one of which, according to the evidence, did, and probably must, eject grit, and that it was quite possible that plaintiff might reasonably have thought that it was coming from the Corporation's chimneys.

In the circumstances, **Mr. Ellison**, for the defendants, said he would not press for costs, and judgment was therefore given for defendants without costs.

OBSTRUCTING A TRAMCAR.

At the Leicester Police Court last week, B. Peacock, greengrocer, was summoned for driving his horse and cart in such a manner as to obstruct the Corporation tramways.

The town clerk, Mr. E. V. Hiley, prosecuted, and defendant pleaded not guilty.

The Tram-driver said he was driving a car in the East Park-road route down the Humberstone-road on the afternoon of the day in question. When near the railway bridge he saw a horse and cart proceeding along the track in front of him, of which the defendant was the driver. Witness rang his bell several times, but he took no notice whatever. Witness drove behind him, sounding the gong all the time, as far as the Forest-road, over 200 yards. Defendant turned round twice and laughed.

Corroborative evidence was given by a passenger.

Defendant was fined 40s. or a month.

OLD TRAMWAY TICKETS.

At the Nottingham Summons Court, William Payne was summoned for attempting to avoid payment of a tram fare. Defendant pleaded guilty.

Mr. H. W. Day, of the town clerk's office, said that defendant got in at Great Alfred-street, and after the car had proceeded for some distance the conductor went round in the usual way to collect the fares. He went to the defendant, who said he had paid and held out a ticket. The conductor passed on, but feeling doubtful went again to defendant, who repeated what he had said before. Later an inspector boarded the car, and examined the tickets. Defendant showed him the same ticket, which had been issued at Trent Bridge on the same journey, and had exhausted itself at the Market-place. It was clear that defendant had picked up the ticket; in fact, he afterwards admitted to the inspector that he had done so.

A fine of 2s. 6d. was imposed.

THEFT OF TELEGRAPH WIRE.

At Brentford Police Court on Saturday, Thomas Newman and Arthur Ballard were charged on remand with unlawful possession of a quantity of telegraph wire belonging to the Postmaster-General.

The prisoners elected to be dealt with summarily, and, on account of previous good character, they were bound over under the First Offenders' Act to come up for judgment if called upon.

COMPANIES' MEETINGS AND REPORTS.

BRITISH WESTINGHOUSE.

The report of the British Westinghouse Electric and Manufacturing Company, Limited, for the year ended July 31, 1904, shows a profit of £50,550. After providing for debenture and loan interest and for the further items set out in the profit and loss account, a balance of £2,809 remains, which the directors propose to carry forward. A considerable sum for the maintenance of the large machine tools has been charged to revenue during the year, and latterly patterns, drawings, etc., have been charged to revenue. The directors, therefore, are of the opinion that the sum of £10,500 provided for depreciation is sufficient to meet requirements. The buildings have been well maintained, and, in the opinion of the directors, no special provision for depreciation thereon is at present necessary. The Board have not deemed it necessary to write off any depreciation on patents, in view of new ones that have been taken out. At the general meeting in February last the capital of the Company was increased by the creation of a further 100,000 6 per cent. preference shares of £5 each. These have been taken up and paid for in full at par by the American Westinghouse Company. In addition to this, but since the closing of these accounts, the American Westinghouse Company has taken up and paid for at 95 per cent. £400,000 4 per cent. mortgage debenture stock. Since Aug. 1 last the temporary loans have been repaid, and the amount due to sundry creditors has been considerably reduced. The result obtained at the close of this the first complete year of manufacturing has shown that the general expense and outlay incident to the development required in connection with the Company's plant at Trafford Park has been much greater than the management anticipated. The varied, and to a large degree novel, character of the work undertaken more than a year ago required additions in equipment of many kinds, and the expense met with in forming the organisation required to execute such work has involved considerable outlay. These expenditures have, however, placed the factory in an advantageous position to execute orders in the future for large generating units. A larger amount of work is now being turned out for a smaller amount of labour than formerly, and a matter of equal importance is that the proportion of contracts executed in the works, as compared with finished material purchased from other manufacturers to fill such contracts, is increasing, while at the same time the margin of profit on work executed in the factory is moving upwards. While it is not possible to declare a dividend upon the preference shares, the outlook is one which encourages the directors to look forward to an improvement during the current year. Orders received during the year ended July 31, 1904, totalled £927,336, as against £1,657,114 in the preceding year. The Company has taken orders during the first three months of the current year aggregating £311,000, as compared with a total of £210,000 for the corresponding period of last year.

WEST INDIA AND PANAMA TELEGRAPH.

The report of the West India and Panama Telegraph Company, Limited, for the half-year ended June 30 last, to be submitted to the meeting on the 30th inst., states that the amount at credit of revenue account is £34,581, a decrease of £322. Expenses have been £23,437, an increase of £386, leaving a balance of £11,144, to which is added £1,825 (interest on investments) and £711 (brought from last account), making a total of £13,679. It is proposed to pay a dividend of 7s. per share on account of arrears to June 30, 1904, on the first preference shares, carrying forward £1,582. This will leave the following dividends in arrear: on the first preference shares £1,728, and on the second preference shares £11,205. Expenses of repairing cables during the half-year amounted to £8,539, being £1,211 less than those for the corresponding period. This is, however, exclusive of a further expenditure of £3,468, which has been charged to reserve, in respect of 40 knots of new cable used in February last in the repair and partial renewal of the St. Lucia-St. Vincent section, which, it will be remembered, was interrupted by volcanic disturbances in September, 1902. The Company's repairing steamer "Henry Holmes" was chartered to the Cuba Submarine Telegraph Company in September last to repair one of their cables, but the charter has since expired and the ship has resumed her ordinary work on the Company's system. The Danish colonies of St. Thomas and St. Croix have renewed their subsidies for a further term of five years. West India commercial prospects are reported to be favourable consequent upon the abolition of the sugar bounties. The improvement to be expected therefrom has, however, not had time to make itself felt in the traffic receipts of the Company.

MAY-OATWAY FIRE APPLIANCES.

The third annual report shows a profit, after providing for depreciation of stock and plant, of £2,033. 13s. 3d., equal to a dividend of about 6 per cent. upon the issued capital of the Company. The directors are now able to make good the deficiency of £1,765. 3s. 2d. which accrued during the earlier years of the Company, when it experienced serious difficulties, which have now, happily, been overcome. Since the last general meeting the Company have put in some of the largest installations of automatic alarms in existence, and the directors believe that that supplied to Messrs. J. and P. Coats, Limited, constitutes a world's record, while the preference shown for the Company's appliances by the great railways and manufacturers having expert engineering departments, and the orders received for repeat installations or extensions from the Corporation of the city of Glasgow, Messrs. Harrods, Limited, J. and B. Stevenson, and others must also be regarded as highly gratifying. The favourable fire loss experience has been maintained, and in no case where an outbreak has originated in any building protected by the Company's system has damage exceeded nominal figures. Application has recently been made to the London County Council for permission to transmit to the metropolitan fire brigade stations calls received from the Company's various City installations, and terms have been received which are now under consideration. Several additional fire brigade stations have been fitted with the Company's apparatus, and protected buildings have been placed in connection therewith. The stations so fitted include the Edinburgh, Belfast, and Aberdeen central stations and the Glasgow eastern, western, northern, and southern district stations; and outfits are being prepared for equipping the district stations in Edinburgh to which protected buildings are waiting to be connected. Meanwhile, shareholders will be glad to know that the experience of the fire departments with which the Company have numerous properties connected has been favourable, and that their goodwill and recommendation continue—a high tribute to the essential merits of the system. The directors consider that the time has now come to apply to the influential associated fire offices for reductions of premiums, and they purpose lodging within the next few days an influentially signed petition asking the tariff companies to authorise in the United Kingdom the rebate already given by them to users of the May Oatway system in New Zealand, the country of its origin. Already concessions are granted to users of the Company's system by non-tariff offices, but the industry will only assume its rightful proportion and status when the tariff companies recognise the benefit of the safeguards provided by lowering the charges for the risks. Agency arrangements have been entered into with the Société

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Industrielle des Telephones, Paris, to develop the French patent rights. The directors have extended their agency arrangements in various parts of the United Kingdom, and have opened branch establishments in Glasgow, Liverpool, and Manchester. Every endeavour is being made to develop the business of the Company, and with the advantages of a growing *clientèle*, well-assorted stocks, an invention commercially and scientifically proven, and no arrears of capital to make good, the Company should be dividend-paying at an early date.

NEW COMPANIES REGISTERED.

H. F. Hill, Limited.—Registered Nov. 19. Object: to acquire certain patents from Mr. H. F. Hill, and to carry on the business of electricians, mechanical engineers, suppliers of electricity for light, heat, motive power, or otherwise, manufacturers of and dealers in electrical apparatus, contractors for tramway, electric railway, and other works, etc.

Fletcher Bros. (A-u-L), Limited.—Capital, £35,000. Object: to acquire and carry on the business at Ashton-under-Lyne of Fletcher Bros., as brassfounders, brass engineers, valve makers, manufacturers of boiler mountings and fittings, gas and oil engine manufacturers, electrical and gasworks plant manufacturers, mechanical, electrical and hydraulic engineers. Registered office: Blandford-street, Ashton-under-Lyne.

Mercedes Motor Works, Limited.—Capital, £2,000. Object: to acquire a license from the Mercédès Company, Limited, for the manufacture in Great Britain of Mercédès engines for motorcars, motor boats, and other purposes, and to carry on the business of manufacturers and sellers of and dealers (as principals or agents) in oil, gas, spirit, and electrical motors and machines, electricians, engineers, mechanicians, rubber manufacturers and merchants, etc.

Lindsey Light Railways Syndicate, Limited.—Capital, £1,000. Object: to apply for and obtain orders for a light railway, under the provisions of the Light Railways Act, or other statute, between Blyton and Frodingham, Lincolnshire, and to carry on the same.

Moorwoods (Manchester), Limited.—Capital, £3,000. Object: to carry on the business of builders' merchants, mechanical and electrical engineers, etc.

Cheshire Light Railways, Limited.—Capital, £1,500. Objects: to obtain from the Light Railway Commissioners or other authority any orders authorising the construction of light railways in Cheshire or elsewhere in the United Kingdom or abroad, to adopt an agreement with R. H. Scotter, and to carry on the business of light railway proprietors, manufacturers of and dealers in railway and tramway carriages, motorcars, omnibuses, locomotives, and engines, etc.

Chameleon Signs, Limited.—Capital, £2,700. Object: to adopt an agreement with M. J. Pearce and W. R. F. Avery, and to carry on the business of manufacturers of and dealers in signs and advertising devices made in accordance with an invention mentioned in the said agreement, manufacturers of and dealers in general electrical, mechanical, automatic, and optical devices, etc. Registered office: 318, Dashwood House, E.C.

Lanchester Motor Company, Limited. — Capital, £50,000. Object: to acquire the undertaking of the Lanchester Engine Company, Limited, and to carry on the business of manufacturers of and dealers in motors and engines of every description, whether worked by oil, electricity, or other power, builders of carriages, wagons, tramcars, etc.

Liens Registered.

Kensington and Knightsbridge Electric Lighting Company, Limited.—A trust deed, dated Nov. 2, 1904, issued jointly with the Notting Hill Electric Lighting Company, Limited (supplemental to a trust deed dated July 12, 1900, covering £100,000, and a further trust deed dated Nov. 18, 1902, covering £50,000, both issued jointly by this company and the Notting Hill Electric Lighting Company, Limited), to secure a further £50,000 debenture stock, ranking *pari passu* with the two former joint issues, has been registered. Trustees—R. B. Martin, M.P., 68, Lombard-street, E.C., and G. H. Hopkinson, 93, Pimlico-road, S.W. Property charged—Freehold generating station belonging jointly to this company and the Notting Hill Electric Lighting Company, Limited.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Madrid.—The General Telegraph Office require tenders for installation and working telephones in the town of Talavera. Tenders to above by Dec. 7.

Guirgia (Roumania)—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Kilmarnock.—The Corporation are prepared to receive tenders for the sole right of advertising on their tramcars. Tenders by Dec. 6. See advertisement.

Salamanca.—The Municipality require tenders for public electric lighting of the town. Tenders by Dec. 12 to above or to Direccion-General de Administracion, Madrid.

Edinburgh.—The Corporation invite tenders for the electric lighting installation at the branch free library, Morningside-road, Edinburgh. Tenders by Dec. 14. See advertisement.

Erith.—The Urban District Council invite tenders for motorcars, trucks, motors, and equipments, track sweeping and watering car. Tenders by Dec. 19. See advertisement.

Swindon.—The Corporation invite tenders for the supply and erection of one 300-kw. steam dynamo, or, alternatively, one 400-kw. steam dynamo. Tenders by Dec. 20. See advertisement.

Madrid.—The Public Works Branch of the Department for Agriculture require tenders for construction and working of an electric tramway between Azeritia and Zumaya. Tenders by Dec 10.

Bradford.—The Corporation invite tenders for the supply of miscellaneous stores required by the tramways department during the year ending Dec. 31, 1905. Tenders by Dec. 17. See advertisement.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Llandilo (Wales).—The Urban District Council invite tenders for testing and calibrating the electricity meters installed in the town (70 in number). Tenders to Mr. R. Shipley Lewis, clerk, Llandilo, before Dec. 6.

St. Marylebone.—The Council invite tenders for the purchase of 1,000 house transformers, of from 1 to 5 kw. capacity, together with a quantity of scrap cable and old cut-outs. Tenders by Dec. 5. See advertisement.

Madrid.—The call for tenders for the service of the electric lighting of Almendralejo was without result. The conditions of contract have, therefore, been modified in certain respects, and tenders are to be called for to be opened on Dec. 22.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

London, S.E.—Tenders are invited for the erection of an electrical traveller to lift 12 tons over a span of 40ft. Persons desirous of tendering should send their names on or before Dec. 10 to B. E. Nightingale, Albert Works, Albert-embankment, Lambeth, S.E.

Fulham.—The Council require tenders for the supply and erection of a 3,000-volt steam alternator of 1,000 kw. capacity, coupled to a Belliss engine, at their generating station, Townmead-road. Tenders to Town Clerk not later than 12 noon on Dec. 20. See advertisement.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Glasgow.—The Corporation invite tenders for electric light installation, etc., for Dennistoun district library. Specifications and forms of tender may be obtained on application to Mr. James R. Rhind, 67, Hope-street, Glasgow, and sealed tenders must be lodged with Mr. James G. Monro, town clerk, City Chambers, Glasgow, by 10 a.m. on Dec. 5.

Stockport.—The Guardians invite tenders for providing and fixing electric light (wiring only), telephones, and bells required at the new infirmary, Stepping Hill. Plans and specification may be seen and all other information obtained from Mr. W. H. Ward, architect, Paradise-street, Birmingham. Tenders to Mr. Charles F. Johnson, clerk, and to be delivered by 10 a.m. on Dec. 12.

Valladolid.—Tenders are required for the public lighting by means of electricity of the city of Valladolid. Fifteen hundred incandescent lamps of 17 c.p. will be required. The concession will terminate on Dec. 31, 1911. The annual payment to the concessionnaire will be about £965. A deposit of £48 is required to qualify any tender. The adjudication will take place at 11 a.m. on Dec. 26, at the Casa Consistorial, Valladolid.

Perth (Australia).—Tenders are invited by the Duputy-Postmaster-General for the supply of the following telephone material; 19½ miles 26-pair lead-covered cable, dry core, to standard specification No. 7; 5,000 paper sleeves, 3in. long by $\frac{3}{8}$in. diameter; 350 yards paper strips, 2in. wide. Conditions, etc., may be obtained at the General Post Offices at Perth, Adelaide, Melbourne, Sydney, Brisbane, and Hobart. Tenders by Dec. 28.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

Bromsgrove (Worcs.).—The Visiting Committee invite tenders for the supply and erection at their new lunatic asylum of the following plant: (Section A) engines, dynamos, booster, and steam services; (B) storage battery and accessories; (C) main switchboard, ring main, feeders, distribution boards, wiring, lamps, and accessories. Specification, etc., may be obtained from Mr. Robert J. Oliver, clerk of the Visiting Committee, Shirehall, Worcester, on payment of £5 for each section of the work as above, which will be returned on receipt of a bona fide tender.

Madrid.—Tenders are invited for the public lighting by means of electricity of the town of Villanueva y Geltru for a term of 10 years. Twenty-four arc lamps of 500 c.p. and 239 incandescent lamps of 20 c.p. will be required. The concessionnaire will be allowed to supply private individuals without payment of a municipal tax subject to his supplying, free of charge, the Casa Consistorial with 75 kw. per month. He will be required to maintain a duplicate set of machinery in order to avoid the possibility of the town being left in darkness through a breakdown. The annual payment (upset price) to the concessionnaire will be 23 145 pesetas (about £678). The adjudication will take place on Dec. 24. A deposit of £68 is required to qualify any tender.

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Madrid.—The *Gaceta de Madrid* of Nov. 9 publishes a notice inviting tenders for the construction and working, for 60 years of an electric tramway between Azcoitia and Zumaya (Province of Guipúzcoa), in accordance with certain conditions set out in the *Gaceta*. An application for this concession has already been received from Don Dionisio Sorseta Garcia, who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on the reduction of the tariff fixed for the conveyance of passengers, etc.; in the event of equal terms being offered, it will turn on a reduction of the period of concession. Adjudication of tenders will take place before the Director-General of Public Works, Madrid, on Jan. 10. A deposit of 16,297 pesetas (about £475) is required to qualify any tender

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegragh Office Yard, Thursday Island, of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

RESULTS OF TENDERS.

Torquay.—We understand that the Council have accepted the tender of the Alphons Custodis Chimney Construction Company, at £3,719, for the erection of the chimney stack at the new generating station.

Dundee.—The Town Council have accepted the tender of the British Insulated and Helsby Cables, Limited, at £2,749. 17s., for the relaying of the present copper strip feeder main throughout the town with insulated cables.

Middlesex.—The County Council have accepted the tender of the Hart Accumulator Company, Limited, Marshgate-lane, Stratford, E., for the supply of storage battery of 115-1,050 ampere-hour standard lighting type cells for Napsbury Asylum.

Belfast.—The Tramways Committee have recommended for acceptance the following tenders: J. G. White and Co., London, permanent way, road bed, paving, and bonding £280,643. 12s. 4d., overhead electrical equipment £38,809. 15s. 5d., underground feeders, telephone and test wires, and spare conduits £65,263. 16s. 8d. (in consideration of getting these three contracts, the firm agree to deduct £1,000 from the total amount of their tenders); British Westinghouse Company, steam dynamos, switchboard, three-phase plant, condensing plant, overhead traveller, and station lighting, £40,933. 5s.; Fairbairn, Lawson, Combe, and Barbour, boilers, superheaters, mechanical stokers, economisers, coal and ash conveying plant, steam, exhaust, and feed pipes, and pumps, £19,740 (subject to the special condition that any work done in the firm's own foundries under this contract shall be done in Belfast); Brush Electrical Company, double-deck electric tramcars, £93,642.

BUSINESS NOTES.

TRACTION.

South Shields.—The Council are considering the question of starting the construction of the tramways at an early date.

Wicklow.—An order in Council has been granted for the construction of tramways, with which Lord Fitzwilliam is closely associated.

Ayr.—The tramway manager is to report upon the advisability of now proceeding with the extension of loop at Chapel Park and loops in Carrick-road.

Middlesex County Council.—At a meeting of the Council the other day it was stated that the Edgware-road and Finchley lines were practically completed.

Croydon.—The Camberwell Borough Council favour the proposed tramway extension to the Crystal Palace, of which we gave particulars in our issue of the 11th ult.

Glasgow.—It has been decided to proceed at once with the construction of the extension from Pollokshaws East to Giffnock. The work will be done direct by the department.

Bath.—The tramway company propose to apply to the Board of Trade for powers to extend their line to Newton St. Loe. The local authorities are understood to be favourably disposed.

Western Telegraph Co.—The directors have declared an interim dividend, payable on Dec. 21, of 3s. per share, or at the rate of 6 per cent. per annum, free of tax, for the quarter ended Sept. 30.

Sunderland.—The Tramways Committee have decided to recommend the Council to have an additional loop made at the east end of the town at a cost of £391. This will enable a 10 minutes' service to be run.

West Ham.—The Works Committee of the West Ham Corporation have commenced the relaying of the tramway lines in the Romford-road preparatory to the length between Stratford and Forest Gate being electrified.

Jarrow.—The British Electric Traction Company's tardiness in proceeding with the tramway scheme is resented by the Town Council, who have decided to vigorously oppose the company's applica ion for an extension of time.

Proposed New Tramway.—It is reported that a tramway has been virtually decided upon from Westbourne to Swanage, near Bournemouth. Private enterprise is responsible for the scheme, which is estimated to cost £68,000.

Hastings.—It is reported that the tramway company intend to seek powers to use the overhead in lieu of the conduit system, both on financial and engineering grounds. The proposed change appears to have excited considerable disfavour locally.

Cardiff.—The question of completing the connection of the Penarth-road tramways with Mill-lane has been referred back to committee. The committee have prepared a new scheme of fares embodying considerable increases. The matter has to come before the Council for their decision.

Maidstone.—The Town Council have decided to promote a provisional order for the following extensions: a line from the top of High-street, up Week-street and Boxley-road, to Penenden Heath and Holland-road; and from the top of High-street, down Gabriel's-hill and Stone-street, to the Loose-road.

Darlington.—It has been decided to issue books of tickets at a reduction of 10 per cent., and a sub-committee has recommended experiments with ½d. fares. A member of the Council proposes that a line should be run right into the station and also along Crown-street, enabling the trams to carry the mails.

West Cumberland Electric Tramways.—It is reported that application is to be made for an extension of time to construct this line. The scheme has been dormant of late, but it is stated that a commencement will be made early in the spring, the financial and other arrangements having been proceeded with.

Devonport.—An enquiry has been held into an application by the Devonport and District Tramways Company for power to extend their tramway at Pennycomequick to the borough boundary at Devonport, and from that point to construct a light railway or tramway through Saltash-road and Cobourg-street to Pound-street, Plymouth.

Halifax.—The borough accountant's report on the Corporation's trading undertakings has been presented to the Finance Committee. For the six months ending Sept. 30 the tramways show a profit of £4,706, representing a substantial increase over the corresponding period of last year. Most of the other enterprises showed losses.

Rochdale.—The Healey section has been approved by the Board of Trade and opened to the public. In connection with the system lately owned by the company, it has been agreed between the authorities concerned that the Littleborough section, which since the transfer has been worked jointly, shall now be worked by the Rochdale Corporation on its own account.

Swansea.—It is stated that the Swansea Gas Company has a bill for nearly £2,000 against the Corporation as the cost of relaying their mains in certain streets, consequent on the tramways extension work. Arbitration proceedings in connection with the property owned by Mr. Graham Vivian, which the Corporation are to acquire for tramway extensions, have been held.

Electric Tramways for Spain.—Notices are published in the *Gaceta de Madrid* of applications for concessions to lay electric tramways in Vigo by Don Alvaro L. Mora, from the Calle de Esparteros to the Puerta del Sol (Madrid), by the Compañia Eléctrica de Tracion, and in La Malvarrosa (Valencia) by the Sociedad Colonia Sanatoria de la Playa de la Malvarrosa.

Newport.—Stoppage of the tram service for 1½ hours occurred at Newport the other day. It was due to an obstruction of the flow of water for working the engines at the power station in Corporation-road. The deputy electrical engineer and tramways manager was soon on the spot conducting investigations, with the result that the cars resumed running with as little delay as possible.

Belfast.—It is stated that the arbitrator, Mr. L. L. Macassey, M.I.C.E., has arranged for the arbitration proceedings in connection with the transference of the tramways to the Corporation to take place in London. The sittings will be held in January next. At a special meeting the Tramways Committee made their recommendations in regard to the acceptance of tenders, of which particulars appear in another column. The contracts, six in number, represent a total of £538,000.

Halesowen.—The District Council have decided to apply to the Board of Trade for an extension of the orders secured in 1901 and 1902, under which they have the power to commence and complete the construction of tramways in the district for a period of 12 months from Dec. 18. The Council have leased their powers for the construction of light railways and the supply of electricity to the Empire Electric Lighting Company, but considerable dissatisfaction exists in the district owing to the fact that the period specified in the agreement expired about two months ago, and no definite action has been taken by the company.

Erith.—The Tramways Committee paid a visit to Bexley the other day and inspected the tramway system of the district, including the car-sheds, cars, permanent way, and generating station. The officials of the Bexley Council furnished all the particulars and information desired. The consulting engineers have reported to the Council that at Bexley-road about half a mile of line has been laid down and a good start made with the paving, and at Abbey Wood a considerable length of road has been opened, and platelaying and concrete are well in hand. Steady progress is being made with the system generally. The deputation appointed to visit several provincial tramways have presented their report.

Leith.—The Tramways Committee had under consideration on Wednesday estimates and specifications for the rails to be used in the reconstruction of the tramway system. Members of the committee

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seem to be of opinion that the streets should not be disturbed until after the New Year holidays, but it is reported that a start will be made early in January. It is proposed that the section along Pilrig-street and Newhaven-road to Bonnington be dealt with first in two parts, so that either horse or electric cars can be run on this section while the work on the other portions is in hand. When the Pilrig-Bonnington lines are completed, the Ferry-road, Junction-road, and Leith-walk route will be proceeded with. It is hoped that the reconstruction will be practically completed in July or August of next year.

Handsworth.—Sir Colin Scott Moncrieff is proceeding with the arbitration which is to settle the price the District Council shall pay for the portion of the undertaking of the City of Birmingham Tramways, Limited, running from the Aston borough boundary to the terminus at Perry Bar, and what rolling-stock the Council shall purchase. Evidence has been given by Mr. G. Conaty (manager) and Mr. A. H. Dickinson (consulting engineer), of the tramway company, and Mr. Robert Green (civil engineer) as to the initial cost and depreciation of the rails, concrete bedding and granite pavement, and rolling-stock. Mr. Conaty said there was a special demand for old tramrails for colliery purposes, and he had sold them as high as £4 per ton. The bedding might have given way in one or two places, but the concrete was as sound as ever. After beginning the evidence of Mr. J. Waugh, engineer, of Bradford, on behalf of the Council, the proceedings were adjourned until the 22nd inst.

Ashton and Stalybridge.—Another conference has been held in reference to the deadlock between these authorities. The negotiations again proved abortive, owing, it is reported, to the attitude of the Stalybridge, etc., Joint Board. The chief obstacle was the Scotland-street route, concerning which Ashton made the following alternative propositions: (1) Ashton Corporation to construct and maintain the Scotland-street tramway route, pay all loan charges, sinking fund, and any other expenses excepting rates and taxes, the Joint Board paying to the Ashton authorities the sum of £450 per annum, plus an agreed price for current taken, and all rates and taxes; or (2) the Ashton Corporation will construct this length of line, the Joint Board to pay all loan and other charges thereon, including rates and taxes, a fixed sum for current taken, and an annual sum to the Ashton Corporation of £250, the Ashton authorities undertaking to maintain and keep the line in good working order. Nothing was arranged, however, and the matter remains in abeyance.

Crystal Palace.—At the meeting of the Crystal Palace Company the other day, the chairman had a good deal to say upon the subject of traffic facilities, of which there are signs of considerable development in the neighbourhood. The London County Council have decided to meet the request of the Croydon Corporation by completing the intended line to the Palace from South Norwood. Then there is a probability, the chairman stated, of the County Council undertaking at no distant date the extension of its South London system to the Palace. Moreover, the Croydon and Beckenham extension to the Penge entrance, already authorised, may be commenced shortly and be in operation by next May. Ultimately, the chairman believed, they would obtain a large network of feeder lines, which was essential to the substantial success of the Palace. There is, in fact, a prospect of extensive traffic in this locality, which will probably have the effect, among other results, of bringing to the famous Sydenham resort the success anticipated by the chairman.

Ipswich.—The receipts from the Corporation trams have fallen a good deal lately. The first big drop in the receipts took place in the week ending Sept. 17, the income falling to £552, as compared with the previous week's £605. The following week there was a drop to £508, or £97 down in a fortnight. Then came drops of £24, £40, and £27 in quick succession, making a reduction in takings between Sept. 10 and Oct. 15 of £191. Then came a modification of the service, presumably to save expense, and the receipts for three weeks were steady, followed by a drop of £43 in the week ending Nov. 5. The following week came a slight rise, and on Nov. 14 the final alterations for the winter service took effect. There was a further drop of £48 on the next week's takings, and for the week ending the 19th ult. there was another drop of £37. Comparing the last-mentioned week with the last week of September there was a fall of £218. The weather has, of course, been less favourable for travelling lately as compared with the summer months, but the difference in receipts is very considerable. There appears to be a good deal of friction with the motormen and conductors.

New Electric Railways.—Amongst the new schemes parliamentary notices have just been issued regarding powers to be sought in the next session to construct two new electrical railways. The first is to be known as the North-East London Railway, and aims at linking up the city with Essex and Hertford, taking in *en route* some of the more populous centres. It is to start from the corner of Eastcheap, and run on to Bishopsgate-street Within and to Shoreditch, then to Hackney, proceeding thence to Southgate and Waltham Cross. The generating stations are to be situated at Hackney and Leyton, close to the recreation ground at the latter place. The second line is drawn on a larger scale. It is entitled the Hammersmith, City, and North-East London Railway. The starting point will be at the junction of King-street West with the Broadway, and the line will go thence to Westminster, with a station in Piccadilly. Gracechurch-street is the next point, and then High-street, Stoke Newington, and Southgate. At Stoke Newington it is intended to branch off to Walthamstow. The gauge suggested is 4ft. 8½in., and it is proposed to erect generating stations at Hammersmith and Kingsland-road, Shoreditch.

Snowdon-Bettws-y-Coed.—The Board of Trade have now finally sanctioned the order for the proposed electric railway from Bettws-y-Coed to the junction with the new Beddgelert and Portmadoc line, the construction of which is being rapidly proceeded with. The promoters of the first-named railway have arrived at a settlement with the Bettws-y-Coed Council with respect to the tunnelling at the Swallow Falls and the level crossing in the village of Bettws-y-Coed. It is understood that the work on this line will be begun in the course of a few months, but in the meantime all energy is being concentrated upon the section of railway down to Portmadoc, which, should the winter be reasonably mild, will probably be finished and opened for traffic at the beginning of next summer, as well as the extension of two to three miles in length as far as the Snowdon station at Rhyd Ddu, the terminus of the old narrow-gauge line, past Llyn Cwellyn to Dinas, on the London and North-Western Railway near Carnarvon. Meanwhile the works of the North Wales Power Company, who are to supply the power, are going ahead with great activity, and it is anticipated that energy will be available by the time the first section of railway is ready. It is intended in due course to electrify the narrow-gauge railway down to Dinas, and to extend the line from Dinas to the Carnarvon Quay. Powers have also been obtained for another light railway from Bettws-y-Coed to Corwen, on the Great Western line, which is also to be operated with current from the Snowdonian power station. The power company intend to construct an embankment at Llydaw for the purpose of increasing the storage capacity of the lake, but this work will not be begun until the line of pipes down to the generating station has been used to lower the level of the lake, and so drain off the water which now saturates the ground on which the embankment will be raised.

Exeter.—The Mayor, accompanied by members and officials of the Corporation, laid the corner stone of the car-shed and offices for the electric tramways on Saturday. His Worship congratulated Messrs. Dick, Kerr, and Co., the contractors, on the able manner in which they were undertaking the work of construction. He hoped that arrangements would be able to be made at a round table conference with the authorities of the growing suburb of Heavitree, which would result in the tramways being continued to Heavitree Park as scheduled in the Act. The length of permanent way under construction is 5½ miles of single track. The amount of the contract for the tramways is £29,227; that for the electrical equipment, including the overhead system, £5,471; the 12 cars, which were being constructed, at a cost of £6,933; and the foundations for the car shed and the superstructure will cost £5,395—totalling about £47,000. The car-shed will have accommodation for 22 cars. For 22 years, remarked his Worship, Exeter had been obliged to put up with a very inefficient and very inadequate service of tramways. Two years ago people were surprised at the statements which he made from Board of Trade returns, that for the year ending June 30, 1902, the present horse tramways carried 407,000 passengers, and the 'buses 42,000, whilst the takings of the tramways amounted to £1,690; but during the nine months that the Corporation had worked the tramways they had carried 414,645 passengers, and the takings amounted to £1,730, so that if in 12 months they could carry close on half a million people with such an inefficient and inadequate service, handicapped as it had been during the past three or four months by the work of reconstruction, he thought they might justly assume that electric tramways extending from Heavitree to St. David's on the one side, and from the cemetery to Dunsford Gate on the other, would amply repay the citizens for the capital the city was expending upon them.

Trafford Park.—The following interesting paragraph is extracted from the *Manchester Guardian* of the 30th ult.: "It is announced that the American Car and Foundry Company have acquired a site in Trafford Park for the purpose of erecting large works for the manufacture of railway wagons and carriages. This company already possess 15 large works in the United States, and their daily 'output' is more than 300 wagons and carriages. They have just undertaken a contract for the supply of the railway carriages for the Baker-street and Waterloo Underground Railway in London. All these carriages will be built and finished at the new establishment in Trafford Park. The only portion of the work which will be imported will be the steelwork, which will be received in a finished state. The remainder of the work will be done in England, and will necessitate the employment of local labour to the extent of £15,000 to £20,000. Although the land at Trafford Park was only acquired yesterday from the Trafford Park Estates, Limited, the company expect to have the workshops erected and the necessary equipment installed and to commence delivering the finished carriages early in March. We believe that the company were pressed to establish their works in the South of England, but that they preferred to come to Manchester. The exceptional advantages for speedy transport offered by the Ship Canal Company and the Trafford Park Estates, Limited (who have connections with all the important railways), coupled with the fact that the supply of the special kind of skilled labour which will be needed is larger in Lancashire than elsewhere, have doubtless weighed with the company in arriving at this decision. The works, which are about to be erected immediately, are only of a temporary character, but it is expected that the further railway contracts which the company are likely to obtain in this country will result in the building of extensive permanent works upon the same site in the near future."

London United Tramways Co.—In an interview the other day Mr. Clifton Robinson stated that a start will be made early next year with the extensive scheme of tramways throughout Kingston, Surbiton, the Dittons, Malden, and Wimbledon, the area embracing 15 route miles. Starting from a physical junction with the existing tramways at Hampton Wick, the route about to be built traverses Kingston Bridge, and proceeds the whole length of Clarence-street to its junction with Eden-street. At this point a line will branch off, and pass down Eden-street, St. James's-road, Penrhyn-road, Surbiton-road, and Claremont-road to Surbiton Station. Here there will be another junction, one line running *via* Victoria-terrace, Brighton-road, and Portsmouth-road to Thames Ditton, and thence on to Bridge-road, East Molesey; while the other line runs up Victoria-road past St.

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Mark's Church, along Ewell-road to Tolworth, and *via* Ditton-road, Hook-road, and Southborough to the North Star at Hook. From the junction of Clarence-street and Eden-street, Kingston, one line will go the whole length of Richmond-road to the borough boundary at Ham, and a branch will run along King's-road up to Richmond Park gates. Another line will run up to the George and Dragon, Kingston-hill, and at Cambridge-road there will be a branch leading to New Malden, and thence *via* Burlington-road and a new road to be constructed to Raynes Park, and along Worple-road into Wimbledon. There is a terminus at the foot of Wimbledon Hill, but the line will cross the railway bridge, and run on through South Wimbledon to the terminus of the London County Council tramways at Tooting. It is understood that arrangements have been come to with the Surrey and Middlesex County Councils for the widening of Kingston Bridge. Mr. Robinson treated the agitation concerning the noise of the tramways humorously. Half a dozen of the authorities have declined to join the movement, but the company will endeavour to remove any reasonable cause of complaint.

London County Council.—At Tuesday's meeting the Council approved the Tramways Bill, which provides for carrying the system over the bridges and along the Embankment, and other smaller works to which we have already referred. The Highways Committee recommended that advances be made to Messrs. John Musgrave and Sons, Limited, notwithstanding the strict terms of the contract, as considerable progress has been made with the erection of the four 5,000-h.p. steam-engines at the Greenwich power station, for which the total order amounts to £96,713. They also recommended that expenditure on capital account not exceeding £2,250 be sanctioned for the provision of brick compartments for the switchgear at the same station, the contractors for this work being Messrs. H. Lovatt, Limited. For the reasons given in our issue of Oct. 28, the committee reiterated their recommendation that the proposal to supply seats for motormen and conductors be rejected. The committee are prepared, however, to arrange for shorter periods of duty. A correspondent to the *Times* states that the roadway along the Embankment is in a very unstable condition owing to the principles of Macadam having been disregarded by the use of irregular-sized stones. At last night's meeting of the City Corporation Alderman Sir John Bell presented a petition from the President and Court of Governors of Sion College against the proposal to run tramways along the Embankment. The receipts from April 1 to Nov. 19 totalled £429,634, against £337,462 last year. The Camberwell Borough Council have decided to urge the County Council to proceed with the construction of the authorised tramway lines in the district by local labour. Preparations are being made for the construction of the Dulwich tramways, the housebreakers being actively at work on Denmark-hill. The Stepney Borough Council have decided, in regard to certain lines, to oppose the Council's Bill for leave to dispense with the sanction of the local authorities to the use of the overhead system.

Pietermaritzburg.—The Corporation electric tramways were opened on the 2nd ult. in the presence of a large and representative company, which included the Mayor and Mayoress, numerous councillors, Government officials, Mr. R. W. Weightman (telegraphs engineer), the borough engineer (Mr. F. Walton Jameson), the tramways manager (Mr. P. Finlayson), the borough electrical engineer (Mr. Skidmore Ashby), and members of the power station staff. The Government engineer, Mr. Bosman, had given his approval earlier in the day. After an inspection of the power plant the party proceeded to the switchboard room, where the duty of turning on the current was performed by the daughter of Councillor C. W. B. Scott, chairman of the Tramways Committee. Satisfactory trials were then run on three cars, and the service was opened to the public. At the luncheon which followed, the chairman of the Tramways Committee referred to the efforts of the borough electrical engineer (Mr. Finlayson) and the borough engineer (Mr. Jameson), who had persevered with the scheme in the face of difficulties, such as the South African War and public apathy in the earlier history of the undertaking. Mr. Finlayson, in the course of his reply, expressed great confidence in the possibilities of the scheme, and recommended the provision of such attractions as bands at the Botanical Gardens and other places, which he thought would prove a valuable factor in enlarging the traffic. He deprecated premature reduction of fares, and quoted the opinion of Mr. John Young, late manager of the Glasgow tramways, that overlapping stages were a mistake. He also paid a tribute to the capabilities of his staff. Subsequently Sir George Sutton, the premier of Natal, pronounced his benediction on the undertaking. The system extends over some seven miles, and the total cost approximates £105,000, a large proportion of which was raised in this country. The Botanical Gardens and Scottsville sections are not quite complete, but are expected to be ready in the course of a few weeks. Extensive patronage has been accorded to the cars.

Aberdeen.—It is proposed to effect certain modifications of the tramway service during the winter, but these will not be of a very extensive character. Mr. Bell, the electrical engineer, reported to the Tramway Committee on Tuesday upon the accident which occurred on Friday last in Castle-street, when one of the live wires was broken and fell, entailing considerable danger to those who were on the street in the vicinity at the time. Mr. Bell pointed out that the accident was due to the negligence of one of the Suburban car conductors. The committee agreed to instruct Mr. Bell to send to the secretary of the Aberdeen Suburban Tramways Company a statement drawing attention to the matter, so that every care might be taken in future to prevent accidents of a similar character. Mr. Bell submitted a report as to the necessity of having a motorcar to be jointly used by the tramway, lighting, and electric departments for getting speedily to any place in the event of an accident occurring, as thereby life might be saved or danger to citizens obviated. It was remitted to the conveners of the three departments to enquire into the proposal. The committee agreed that a new system of indicating the destinations of cars, similar to that in operation at Manchester, should be adopted. Instead of having the destination painted on the cars, slipboards, with the names of the places, will be attached to the ends and sides of the cars, rendering them interchangeable. The dispute between the Corporation and the Great North of Scotland Railway Company, to which we referred in our issue of the 11th ult., came before Lord Pearson last week. The purpose of the application was to obtain interdict against the respondents making or maintaining in Union-street and Bridge-street a tramway passing place, junction, or such work, without the consent of the complainers, at a space less than 9ft. 6in. from the outside of the foot pavement opposite complainers' property of the Palace-buildings, as said pavement existed on Aug. 19 last and before proceedings by the respondents. An injunction was also sought restraining the Corporation from making alterations to Union-street or Bridge-street so as to diminish the width of the pavement opposite the complainers' property in these streets. The complainers referred to the negotiations in 1903 regarding the respondents' application for a provisional order to make and maintain certain lines of tramway in Aberdeen. After much negotiation the complainers agreed to withdraw their opposition to the order which was accordingly obtained, but upon certain terms, and a clause was inserted on the assumption of the permanency of the foot pavement of the width then existing. On May 11 the burgh surveyor wrote to the respondents' general manager with a plan showing a proposed additional junction between the tramway as authorised in Bridge-street and the existing tramways in Union-street. The nearest rail to the foot pavement at complainers' property was shown as only 9in. off, and showing a proposed rounding off and narrowing of the foot pavement at the junction to the extent of 6ft. The complainers wrote that they could not see their way to agree to this. On July 30 notice of application to the Board of Trade for consent to this junction appeared in the newspapers, and the complainers lodged representations strongly objecting to the proposals, but while this was before the Board of Trade the respondents' workmen, during the night of Aug. 19, curtailed the foot pavements, and narrowed them to the extent of about 7ft. 6in. width at the corner. The Board of Trade declined the company's application for a prohibition of the junction. The Corporation denied infringement of the company's rights, and contended that they had acted within their powers and with the consent of the Board of Trade. They do not project any further alterations to the pavement. Lord Pearson refused an interim injunction, and the case will in due course go to the Court of Session.

LIGHTING AND GENERAL.

Plean (Stirling).—The church of Plean has just been lighted by electricity.

Bethnal Green.—The Borough Council's electric lighting scheme is estimated to cost £80,000.

Islington.—Mains are to be extended, at a cost of £220, to meet recent applications for current.

Retford.—The Traders' Association has decided to memorialise the Corporation against the proposed electric lighting scheme.

Burgess Hill.—It is expected that a move will be made shortly with regard to the Council's electric lighting provisional order.

Boston.—An enquiry has been held into the application of the Town Council for sanction to borrow £20,000 for electric lighting purposes.

Sales of Plant.—Particulars of sales of various plant by the county borough of West Ham, the Western Electric Company, and others will be found in another column.

Newport (Mon.).—The electrical power service was suspended for an hour at mid-day on Tuesday owing to an obstruction in the water-meter at the Corporation-road works.

Goole.—The Board of Trade have decided to defer the consideration of the question of revoking the Urban District Council's electric lighting order for one year from Dec. 31 next.

Maidenhead.—An enquiry has been held into the Town Council's application for a loan of £7,000 for purposes of electric lighting, including extensions to Bray, Maidenhead Court, and Taplow.

Carnarvon.—The laying of the cables has now been practically completed, and the construction of the building at Balaclava is well in progress. It is hoped that the whole work will be completed by Christmas.

Haywards Heath.—The Haywards Heath Electric Supply Company have notified that they do not intend applying for a provisional order this year, but the Urban District Council will apply for an order themselves.

Stock Exchange. — The Stock Exchange Committee have ordered the Calcutta Tramways Company's further issue of 2,732 ordinary shares of £5 each, fully paid, Nos. 102,269 to 105,000, to be quoted in the official list.

Ormskirk.—The District Council have been informed by the Local Government Board that, notwithstanding the objections of the Council, the Board would issue an order authorising the Guardians to proceed with the electric lighting works at the workhouse.

Change of Address.—The registered office of the Newcastle-upon-Tyne Electric Supply Company, Limited, at Newcastle, has been removed from 50, New Bridge-street to Royal Exchange-buildings (situate at the corner of Grey-street and Hood-street).

Torquay.—To give employment to men in need of work, the Local Government Board have been asked to provisionally sanction the expenditure forthwith of £10,000 on account of the loan of £42,000 for the excavations, etc., of the new electric lighting works.

Huddersfield.—At the last meeting of the Chamber of Commerce a discussion arose on alleged defects of the local telephone service, and it

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was decided to approach the National Telephone Company and also to communicate with Sir James Woodhouse and Sir Albert Rollit in the matter.

Dover.—The Electricity Committee have decided to adopt prepay ment meters, and in inviting applications state that for every 6d. placed in the slot sufficient energy will be obtained to light an 8 c.p. lamp for about 32 hours, or a 16-c.p. lamp for 16 hours. There is no charge for meter rent.

Southall-Norwood.—The Urban District Council are applying for an electric lighting provisional order because a private company is applying for powers. At the last meeting it was distinctly stated that the action of the Council was only in defence of the ratepayers, and not against the gas company.

Electrical Goods for Australia.—We are informed that Mr. O. L. Remington, general manager of Messrs. Wm. McLean and Co., of Melbourne, will be at the Hotel Cecil after Dec. 3 for the purpose of arranging for the representation in Australia of new lines of electrical goods and appliances. Mr. Remington also offers to reply to any manufacturer desiring information on the Australian electrical situation.

Gravesend.—The following committees have been appointed: Electric—The Mayor; Aldermen Russell and Wood; Councillors Sandford, Berkowitz, Rhodes, Davies, Enfield (chairman), Naylor, Archer, Prevost, Cosh, Byrne, Tolhurst, Schultz and Goldsmith. Paving, Lighting and Works, and Tramways—The Mayor; Aldermen Russell, Fletcher, and Cooper; Councillors Sandford (chairman), Berkowitz Davis, Enfield, Walter, Archer, Prevost, Cosh, Byrne, Tolhurst, Schult, and Goldsmith.

Portsmouth.—The Portsmouth municipal telephone exchange has obtained the County Council's consent to the erection of a line of telephone poles on the main road between Havant and Rowlands Castle. We understand that the Corporation are experimenting with four arc lamps of a new type. The lamps will be of between 800 c.p. and 1,000 c.p., and will cost £10 per annum apiece, as compared with the present cost of £18 per annum per lamp. The Roads and Works Committee propose to erect one of these lamps each in Portsmouth, Southsea, Landport, and Copnor.

Middlesbrough.—Messrs. Pease's Tubular Construction Syndicate, of Darlington, have been awarded the contract for the construction of a large electrical power station at Messrs. Bell Bros' steelworks at Middlesbrough, which will be entirely composed of patent steel frame plates and galvanised sheets on a foundation of concrete. The power plant, which will be one of the largest in any of the industrial establishments in the United Kingdom, will consist of three high-speed direct-coupled engines and generators, and a combined horizontal engine and dynamo, giving 1,250 i.h.p. The plant will also supply power to the works of Messrs. Dorman, Long, and Co., Limited.

Wolverhampton.—We understand that the new plant which has lately been laid down at the electrical generating station of the Corporation, is working very satisfactorily. This new machinery takes up about half the space of that which it has supplanted, but supplies much more power. The machinery which was laid down about the year 1896 consisted of horizontal rope-driven sets, which generated at a pressure of 2,000 volts. About 1899 the system of supply was changed, the low-tension, three-wire system at 500 volts being substituted. The engine-room, which formerly contained 1,000 h.p., now contains 4,500 h.p., and there is still room left for another 4,000 or 5,000, which may eventually save a large capital expenditure in building.

Mercury Vapour Lamps.—A company has now been formed to work the United Kingdom patents of the Bastian and Salisbury mercury vapour lamp, and Messrs. Rumney and Rumney, 39, Victoria-street, Westminster, have been appointed sole agents. We are informed that the delay which has occurred in putting the lamp on the market is owing to the many improvements that have been made since it was first shown, and that the lamp now designed is a self-contained one, consuming from ·25 to ·3 of an ampere at 200 to 250 volts. The candle-power is, owing to the colour, very difficult to determine accurately. It is estimated at not less than from 120 to 160. The lamp at present designed is only suitable for direct current but the inventors fully expect within a short time to have an alternating-current lamp ready.

The Recent Gale.—Although considerable damage was done to telephone and telegraph wires in some parts of the country, notably at Newcastle, it is satisfactory to know that in a very little time the Post Office authorities will be able to look with complacency on the fiercest storms that may rage. The underground system to Birmingham, which was opened more than two years ago, has worked very smoothly and well. The cables have also been completed as far as Warrington, and the system has been in working order for some time. Subsidiary cables are also working east and west of that town. From Warrington to Carlisle, a distance of 120 miles, the cables will soon be completed. The system from Warrington to Carlisle, it is hoped, will be ready for opening early in the spring, and then an extension of the system will be pushed on to Edinburgh and Glasgow, and subsequently, in all probability, further north.

London Gazette.—The partnership between Walter John Perry and Henry Arthur Aylett, carrying on business as electrical mechanical engineers at 257, Fulham-road and 44, Pelham-street, Chelsea, has been dissolved by mutual consent. The last day for receiving proofs in the estate of Charles Manners Downie, electrical engineer, 4, Bloomsbury-street, London, is Dec. 12. George Stapylton Barnes, late senior official receiver and liquidator, has been released from Nov. 21 in the matter of the Electric Railways Company, Limited. A receiving order has been made out on creditors' petition in the estate of William Watson and George Hautingdon, electricians, 83, Battersea-rise, Bond-street, London. The first meeting will be held on Dec. 9, at 2.30 p.m., at Bankruptcy-buildings, Carey-street, London. A receiving order has been made out on debtor's petition in the estate of Harry Cooke, electrical engineer, 102, Bucclench-road, Normacot, Longton.

Leigh.—An enquiry has been held into the application of the Corporation for sanction to borrow £16,115 for the purpose of extending the electricity works. The first installation at the electricity works was completed in February, 1899, and the loss on the working up to Nov. 9 of that year was £338; between Nov. 9, 1899, and March 31, 1900, the deficit was £247; and for the year ending March 31, 1901, the loss amounted to £101. Since then there have been profits made every year, that to March, 1902, being £80; to March, 1903, £263; and to March, 1904, £336. The total profits since the opening of the works, therefore, have been £681 and the total losses £687, so that the net loss has been only £6. This, said the town clerk yesterday, was a very good record considering the character of the works. There are at present 164 light and 87 power consumers, and the works are short of plant. The number of units sold has increased from 76,998 in 1899 to 460,305 this year.

Erith.—Messrs. Hawtayne and Zeden, the consulting engineers, have reported the inspection by them of the work being carried out by Messrs. Yates and Thom, Sir Hiram Maxim Electrical and Engineering Company, and the British Westinghouse Electric and Manufacturing Company, Limited, and found the same proceeding in a satisfactory manner. The Electricity Committee have further considered the application of Callender's Cable and Construction Company, Limited, for an additional supply of electric energy to their works, and have offered to enter into an agreement with the company, for the period of three years from date of acceptance of the offer, in lieu of the existing agreement, upon the following terms—viz.: to supply the whole of their demand upon a rebate system at the rate of 6d. per unit for the first hour's use per day of the maximum demand, and 1½d. per unit for all additional units, subject to the following discounts—25,000 and under 50,000 units per quarter, 9 per cent.; 100,000 units and over per quarter, 18 per cent., provided that the discounts shall only be allowed upon payment of the account within one month from the date of rendering the same. The committe recommend that the above tariff be adopted for all consumers o 100,000 units and over per annum.

Private Institutions.—Extensive additions and alterations have lately been made in the electric lighting arrangements at Culford Hall, the residence of the Right Hon. Earl Cadogan, K.G. Under the direction of Mr. R. S. Williams, M.E.I., the mansion has been extensively rewired, and at the generating station great improvements have been made. The engines have been separated from the boilers and placed in an adjoining room. A larger and more powerful boiler has been added to the plant, and a compound cylinder engine has been fitted up in the engine-room. Mr. L. A. Waterfield has also a recent installation at Dunstable. The engine, dynamo, switchboard, and accumulators have been installed in buildings some little distance from his house, current being taken thereto by lead-covered underground cables. The plant consists of a 7-h.p. Crossley gas-engine, driving by means of a long belt a Holmes Castle dynamo capable of running 140 8-c.p. lamps, or, in conjunction with the cells, 240 such lamps. There is a switchboard of three panels in black and white marble, with Nalder volt and ampere meters, an automatic charging switch, etc. The accumulators are located on the floor above, and are of E.P.S. Company's make, "K" type, and large enough to run all the lamps in the house for four or five hours. The contractors were Messrs. Garrett Bros. and Co., of Dunstable and Northampton.

Bermondsey.—At the last meeting of the Borough Council Councillor Vezey, chairman of the Electric Lighting Committee, in presenting the terms upon which it was proposed to supply electrical power and light to the Surrey Commercial Dock Company, said the tariffs were based upon the consumer's maximum demand and the number of hours per day the electricity is being used. If the electricity was used continually during the day the charge per unit is considerably reduced as compared with the charge made for a small day supply, as the standing charges of the Council's plant were the same practically whether the plant is working or at a standstill. The Dock Company were prepared to enter into an agreement for five years, with option of renewal for a second five years, at the following charges: For power, 2d. per unit up to 10,000 units per annum; 1¾d. for each unit beyond 10,000 and up to 20,000 per annum; 1½d. for each unit in excess of 20,000 per annum. If the consumption exceeds 50,000 per annum, the first 50,000 will be charged at 1½d. per unit; from 50,000 to 100,000, 1¼d. per unit; and all current in excess of 100,000 units at 1d. per unit. For lighting, 3½d per unit; any excess to be added to power consumption and charged accordingly. He moved that an agreement be entered into with the company upon these terms. The terms of the supply were fixed by the Council on Oct. 6, 1903, and those terms were adopted by the committee as the basis of a sliding scale upon which this agreement was based. After discussion the matter was again adjourned.

Electric Lighting Audit Regulations.—The following letter has been addressed by the London County Council to the Camberwell Borough Council: "The Highways Committee of the Council have given very careful consideration to the question raised in your letter of June 18, 1903, on the subject of competing electric lighting services in the borough of Camberwell, and to the points which arise in connection therewith. The committee have had the matter before them from time to time in connection with the general question of the electric lighting supply in London, and they have not, therefore, been in a position to reply before, at length, to the letter of the Borough Council. In connection, however, with the question of the audit of accounts the committee have instructed me to submit certain observations. With reference to the refusal of the Board of Trade auditor to hear the Camberwell Metropolitan Borough Council on the audit of accounts of the County of London Electric Supply Company, I am to suggest, for the consideration of the Camberwell Metropolitan Borough Council, that Section 8 of the company's order might be construed as

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enabling the Board of Trade to direct the auditor to take into account the circumstances of the company and to allocate the capital expended between areas of the various local authorities in which the company is operating, and to prescribe that any party interested should be allowed to appear and be heard before the auditor. In this connection the committee would suggest that the Borough Council might consider the question of applying to the Board of Trade to make regulations to meet this point. The committee feel that the Council could not, with advantage, make representation to the Board of Trade on the question of the refusal of the Board to grant a competing order in Camberwell."

Southend.—An enquiry has been held into the application of the Town Council for sanction to borrow £56,000 for electric lighting purposes. The town clerk (Mr. W. H. Snow) and the electrical engineer (Mr. W. E. J. Heenan) gave evidence. The Town Clerk said the loan was required for extensions of the boiler-house and engine-house at the electricity generating station and for increasing the plant by the provision of four boilers, three dynamos, and an economiser, in accordance with the electrical engineer's particulars. The Council also wished to borrow money for the extension of the electric lighting mains through 53 additional streets as occasion might require. The engineer had told them that for present requirements they ought to have one additional dynamo and two boilers. The whole of the money would have to be expended within three years. The demand for electric lighting was increasing rapidly, and the application was made so that they might not keep consumers waiting. At the time of the application for the last loan for electric lighting in September last year the number of lamps connected with the mains were 27,800, and in October of the present year 42,284, giving an increase in a year of 14,484 8-c.p. lamps. The total capacity of the present generating plant was 1,125 kw., but on Sept. 24 the lighting load had reached 534 kw. and the traction load 330 kw., making a total of 864 kw. This left only a margin of 261 kw., reckoning upon the present demand, and the demand was increasing steadily. If one of the 350-kw. dynamos became disabled, they would have to shut down the works because they had not enough stand-by. For the financial year ending March 31 last the net profit was £358. 14s. 2d., but it was only since October, 1902, that they had been able to give a continuous supply. The Electrical Engineer stated that one of the items was an amount of £2,400, which would provide for 300 lamps at £8 each to be used for purposes of street-lighting.

Edmonton.—The District Council held a special meeting on Thursday night, Nov. 24, to consider the offers of the North Metropolitan Electric Power Supply Company, the Industrial Engineering Company, Foot and Milne, Limited, and the National Construction Company, Limited. Mr. Hawes (of the firm of Hammond and Son, consulting engineers) was present, and made an exhaustive report on the offers. He explained that that from the North Metropolitan Company was practically an offer to take over the Council's powers and work the undertaking on their own lines, the Council not to have the privilege of purchasing it until after the expiration of 26 years. The current would be supplied from one of the company's large power stations to a transforming station in the district, and would be distributed on the three-phase system. That might be a disadvantage to the Council when they acquired the undertaking, because the district was eminently suitable for a direct-current supply. The company limited the mains at the start to the compulsory area, whereas he did not think the Council would do so if they established the works. The rates of charges quoted by the company were quite reasonable both for lighting and power, and also for public lighting, provided that the latter included the carboning, trimming, and maintenance of public lamps. The company gave the Council the option of considering the revision of the tariff every seven years. They were willing to divide the net profits after taking 5 per cent. upon the whole of the capital involved, which he supposed would mean after also paying directors' fees. The other three offers were of a different character, being for the execution and maintenance of works. Foot and Milne, Limited, offered to maintain the undertaking for 25 years, and to give the Council certain conditions of purchase up to 15 years. After six months' notice they were prepared to transfer the undertaking to the Council upon the Council paying any loss they might sustain plus 4 per cent. interest, but less 4 per cent. on any surplus profits which they might make beyond the amount of the interest and sinking fund, which they would have to pay to the Council. They did not state the prices for current, which was a bad fault. The Industrial Engineering Company's offer was conditional upon the Council laying down gas-driven dynamos, and upon all the plant being manufactured by themselves. They further agreed to work the undertaking for only five years, and under their terms, if the Council decided to take it over within that period, they would practically have to guarantee them a gross profit of nearly 10 per cent., which would be an extraordinary yield. The offer from the National Electric Construction Company deserved the Council's consideration. They were prepared to tender for the complete works to the Council's own specification, and they required a bonus of 5 per cent. on the net price of the tender. They agreed to maintain for 25 years, and they gave the Council the option of purchase at seven, ten, or fifteen years—at seven years on the basis of the payment of a bonus of 12 per cent., at 10 years of 7½ per cent., and at 15 years of the exact amount of the capital expended. They agreed to divide all the profits beyond 3 per cent. if the option to take over at seven or ten years was not exercised. Their prices were distinctly favourable—flat rate, 5d. per unit; maximum demand rate, 7d. per unit for the first hour and 2d. afterwards. For power they quoted a sliding scale. Mr. Hawes also dealt with an offer received from the Metropolitan Company to supply in bulk. Their prices worked out at about 2·37d. per unit for maximum demand supply for 200 hours, and 2d. per unit for regular supply every day of the year for 300 hours. His firm did not see how the Council could afford to pay for a bulk supply, high-pressure tariff, at a price exceeding 1·14d. per unit. Failing an offer approaching that figure the Council should devote their attention to the tender of the North Metropolitan Company to take over the Council's powers, or to that of the National Electric Construction Company. A long discussion ensued upon a motion that the former of these two offers should be accepted. An amendment was brought forward that a contract should be entered into with the latter company. Several members reflected upon the methods of the North Metropolitan Company. The meeting was in the end adjourned under the standing orders without the amendment having been voted upon.

Stoke Newington.—At a special meeting of the Council on Tuesday the following report and recommendations of the Electric Lighting Committee were adopted: "The publication in the month of June last of the committee's report of the 16th of that month, led to the reopening of negotiations which have resulted in the modification of the scheme which the committee previously submitted to the Council, and the committee now submits that scheme so modified for the approval of, and adoption by, the Council. The main outlines of the scheme remain as at the date of the committee's report of June 16, 1904, but certain modifications are suggested as hereinafter detailed. The chief modification which the committee has sought and obtained is the introduction of a safeguard against any possible loss by the Council during the early years of the working of the undertaking, a loss which the committee in its last report estimated as possibly involving a charge on the rates of about 1d. in the £. It has now been arranged that during the first three years of the Council's undertaking, and for such additional number of years as the Council shall think fit, the company supplying the energy shall be paid for such energy the amount of the net revenue which the Council may derive from the undertaking, and that any loss which may occur shall be borne by the company. Whenever the Council thinks fit this arrangement may be determined, by not less than six months' previous notice, on March 31, 1909, or any subsequent March 31. Upon such determination the scheme outlined in the committee's report of June 16, 1904, will come into operation with the following modifications: (1) It is left open to the Council to make an arrangement with the Islington Council for the supply of energy at or near the junction of Blackstock and Seven Sisters roads to enable this Council to comply with an application recently received for the supply of such energy; and provisions are made for the continuance of any such arrangement with the Islington Council, similar to the provisions previously made respecting the Council's agreement with the Hackney Council. (2) The minimum period of 12 years mentioned in the former report as the period before the expiration of which the agreement there detailed could not be determined will now run from the determination of the system already explained as intended to apply to the early years of the undertaking. It is a part of the scheme that the Council's scale of charges shall be revised, so that instead of a uniform or flat rate of 5d. per unit for light, consumers shall pay on the maximum demand system at the rate of 7d. per unit for the first hour's daily use of the maximum demand in each quarter and 2d. per unit for all subsequent consumption; and that in place of the present 3d. per unit for power there shall be charged 5d. per unit for the first hour's daily use of the maximum demand and 1d. per unit for all subsequent consumption when the demand does not exceed 20 h.p., with the substitution of 4d. for 5d. when the demand does exceed 20 h.p. Present consumers, however, are to have the option of continuing at present rates. The charge for public lighting is to be 1·45d. per unit for lamps alight during all-night hours, and 1·85d. per unit for those alight during half-night hours. So far as regards the nine arc lamps in High-street and Stoke Newington-road, the total charge is not to exceed the £20 per lamp now payable to the Hackney Council. The scheme outlined in the committee's report of June 16, 1904, is to be proceeded with. The works are to be carried out to the reasonable satisfaction of the company, and the agreement provides for such extension as the Council and the company may agree, or as the Council may be lawfully called upon to undertake. Provision is made for the reference to arbitration of disagreements on these points. The company is to bear as part of the expenses of the undertaking the interest and sinking fund or repayment of loan upon the capital outlay involved by the scheme, including the £3,000 already raised, and if the London County Council should require a maintenance or reserve fund for repairs or renewals, that also is to be similarly borne; but if any part of the last-mentioned fund remain at the termination of the period during which the company is to take the profits and bear the losses, the amount so remaining is to be repaid to the company. When the yearly receipts for energy supplied for lighting exceed 4d. per unit for the total number of units supplied during the year, the excess is to belong to the Council, and similarly any surplus over 3d. per unit for the total number of units supplied during the year for power is to go to the Council. The agreement submitted by the committee with its report on June 16 last has been revised in accordance with the foregoing provisions, and the revised agreement is now submitted herewith. Since June 16 the company has commenced its supply of electrical energy for the purposes of the running of the trams connecting Finsbury Park with Tottenham and Wood Green, and the tramcars have been running for some time past. In lieu of the recommendations in its report of June 16, 1904, the committee recommends: (1) the adoption and sealing of the agreement with the North Metropolitan Electric Power Supply Company submitted herewith; (2) the adoption and carrying into effect of the scheme outlined in this report, including the acquisition of the necessary sites, the erection and equipment of the necessary station, and the laying of cables in Church-street, Lordship-road, Lordship-park, Manor-road, Woodberry Down, and Seven Sisters-road; (3) the reference to the General Purposes Committee of the acquisition of the sites for the meter and transforming stations; (4) the immediate appointment of the Standing Electric Lighting Committee, and the reference to it of all the foregoing works other than the acquisition of the said sites. At the next meeting of the Council it will be proposed that the agreement be sealed.

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PROVISIONAL PATENTS, 1904.

Nov. 21.

25243. Improvements in or relating to the "party line" system of telephones. Harry Benwell Stocks, 5, John Dalton-street, Manchester.

25248. Improvements in or in connection with electric ignition apparatus for internal-combustion engines. William Clapham Priestley and Benjamin Holroyd, 30, Park-row, Leeds.

25249. Improvements in electric switches for the ignition circuits of multiple-cylinder explosion motors. Ernest Talbot and David Môndey, Bank-buildings, George-street, Sheffield.

25265. Improvements in or relating to the manufacture of storage battery or accumulator electrodes. Alfred Julius Boult, 111, Hatton-garden, London. (Accumulatoren und Electricitäts- werke Actien-Gesellschaft vormals W. A. Boese und Co., Germany.)

25276. Improvements in vapour electric lamps, rectifiers, and the like. The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

25282. Improved electrode for apparatus producing radiant electrical energy. Siemens und Halske Aktien-Gesellschaft, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 24 1903, being date of application in Germany.) (Complete specification.)

Nov. 22.

25329. Improvements in electrical measuring instruments. William Clark Fisher, 24, Albany-road, West Ealing, W.

25331. Improvements in treating the contents of electrolytic cells. James Hargreaves, May Villa, Farnsworth-in-Widnes, Lancs.

25370. Improvements in telephony. John Hodgson Lee and Arthur Emilio Roles Bottone, 3, Arlington-street, London.

25376. Improvements in or relating to electric batteries. Heinrich Csanyi, Eugén Klupathy, and Gabriel von Bárczay, 111, Hatton-garden, London.

25378. Improvements relating to electric air-gap condensers for use with high-frequency currents. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane. London. (The Electro-Radiation Company, United States.)

25382. Improvements relating to rotary spark-gap apparatus for use with high-frequency currents. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The Electro-Radiation Company, United States.)

25386. Improvements in single-phase commutation motors. Thorsten von Zweigbergk, 18, Southampton-buildings, Chancery-lane, London.

25466. Improved method of amplifying variations of energy in electric circuits. Peter Cooper Hewitt, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

Nov. 23.

25458. Improvement in electromagnetic circuit breakers. Veritys, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham

25463. Improvements in and connected with brush-holders for dynamo-electric machines and electric motors. Ernest Sherwood Woollard Moore and Sidney Bourne, Prince's-chambers, Wolverhampton.

25492. Trolley for electric cars. Lewis Mitchell McBride, 81, High Holborn, London.

25498. Improvements in the construction and attachment of gear wheels for electric and similar high-speed cars. Alfred Wiseman, Prudential-buildings, Corporation-street, Birmingham.

25504. Oscillating magneto sparking plug. Richard Howard Derry, 3, Shenley-road, Camberwell, London.

25519. Improvements in electric incandescent candle lamps. Frederick Charles Dafforn, 34, Sherborne-gardens, West Ealing, London. (Complete specification.)

25524. Improvements in electric lighting of railway carriages and the like. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (John Denham, Cape Town.)

Nov. 24.

25592. Improvements in electric switches. Charles Ernest Hunter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25610. Improvements in or relating to wireless telegraphy. Franklin Wise Howorth, 46, Lincoln's inn-fields, London. (George Owen Squier, United States.)

25613. Improvements in trolley wheels for use on electric railways. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Solomon W. Bates, United States.)

25620. Improvements in apparatus for controlling or/and supplying current for power and light on consumers' premises during certain periods. Alfred Mills Taylor, 77, Chancery-lane, London.

25625. Means for facilitating the control of accumulator cells. Henry Leitner, 4, South-street, Finsbury, London.

25630. Improvements in and relating to systems of control for electrically-operated doors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25631. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25632. Improvements in and relating to electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25633. Improvements in reverse-current relays. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25634. Improvements in seals for vacuum tubes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25635. Improvements in attachments for trolley poles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25636. Improvements in and relating to electric power transmitting mechanism. The British Thomson-Houston Company, Limited, Hans Sigismund Meyer, and Bernard Hopps, 83, Cannon-street, London.

25637, 25638, 25639, 25640, 25641, 25642, 25643, 25644, 25645, 25646, and 25647. Improvements in or connected with space telegraphy. John Stone Stone, Norfolk House, Norfolk-street. Strand, London. (Dates applied for under Patents Act, 1901, Nov. 24 and 25, 1903, being dates of application in United States.) (Complete specification.)

Nov. 25.

25648. Improved electric glow lamp with combined reflector or shade. Walter Bidford Spurrier, Laurel Villa, Gibbs-road, Newport, Mon.

25682. Improvements in arc lighting lamps. Lorens Sigfrid Andersson, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 30, 1903, being date of application in Sweden.) (Complete specification.)

25693. Improvements relating to insulated chairs for carrying electric current conducting rails. Walter Way, 27, Dalling-road, Hammersmith, London.

25708. Improvements in electric projecting lamps chiefly for enlarging and projecting lanterns. Leo Kamm, 27, Powell-street, Goswell-road, London.

25729. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25730. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 26.

25764. Improvements in electric motor controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25781. Improvements in or connected with electric ignition apparatus particularly applicable for explosion engines. Lewis Charles Ingram, Samuel Raphael Cohen, and Barnett Raphael Cohen, 33, Chancery-lane, London.

25784. Improvements in means for regulating electric circuits. Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

25786. Improved construction of appliances for producing electric light displays. Alexander Elis Dakhyl and Antonio Gallanti, 173, Fleet-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 8, 1904.

1904.

1027. Electric light switches, electric bell pushes, and the like. Beldam.

1036. Accumulators or secondary batteries. Pescatore.

1044. Electrical contact maker for gas, oil, and all internal-combustion engines. Alltree.

2496. Apparatus for producing oscillatory electric currents. Hewitt. (Date applied for under International Convention, Feb. 9, 1903.)

4953. Apparatus for automatically interrupting an electric current. Aktiebolaget Svenska Elektriska Urfabriken. (Date applied for under International Convention, March 3, 1903.)

6972. Electrodes for arc lights. Gerard and Fiedler.

14136. Brush-holders for dynamo and other rotary electrical machines. Foot. (Date applied for under International Convention, June 24, 1903.)

17741. Alternating-current power-transmitting apparatus. Fairweather. (Arnold Magnetic Clutch Company.)

19125. Brush-holders for dynamo and other rotary electrical machines. Lamme. (Date applied for under International Convention, Sept. 16, 1903.)

20896. Manufacture of water jackets, casings, and the like by electrolytic means. Bosquet.

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21463. Method for increasing the activity in electrode masses of badly-conductive metallic oxides or hydrates in accumulators with invariable electrolyte. Jungner. (Date applied for under International Convention, Oct. 31, 1903.)

21795. Dynamic-electric clutch or electromagnetic gearing. Von Lieben and Reisz.

21913. Manufacture of galvanic cells. Ziegenberg.

To be published Dec. 15.

1903.

25669. Electric conductors or cables. Brown.

25854. Suspenders for overhead electric conductors. British Thomson - Houston Company, Limited. (The General Electric Company.)

25970. Current collector for use in stud-contact systems of electric traction. Griffiths and Bedell.

26180. Electric fuses or cut-outs. Hepke, Diener, and Ascher.

28252. Electric lighting batton for theatrical and other purposes and method of preventing confusion of colours by lamps therein. Sunderland.

1904.

45. Electrically-controlled lifts. Richmond and Carey.

660. Electric alarm bells. Plato.

699. Electric stoves and heating and cooking apparatus. Bauer.

820. Electric switches and the like. British Thomson-Houston Company, Limited. (General Electric Company.)

1326. Electrical switches. Hope, Sugden, and Gardner.

1481. Alternating-current electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

1482. Alternating-current electric motors British Thomson-Houston Company, Limited. (General Electric Company.)

1483 Alternating-current motors. British Thomson-Houston Company, Limited. (General Electric Company.)

1625. Electric arc lamps. Gross.

1642 Electric switchboard. British Thomson-Houston Company, Limited, Wedmore, and Whitcher.

2676. Electric couplings for arc lamps and the like. Schaefer. (Bastians and Wehrmann.)

3328. Switches for electric lighting and heating. Lundberg and Lundberg.

3357. Rapid trembler for induction coil. Marks. (Guenet.)

6429. Elastic insulating clutches for electric dynamos and motors. Lake. (Risso.)

11168. Safety devices for protecting dynamo-electric machinery and the like against the excessive voltage occurring when they are switched in or out. Electricitäts Actien-Gesellschaft vorm. W. Lahmeyer und Co. (Date applied for under International Convention, June 27, 1903.)

15258. Electro-magnetic switch devices for telephone stations. Arnheim. (Rights under Patents, etc., Act, 1901, not granted.)

17672. Induction coils for medical and other purposes. Dymond. (Watson and Wheeler.)

18561. Live-rail protections for electric railways. Linkleter.

20000. Coils for electrical apparatus. Fortescue. (Date applied for under International Convention, Sept 30, 1903.)

20063. Process and furnace for subjecting solid materials to the action of the electric arc. Birkeland and Eyde. (Date applied for under International Convention, Sept. 19, 1903.)

20478. Telegraph systems. James. (Crehore.)

20531. Protectors or polishers for commutators, collector rings, and the like in electric machines. Boult. (Elektricitäts-Gesellschaft Zschockelt m. b. H.)

20689. Regulation or control of dynamo-electric machines and electric motors. Schneider.

22287. Electrical switches. Lundberg and Lundberg.

22536 Auxiliary appliance for the prevention of the occurrence of excess pressures on switching on and off electrical installations of high voltages, applicable also for testing purposes. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

23031. Fuse heads for electric blasting. Render.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅜-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	15/32-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5¼-6
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅜-2½
—— 4 per cent. Mortgage Debenture Stock	100	–	88-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅜-½
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	69-73
Callender's Cable, Debentures	100	–	104-106
—— Ordinary	5	–	9½-10
—— 5 per cent. Pref.	5	–	5⅛-5⅜
Crompton and Co.	5	–	14-14½
—— 5 per cent. Debentures	100	–	92-97
Edison and Swan United, "A" Shares, 1-99,261	5	–	⅜-½
—— "A" Shares, 01-017,159	5	–	1-1¼
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼-1½
—— 7 per cent. Cumulative Pref.	2	–	2½-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10¾-11¼
—— 4½ per cent. Preference	5	–	5¼-5⅜
—— 4½ per cent. Debentures	100	–	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	20 20½
—— 4 per cent. Debentures	100	–	99-102
Parker, Thos., Limited, Ordinary	10	–	10-10½
Telegraph Construction and Maintenance	12	–	38-40
—— 5 per cent. Bonds	100	–	103-105
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	12-13
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9½-10
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock. Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	7⅜ 8
—— Nos. 20,001-30,000	5	–	7-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12½-13¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	106-109
Charing Cross and Strand, Nos. 1-70,000	5	–	8½-9
—— 70,001-80,000	5	..	8-8½
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅜-5
—— 40,001-80,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	103-106
Chelsea Electricity Supply	5	–	6½-6⅜
—— 4½ per cent. Debentures	100	–	109-111
City of London, Ordinary	10	–	10¼-11
—— 6 per cent. Cumulative Pref.	10	–	13½-14
—— 5 per cent. Debenture Stock	100	–	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	104-106
County of London Electric Supply, Ordinary	10	–	9¼ 9⅜
—— 6 per cent. Cum. Pref.	10	–	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	101-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	5⅞ 6¼
—— 6 per cent. Cum. Pref.	5	–	5¾-6⅛
—— 4½ per cent. First Mort. Deb.	100	–	106-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	102-105
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7⅛ 8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	100-102
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	⅛-¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	–	12-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10½
London Electric, Ordinary	3	–	2-2½
—— 6 per cent. Pref.	5	–	5⅜-5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	97-99
Metropolitan Ordinary	10	–	16-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5⅛-5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	–	14½-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	101-103
Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,310	5	–	6-6½
—— 4 per cent. Debenture Stock	100	–	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2⅜-2½
—— 4 per cent. Debenture Stock	100	–	83-87
South London, Ordinary		–	4¼-4½
South Metropolitan Electric Light and Power Co., Ord.	1	..	⅛-¼
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	107-110
—— Ditto, June, 1904		..	
St. James's and Pall Mall, Ordinary, 101-30,080	5	–	14¼-14⅜
—— 7 per cent. Pref.	5	–	8½-9
—— 3½ per cent. Deb.	100	–	99-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	–4	15/16-5 1/16
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–4	15/16-5 1/16
Westminster, Ordinary	5	–	12⅜-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6½ 7
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅛-5⅜
—— Ord.	5	..	6¾-7⅛
—— Permanent 6 per cent. Debenture Stock. 1888	100	–	143-146
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	106-107
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	9-10
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103
—— Ord Pref.	100	..	102-105
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	–	102-104 p c
—— 4½ per cent. Vancouver Power Deb.	100	–	97-100
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10¼-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	..	95-97

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Name.	Amount paid.	Last price.
	£	£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	3 13/16-3 15/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5⅜-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5⅜-5⅝
—— 5 per cent. Deb. Stock, Red.	100	106-108
—— Prov. Cert., all paid	100	102-105
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	96-99
Calcutta Tramways, Limited, 1-102,268	5	7⅜-7⅞
—— 4½ per cent. 1st Deb. Stock, Red.	100	105-108
Cape Electric Tramways, Nos. 1-480,000	1	1⅛-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4⅞-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	9½-10
—— 5 per cent. Cum. Pref.	10	11-12
—— 4 per cent. Debentures	100	101-103
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb Stock	100	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	3⅞-4¼
—— 4 per cent. Debenture Stock	100	90-93
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	10⅛-10⅞
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	104-106
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	103-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	¾-¼
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	103-105
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-1¼

Name.	Amount paid.	Last price
	£	£
Oldham, Aston, and Hyde Tramway, Ordinary	10	·12½
—— 5 per cent. Cum. Pref.	10	8½-8¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary 20,001-40,000	10	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-8¾
—— 4½ per cent. Debenture Stock	100	99-102
South Lancashire Electric Traction and Power Company —— £250,000 Ordinary	1	1
—— £101,152 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Electric Railways.—

Central London, Ordinary	100	93-95
—— 4 per cent. Pref.	100	101-103
—— " " deferred	100	84-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	108-110
City and South London, Consolidated Ordinary	100	46-47
—— 4 per cent. Debenture Stock	100	104-107
—— 5 per cent. Pref. Stock '91	100	122-125
—— " " " '96	100	117-120
—— " " " '01	100	114-117
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99½-99¾
Waterloo and City, Ordinary	100	88-90

Telephones.—

National Telephone, Preferred	100	107-108
—— Deferred Stock	100	96½-97½
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5⅜
—— 5½ per cent. Deb. Stock, Red.	100	98-99
—— 4 per cent. Deb. Stock, Red.	100	104½-105½
—— 4 per cent. Prov. Cert.	—	67½-68½
Oriental Telephone and Electric Company	1	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 26	1,024	1,076	− 52	+ 5,739h	19½	19½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 26	172	170	− 8	+ 493	8	8	,, 15	14,160	3,201,585	336,049	1·03	10·11	1,770	5·04
Barking Corporation	,, 26	52	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 27	874	973	− 99	− 534	23·53	23½	March 31	56,0·3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Corporation	,, 26	311	—	—	—	—	6½	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 26	4,861	4,956	− 105	—	6½	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 25	707	700	+ 7	+ 3,236	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·99
Blackpool Corporation	,, 24	279	286	− 7	+ 5,913	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 26	170	160	+ 10	+ 331	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	,, 27	1,576	1,685	− 109	+ 363	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·69
Bournemouth Corporation	,, 23	742	778	− 36	+ 2,071	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 19	3,715	3,407	+ 308	+26,248	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 27	669	734	− 65	+ 3,257h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 25	4,354	4,350	+ 4	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 26	912	751	+ 161	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 27	249	300	− 51	—	8½	—	March 31	11,574	2,556,134	282,378	1·08	9·81	1,570	7·57
Cardiff Corporation	,, 26	1,704	1,794	− 89	+ 1,547	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 26	173	161	+ 12	+ 205	—	—	Dec. 31g	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 26	7,229	6,951	+ 278	− 754	6	6	,, 31	362,471	44,953,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 27	3,754	3,310	+ 44	− 1,874h	6½	6⅝	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	,, 23	155	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 24	381	406	− 24	− 2,539	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 25	198	198	—	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 26	146	157	− 11	− 256	4½	4½	,, 31	11,255	2,871,332	280,901	0·91	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 25	79	86	− 7	— h	7	6½	Dec. 31g	6,241	688,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 25	3,341	3,569	− 228	} —	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 25	685	717	− 32											
Dundee City Tramways	,, 23	778	788	− 10	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 24	547	583	− 36	+ 1,422	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 26	12,770	13,159	− 389	+19,780h	145	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 23	204	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 16	2,625	2,352	+ 273	+ 3,872	33	30½	March 31	68,283	16,322,054	1,387,885	1·00	11·79	2,059	8·77
Huddersfield Corporation	,, 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	,, 26	2,042	1,825	+ 217	+ 9,833	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 26	332	327	− 5	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 23	87	126	− 39	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 24	201	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 26	4,970	4,872	+ 98	+11,670	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 26	1,531	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 14	10,075	9,465	+ 610	+14,031	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 27	1,426	1,560	− 134	− 1,884h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— e
London County Council	,, 5	12,382	10,010	+2,372	+75 926	46½	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Oct. 29	160	175	− 15	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	Nov. 21	91	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 26	10,420	10,969	− 549	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 25	1,594	1,073	+ 520	+10,925h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 25	97	83	+ 14	+ 1,265	2½	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	
Newcastle-on-Tyne Corptn.	,, 26	3,429	3,426	+ 3	—	45	38½	,, 25	135,027	39,715,120	4,059,807	1·1	10·94	4,111b	
Newport (Mon.) Corporation	,, 26	491	445	+ 46	+ 434	15	—	—	—	—	—	—	—	—	
Portsmouth Corporation	,, 25	1,229	1,292	− 63	+ 5,612	29	29	,, 31	91,448	18,204,426	1,928,193	1·15	12·39	—	
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·65
Rotherham Corporation	,, 24	387	419	− 32	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	,, 5	81	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 27	4,094	4,259	− 165	+ 3,071	34½	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 24	780	818	− 67	− 2,195	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	Oct. 19	272	243	+ 29	+ 1,292	6½	—	—	—	—	—	—	—	—	—
Stockport Corporation	Nov. 25	407	323	+ 84	+ 7,812	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 29	1,063	970	+ 93	+ 942	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	,, 9	160	—	—	—	3½	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 26	585	571	+ 14	—	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 24	970	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 23	629	384	+ 245	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. e Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Birmingham Electric Club.—This organisation, we are pleased to see, has so far taken root that the opening meet is to be held to-morrow night, when the president, Mr. J. J. Inniss, will deliver his inaugural address. We have received a copy of the proposal form for membership, the conditions of which seem reasonable. A member of the committee intimates that the main lines of the club are to be "the spread of electrical knowledge, and no class prejudice." Everything, the same gentleman remarks, points to a pronounced success.

McMillan Memorial Fund.—As the result of Mr. W. H. Patchell's appeal for contributions to this fund at the Institution's annual dinner last week, a total of about £160 was immediately collected, while some £16 more is promised. As the balance necessary to bring the fund up to the desired £2,000 is now only a matter of £60 or so, it has been decided to keep the appeal open for a few days longer. Seeing how nearly the fund approaches the contemplated figure, it would be particularly regrettable if it now failed to realise the complete sum.

Rapid Telegraphy.—A demonstration of the working of the Pollak-Virag apparatus for telegraphic transmission is to be held at the Carlton Hotel to-day. It is stated that 50,000 words an hour can be sent over the wires by this method. Since the conference at Paris in 1900 great progress has been made in the trials of the system, and it is now reported that all difficulties have been surmounted, and that the apparatus has been put into such simple form that any telegraphist can use it after a few days' practice. It is claimed that the invention will be of special advantage in connection with Press telegrams and private Press wires.

Northampton Institute.—As announced in our issue of the 18th ult., the prizes and certificates will be presented to-night by Lord Reay, at eight o'clock. This will be preceded by an organ recital. Afterwards a conversazione will be held, in connection with which a number of interesting features have been arranged, including a short lecture on "Electric Lighting—Past, Present, and Future," by Dr. C. V. Drysdale. The conversazione will be continued to-morrow from 6.30 to 11, when there will be two promenade concerts and an organ recital. Other attractions comprise demonstrations of various processes, exhibition of apparatus, and gymnastic displays.

New Publications.—"Fowler's Mechanical Engineer's Pocket Book for 1905" (Manchester: Scientific Publishing Company; leatherette and red edges 1s. 6d., leather and gilt edges 2s. 6d.).—"A Treatise on the Theory of Alternating Currents," by Alexander Russell (Cambridge University Press; London: C. J. Clay and Sons and H. K. Lewis).—"The A.B.C of the Differential Calculus," by W. D. Wansbrough (The Technical Publishing Company, Manchester; John Heywood, Manchester and London; and Simpkin, Marshall, and Co., London. 3s.). "The Practical Electrician's Pocket Book for 1905" (London: S. Rentell and Co., Limited).

The Royal Society of Edinburgh.—As already announced, the council of the Royal Society of Edinburgh have awarded the Gunning Victoria Jubilee prize for 1900-1904 to Sir James Dewar for his researches on the liquefaction of gases, extending over the last quarter of a century, and on the chemical and physical properties of substances at low temperature. In addition, the council have awarded the Keith prize for 1901-1903 to Sir William Turner for his memoir entitled "A Contribution to the Craniology of the People of Scotland" and for his "Contributions to the Craniology of the People of the Empire of India," Parts I., II.; the Makdougall-Brisbane prize for 1902-1904 to Mr. John Dougall, M.A., for his paper on "An Analytical Theory of the Equilibrium of an Isotropic Elastic Plate"; and the Neill prize for 1901-1904 to Prof. J. Graham Kerr, M.A., for his researches on Lepidosiren paradoxa.

Electro-Harmonic Society.—We are informed by Hon. Sec. Lane that at a meeting of the executive committee the growing practice amongst members of reserving chairs before the concerts commence, especially on "ladies' night," was discussed, and it was felt that the time had come for the introduction of some regulation on the matter. After careful consideration, the following regulation was unanimously adopted: "That chairs may only be reserved up to ten minutes to eight o'clock, after which time any vacant chairs may be occupied." The committee believe that the above rule will meet the general convenience, and they confidently rely upon the members to assist in its observance. As some few instances of smoking were observed in the hall at the last concert, the committee take this opportunity of earnestly requesting members to refrain from smoking in any part of the hall or gallery at the "ladies' night" concerts in future.

Windsor Castle.—Unlike her late Majesty, who entertained an aversion to electric lighting, King Edward greatly favours this form of illumination. It was installed at Marlborough House and at Sandringham a good many years ago, and since his accession he has had both Buckingham Palace and Windsor Castle lighted throughout by electricity, which is also utilised in various other ways. During the late reign there was a small generating plant under the north terrace at Windsor Castle, but that was removed, and the whole of the current required is now supplied by the local electric company, the lighting being regulated by an official within the Royal residence. There are many thousands of lamps fitted throughout the length and breadth of the Castle, the whole of which were in demand during the presence of the King and Queen and their Royal guests from Portugal. On the evenings of the concert and the dramatic performance the consumption of current exceeded all previous records.

The Tyranny of the Telephone.—Subscribers to the telephone in Paris are so impressed with their grievances that they have formed an association. They complain of defective staff organisation, inattention, and incivility. A meeting was held the other day at the Palais d'Orsay Hotel to claim justice in regard of their grievances, and to do justice to a banquet—it is not clear which was the paramount feature. The assembly was of a cosmopolitan order, including the Marquis de Montebello, who presided, a politician, journalists (male and female), and some actresses. One of the latter, Mdlle. Sylviac, who said some very emphatic things over the wires one day to one of the telephone girls, was introduced by the marquis as the Joan of Arc of the telephone for having raised the standard of revolt against defective organisation. The marquis pointed out that the agitation for a better telephone service had brought to the table men of clashing political opinions. He likewise cordially thanked the Press for having ventilated the grievances and backed the claims of the victims of the telephone. In every country, concluded the marquis, the telephone is a perfected invention save and except in France, and it was the duty of the subscribers to see that an amelioration in the service takes place. M. Marcel Sembat, a deputy, next spoke, expressing a hope that the telephone would be made a practical business aid, and not an instrument of irritation.

Entering the Profession.—In last week's issue of *T. P.'s Weekly* there appears an interesting article on "How to Become an Electrical Engineer," which is the sixth

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article of the series entitled "Careers for Men and Women." We see no evidence, however, in the article before us that women are likely to invade in any number the profession of electrical engineering. The remarks on the making of the engineer, both as training in college or evening classes and in the workshop, are exceedingly well thought out, and the author is equally fair when he deals with the reward which an electrical engineer may expect after training. He puts the usual cost of a three years' technical college course at from £60 to £80, and the works premium at a maximum of £300 for three years. In return for this the high-class works manager or power supply engineer may receive as much as £1,500 a year. As the author naïvely puts it, however, "the average electrical man studies practical economics on £150 to £200 a year, while operatives will take anything from 25s. to 45s. per week. No one can determine the exact amount to be expected, for it depends largely on each man's energy and resource, and also upon those unexpected happenings which in every career determine whether the life-effort of a man will spell success or failure." The only criticism we have to make on the article is that no mention is made of the Central Technical College in Exhibition-road, which ranks, in our opinion, higher than any of the colleges and schools mentioned in the article.

Electric Driving in Cotton Mills.—The advantages of electricity for driving cotton mills have obtained recognition in Spain, where one of the largest proprietors (the Marquis of Larios) has decided to introduce it. His two spinning and weaving mills at Malaga are the biggest in the country, employing some 5,000 hands. Arrangements have lately been made by him for obtaining a supply of electric power from the Chorro Power Company, which has established a generating station in the celebrated Chorro Gorge, some 50 miles north of Malaga. The power is transmitted by three-phase current at a pressure of 25,000 volts to a sub-station in Malaga, where the pressure is reduced to 2,500 volts, part of the energy being supplied to the Malaga electric lighting station. A secondary receiving station is to be placed at each of the two mills, containing three-phase transformers for reducing the pressure from 2,500 to 400 volts for supplying the three-phase motors, which will be employed universally throughout the mills, the steam plant being entirely discarded. There will be 72 motors, varying in power from 3 h.p. to 150 h.p., and aggregating 2,500 h.p. It is anticipated that the use of electricity will result in a saving of over 20 per cent. in operating costs. The installation will be one of the largest and most complete of its kind, and the contract for the plant excited keen competition among the leading German, Austrian, and Swiss firms, so that Messrs. Mather and Platt, Limited, of Salford Ironworks, Manchester, have scored a gratifying success in obtaining the order. This success in a neutral territory is the more satisfactory because it has generally been assumed that British makers have not devoted so much attention to polyphase work as their Continental rivals.

Daily Consular Reports.—We have received from the Department of Commerce and Labour at Washington, U.S.A., a copy of the "Daily Consular Reports" for Nov. 16 this year. These reports are of great value to commerce in any country which does an export trade. For instance, in the report before us we find information as to the marketing of goods in Greece, Malta, the Netherlands, Russia, and Scandinavia. The figures given show not only the actual trade between the United States and the country in question, but also the various sub-divisions of goods actually exported. These figures enable the commercial man to see what the possibilities are in his particular line, and from written reports he gets some useful hints as to the way in which business is conducted in these countries. It is obviously absurd for a wholesale trader in England, for instance, to attempt to break down the trade customs in the country to which he is exporting. He will be much wiser if he increases his selling prices in order to meet the additional risks involved by these customs. For instance, speaking of Denmark, the report shows that three months' absolute credit on all foreign goods is granted in all foreign countries except the United States. The report goes on to say that there is a disposition on the part of German merchants to extend the credit beyond the usual three months. The U.S.A. consul at Copenhagen points out that the enforcement of the well-known rule of cash payment against bills of lading in New York is a great hindrance to the American export trade to Denmark in many lines of goods. There is no doubt that our large mercantile houses are well informed as to the best way in which business can be conducted in foreign countries, but some such system of consular reports issued more promptly would be of more use in this country to smaller firms commencing their export trade.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, in the chair. Colonel C. W. Carr-Calthrop, Mr. Cecil Hanbury, Dr. E. Graham Little, Mr. Hugh Makins, and Mr. E Reinach were elected members. The following are the lecture arrangements at the Royal Institution before Easter: A Christmas course of lectures (experimentally illustrated and adapted to a juvenile auditory) on "Ancient and Modern Methods of Measuring Time," by Mr. Henry Cunynghame; Prof. L. C. Miall, Fullerian professor of physiology, R.I., six lectures on "Adaptation and History in the Structure and Life of Animals"; Prof. Karl Pearson, three lecture on "Some Recent Biometric Studies"; Prof. W. E. Dalby, two lectures on "Engineering"; Mr. A. H. Savage Landor, two lectures on "Exploration in the Philippines"; Mr. Churton Collins, two lectures on (1) "The Religion of Shakspere," (2) "The Philosophy and Significance of 'The Tempest'"; Prof. W. Schlich, two lectures on "Forestry in the British Empire"; Mr. J. J. H. Teall, two lectures on "Recent Work of the Geological Survey"; Prof. H. H. Turner, three lectures on "Recent Astronomical Progress"; Prof. R. Meldola, two lectures on "Synthetic Chemistry" (experimental); Sir Alexander Mackenzie, three lectures on the "Bohemian School of Music" (with musical illustrations); Mr. D. G. Hogarth, two lectures on "Archæology"; Prof. J. J. Thomson, three lectures on "Electrical Properties of Radioactive Substances": and the Right Hon. Lord Rayleigh, three lectures on "Some Controverted Questions of Optics." The Friday evening meetings will begin on Jan. 20, when a discourse will be delivered by Prof. Sir James Dewar on "New Low-Temperature Phenomena." Succeeding discourses will probably be given by Dr. E. A. Wilson, Mr. Cecil Smith, Mr. J. W. Gordon, Prof. H. Marshall Ward, Chevalier G. Marconi, Prof. J. J. Thomson, Sir Squire Bancroft, Prof. G. H. Bryan, Prof. J. Wright, Prof. J. C. Allbut, the Right Hon. Lord Rayleigh, and other gentlemen.

Metropolitan Railway.—This company, a considerable portion of whose system will be ready for electric traction in a very few weeks now, have decided to have carriages of two classes. They do not consider that any appreciable delay will result from this arrangement. This may be so if the public lend their co-operation by stationing themselves at the sections of the platforms devoted to the respective classes as indicated by the signboards;

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unfortunately, they do not always do this. Two classes, however, cause much less delay than three, the effect of additional classes beyond two being to multiply, rather than merely to add to, the confusion. The Metropolitan Company's rolling-stock is of a sumptuous character and of the latest design. The cars are a little over 50ft. long, arranged with both transverse and longitudinal seats. The superior class non-smoking cars are upholstered in art-green moquette; the interior panels and mouldings and the decorative work are very attractive. The smoking cars of the higher class are similar in all respects save upholstery, which is carried out in green leather. The second-class cars all have buffalo hide seats, and the decorative work is less elaborate. Electrical heaters are supplied to all the carriages, which are brilliantly lighted by electricity. In the construction every provision has been made to ensure the fullest protection against fire. The floor is of steel, covered with a non-combustible cement; the roof is of asbestos; the sides (the outsides of which are painted and varnished to represent polished teak) are, like the frame of the seats, of steel; while the upholstery is inflammable. Each car is mounted on English manufactured pressed-steel four-wheel bogie trucks, and each of the axles in the case of the motorcars is driven by a separate iron-clad motor of 150 h.p. normal capacity. Having a motor-car at each end, every train of six carriages will carry eight electric motors. Each car will seat 49 passengers, and the train has a driver's compartment and a luggage compartment at one end and a covered-in platform at the other. The platform is fitted with a vestibule, having sliding doors of an entirely new design.

Personal.—Prof. H. S. Hele-Shaw, of the University of Liverpool, has resigned his position as head of the faculty of engineering, having accepted the post of senior and responsible professor of the new technical institute which it is proposed to establish in the Transvaal. Prof. Hele-Shaw went out to South Africa last year for the Colonial Office as organiser of technical education in the Transvaal, and it is upon his reports that the Government propose to set up the new institution in or near Johannesburg. The council of Liverpool University passed a resolution on Tuesday recording their appreciation of his valuable services to the university and to education generally, and congratulating him upon his election to such an important office. In 1876 the professor secured the Whitworth scholarship; two years later he obtained the Miller scholarship in the Institute of Civil Engineering, and he also took various other honours during his course at the University College of Bristol, where he became lecturer and afterwards professor. He went to Liverpool as the first professor of engineering at a time when there was no endowed chair and no laboratories, and commenced his duties with three students. To-day the university possesses a faculty in engineering, and one of the largest schools in the world. His appointment last year by the Colonial Secretary as organiser of technical education in the Transvaal placed him in the position of having held the first professorship of engineering in three separate institutions. During the time he has been in Liverpool, and previously, he has contributed upwards of 60 papers to all the scientific institutions, both in this country and abroad, and has been awarded such distinctions as the Watt gold medal, the Telford premium in the Institution of Civil Engineering, the gold medal of the Institution of Naval Architects, and numerous other medals and premiums for his scientific researches. He has also been awarded the honorary degree of doctor of laws at the University of St. Andrews, and the coveted honour of a fellowship of the Royal Society. Prof. Hele-Shaw will leave England at the beginning of the new year, and we wish him every success in his new sphere.

Tramways and Light Railways Association.—The fact of the Institution dinner falling on the same night as Mr. Sellon's paper on "Running Powers," with which we deal fully in another part of this issue, reflected itself in the limited attendance at the Society of Arts rooms. The audience comprised two or three visitors not usually seen at these meetings, including a barrister and an alderman, both of whom spoke. Though the discussion was only participated in by four speakers, it ran into an hour and a half, with Mr. Sellon's reply. The keynote of the discussion was whether inter-running should be by compulsory powers—that is to say, whether there should be a general enactment providing for reference to some tribunal if private negotiations failed, or whether everything should be left to voluntary arrangement. There was considerable diversity of opinion under this head, which extended to those belonging to the same class of interest. Thus, while the president, a corporation man, was opposed to compulsory powers, the representatives of the West Ham Corporation considered inter-running of such paramount importance as to quite justify a general enactment. Again, Mr. Sellon advocated a general enactment, while Mr. England (of the Wakefield Light Railway Company) considered it unnecessary, holding that the managers were quite capable of settling such matters. Two or three humorous incidents arose out of the question of changing crews at the boundary. The president having expressed himself in favour of this plan for rural districts with an infrequent service, such as a car every 20 minutes, Mr. Sellon retorted, "Every 20 minutes! Why you would do better to run a donkey-cart." An animated discussion ensued, which was terminated by the president explaining that he had not suggested such a method for urban traffic, but only for sparsely-populated districts, where the service must often be relatively infrequent. Mr. England candidly acknowledged himself an opponent of this system. It is too expensive, he remarked, because when the car reaches the boundary the men are apt to go "round the corner," so it needs an inspector to look after the men, and a traffic superintendent to look after the inspector. Altogether, the meeting was of considerable interest, and the importance of the subject made it more regrettable that clashing with another ceremony prevented a representative audience from being present.

Torpedo-Boat Construction.—There was an exceptionally large attendance at the meeting of the Junior Institution of Engineers on Saturday, when a paper, entitled "Some Points of Interest on Torpedo-Boat Construction," was read by Mr. H. E. Yarrow, Stud.I.C.E., of Poplar. Commencing with considerations with respect to the hull, the author showed the importance of realising in the design the maximum strength with the minimum weight, uniform elasticity throughout its length being essential. Any sudden change of section in these lightly-constructed vessels formed a source of great danger, and it was quite possible by adding material to reduce the actual strength. Passing on to questions with regard to riveting, hot *versus* cold riveting processes were discussed, the latter being advocated as possessing advantages over the former. In the best work the holes were drilled in preference to being punched. It was of great importance to minimise vibration as much as possible, and the author illustrated by means of lantern slides the effect of a properly-balanced engine on the stability of the boat itself. The superiority of a four-cylinder as compared with a three-cylinder engine in this respect was indicated. The necessity of more attention being given to the design of auxiliary engines was

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commented upon, and considerations in regard to lubrication were entered into, the author insisting that all internal lubrication should be dispensed with absolutely, both in the main and in the auxiliary engines. No real difficulties occurred in this, and the good results on the working of the boilers were obvious. With the use of high-pressure steam the paper showed how imperative it was to specially consider the best practice relating to steam-pipes; those of small diameter being recommended for various reasons, amongst them being superheating of the steam and ensuring that each boiler was developing approximately its proper proportion of the power required. Referring to steam-turbines, the author held that although they possessed many advantages over reciprocating engines, they could not be regarded as economical for varying speeds as in torpedo-boats. He alluded favourably to the explosive type of engine, which was developing so rapidly at the present time. It presented many characteristics specially advantageous to its adoption in the class of boat under consideration, including elimination of the boiler-room staff, and general reduction of weight. The paper was succeeded by an animated discussion.

Magnetic Storms.—The communication of Mr. E. W. Maunder last week to the members of the British Astronomical Association, upon the connection between sun spots and magnetic storms, aroused a wide degree of interest in scientific circles. Mr. Maunder has lately been engaged in investigating this subject, which has been debated for 60 years. In 1892 Lord Kelvin declared that magnetic storms cannot be due directly to magnetic changes in the sun, which view was already entertained by certain scientists. Another hypothesis was that they are due to streamers, analogous to the cathode rays in Crookes's electric vacuum tubes, which impinge on the earth. This was put forward by the late Prof. FitzGerald at the time of Lord Kelvin's address, and has recently been elaborated by Arrhenius and others. But authorities have never denied that magnetic storms are due to some kind of solar activity. An observational difficulty that confronts the enquirer is that in some cases the appearance of sun spots is not followed by magnetic storms, and in other cases there are storms without sun spots. Mr. Maunder said he had often considered the question, and, though he was satisfied that there was a general agreement between the appearance of spots and of storms, especially when only big spots and big storms were taken into account, yet he could not get that agreement to go far enough when all the disturbances were taken into consideration. Nor did he make better progress when he took other solar features, such as faculæ or prominences. But when examining the Greenwich records for the 20 years 1882-1901, he noticed that in many cases the disturbances occurred at a mean interval of $27\frac{1}{3}$ days, the apparent period of the sun's rotation, and he then began to compute the longitudes of the centre of the sun's disc at the time of the beginning of the disturbances. This led him to the discovery that of 276 storms one-third were arranged in pairs equal to one rotation of the sun, while three-quarters showed a rotational period in one form or another. The conclusions he arrives at are that our magnetic disturbances show a very strongly marked tendency to recur with the return of certain definite meridians of the sun to the centre of the disc. The consequences are revolutionary. "First of all," Mr. Maunder states, "it decides beyond question the 60 years' controversy. The origin of our magnetic storms does lie in the sun. Next, it introduces a totally new conception of the magnetic action of the sun. It is not from the whole surface; it is not radiated equally in all directions. But it is from certain restricted areas and along certain narrow lines." The figures and data on which Mr. Maunder's views are based have excited a good deal of attention among scientists, as until these have been investigated criticism is impossible.

Electrical Finance.—The conditions which govern the selling price of electrical energy are by this time quite clear to the electrical engineer. We regret to say that the average consumer of electrical energy is not so conversant with the governing factors which go to make up the selling prices, and hence we find complaints against those scales of charges which give preference to the long-hour consumer. We have this week received a cutting from the *Southwark and Bermondsey Recorder and South London Gazette*, which clearly shows that the Bermondsey Municipal Association are lamentably ignorant on this subject. This association have hired a column of our contemporary in which to express the views of its members, and in last week's issue it dealt with the electric lighting undertaking. This, we are assured, is in a very bad way, and we think it only fair to the writer of the article to reproduce one paragraph of his condemnation in full. This reads as follows: "The nature of the business militates against all prospects of success, inasmuch as the bulk of the supply is for power purposes, every unit of which is sold under cost price. During the half-year ended Michaelmas 44,031 units have been sold to private consumers for lighting and 109,395 for power purposes. The supply for power represents the disposal of wastage, electricity not being, as gas, storable. Whoever heard of a business producing more than twice as much wastage as saleable materials? *Mirabile dictu*, the committee seems bent upon extending this unprofitable department of their business, having invested considerable capital for certain contracts, every unit of which represents a loss of at least 1d. Power: number of units produced, 109,395; cost of manufacture, according to official figures at 2·23 per unit, £1,139. 10s. 8d.; price obtained, including meter rent, £866. 7s. 9d.; loss on half-year, £273. 2s. 11d. Lighting: number of units produced for private consumers, 44,031; cost of manufacture, according to official figures at 2·23 per unit, £416. 19s. 9d.; price obtained, less 10 per cent. for units unaccounted for, depreciation, etc., £672. 7s. 4d.; profit in half-year, £255. 7s. 7d.. Net loss in half-year, £17. 15s. 4d. To this net loss must be added instalments of loan, interest, half the cost of the dust destructor, provisions for a sinking fund, depreciation of machinery, etc., and many other incidental expenses, making in all a gigantic total." The article in question is signed "Municipal"; we should much prefer that the writer had given his own name, so that we could refer him personally to numberless articles which would show him the error of his ideas on the above subject. The naïve idea that the supply of power represents the disposal of wastage, because electricity cannot be stored as gas can, is laughable, but it is lamentable that a man who undertakes to educate either the Bermondsey Municipal Association or through it the Bermondsey ratepayers should not take the trouble to ascertain the facts before he puts the same into the public press. His idea that the average works cost per unit is, therefore, the cost of every unit shows that he has not done so, and hence his whole remarks on the question are misleading, untrue, and quite valueless.

Junior Institution of Engineers.—A visit was paid by the members of this institution on Saturday to the London Coliseum, where they witnessed a demonstration of the revolving stage. There are three concentric rings or stages, the outer one and the intermediate being 12ft. across and the middle circle 25ft. 7in. The entire diameter across the three is 75ft., and so accurate has been the

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building up that only 1in. of clearance is necessary to permit of the tables running separately, without rubbing or touching. The tables are built up on rolled-steel underframes, 9ft. high, and instead of the motive power and wheels being on the carriages as in a tramway, the engineer (Mr. E. Wingfield Bowles) has designed a runway on the underframes which runs on the motors, thereby reversing the usual order of things, and securing considerable lightness, absence of moving contacts for the current, and a great reduction in the noise. The electric motors, 14 in all, used for driving the stages are all set on adjustable beds for levelling up to the level of the fixed or permanent stage surrounding the outer ring, and the motors are all controlled from the special switch pillars on a raised gallery on the prompt side of the stage, which overlooks every part of it. The signalling to the drivers is effected by means of a special form of ship's engine-room telegraph worked from a position on the stage level, where the stage manager has also to hand speaking-tubes, lamp-signal keys, and telephones to all the points where engineers are stationed to work the numerous electric apparatus. On receiving a signal on his dial the table driver has only to turn to the controller wheel, and the table, 75ft. in diameter, can be turned, stopped, and reversed, the actual controller or switches being in a chamber below the stage. There are other electrically-driven devices which can, in an emergency, be worked by hand at sufficient speed to prevent an absolute breakdown of the entertainment. The scenery proper will be hoisted by compound electric-driven winches. When complete there will be 30 electric motors at work in the building. There are 12 miles of cable in connection with the various circuits on the stage, and the consumption of electrical energy will, it is stated, exceed by 50 per cent. that of any other theatre or music hall in London, though every possible device for saving current has been brought into play. Fireproof cables and a completely connected and earthed steel-tube conduit system are used in connection with the illumination of the building. The illuminating power on the stage is equal to about 5,000 8-c.p. incandescent lamps, and the auditorium has upwards of 2,000 similar lamps. The public parts of the theatre are divided into two separate installations, supplied by two independent companies, so that, in the event of failure of the one supply, the public may have in every part a sufficiency of light from the other. These installations are kept entirely apart from the stage supply, so that no accident on the stage can affect the lights in the public parts of the house. Special novel effects will be produced by means of electric projectors and the biograph lanterns in various parts of the building, for which fireproof rooms have been provided as part of the structure. The main stage switchboard has 85 distinct switches, which are so combined that, by interlocking and automatic releasing, it is possible for one man to control all the lights on the stage and produce combinations of colours at any strength.

Royal Society.—The anniversary meeting of the Royal Society was held at Burlington House on the 30th ult., when the president, Sir William Huggins, delivered an historic survey of the society's existence. In the evening the anniversary dinner was held at the Hôtel Métropole. Engineering, science, law, politics, medicine, and literature were all represented. Mr. Arnold-Forster, M.P., in giving the toast of the society, created some amusement by remarking that it was a somewhat dangerous thing to turn a politician loose among such a distinguished collection of scientists, because in the practice of British politics there was probably less science used than in any other pursuit known to man. Since entering the Government he had every day been more and more impressed with the need for a greater knowledge in our public life of what scientific men were thinking, what they were doing, and what they hoped and meant to accomplish in all the great departments of scientific life throughout the globe. There was absolutely infinite opportunity for the work of trained minds in that very important department of our national life, the public service. Even in his short official life, he was glad to say that he had lived to see some progress made in the direction in which he wished to see this nation travel. Glancing at the list of their fellowships, he found that no fewer than 31 Fellows of the Royal Society either were or had been officers in the Royal Navy or in the army. He paid a high tribute to Sir William White, Prof. Ewing, and other Fellows of the society for their services to the navy and in various spheres. Scientific establishments were particularly wanted for the army and navy. He looked to Sir Arthur Rücker, in his great fairy palace at Kensington, to establish a great metallurgical laboratory where they might concentrate all the work they were now trying to perform with regard to metallurgy, which was so important in all manufactures both for the navy and the army. He should look to another Fellow—Sir Oliver Lodge—to re-create our public schools. The President, in tracing recent developments of science, said that at no time in the past had the pace of scientific progress been so rapid; at no time so imminent the clearing away of the mist of the unknown from many points of strategic importance for the conquest of more knowledge of the inner relations of things. In physics only a few years ago Prof. J. J. Thomson took by storm the outworks of the central citadel of nature—the chemical atom. His later brilliant attacks, aided by the new artillery of radioactive radiations, might be said to have carried the keep itself. This stronghold of matter was found to be a place of positive electrification in which swarms of negative electrons are winging their mazy rounds. Material mass gives place to the electric mass of moving electric charges. On this view the chemical elements, each with its individual properties, but all falling into family groups according to a periodic law, have their origin in differences in the number of the electrons and in the figures of their giddy dances, whirling within the atom. In a eulogy of the new medallists he said that the Copley medal, the society's highest distinction, was awarded to Sir William Crookes for the extensive researches in chemistry and physics by which he had enriched physical science in many departments. The Rumford medal was awarded to Prof. Rutherford for his researches on the properties of radioactive matter, and it was not too much to say that by his detection and investigation of radioactive emanations and their transformations he had added an unexpected domain of transcendent theoretical interest to physical science. The Davy medal was awarded to Prof. Perkin, jun., for his masterly researches in the domain of synthetic organic chemistry, carried on continuously during the last 25 years, beginning with the cyclic compounds of carbon through his work on camphoronic acid, the constitution of camphor and other bodies, to his more recent work on the synthesis of terpin. Sir Joseph Swan had gained the Hughes medal for his invention of the incandescent lamp, and his other inventions and improvements in the practical application of electricity, also his inventions in dry-plate photography. "Was it too much to say," asked the President, "that Sir Joseph had abolished night?" Sir Joseph Swan, in replying, said that all the medallists that day had gained awards for research and discovery except himself, who was recognised for invention. He would point out how often invention had coincided with investigation, and had led to discovery.

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RUNNING POWERS.*

BY STEPHEN SELLON, A.M.I C.E. (MEMBER).

"Whereas the construction of the tramways, which are hereinafter described, will be of public and local advantage."

The above words, or their equivalent, will be found in the preamble of many Tramway Acts; they are, therefore, the ostensible primary justification for the granting of powers for legalising tramway construction. They are the *raison d'être* of tramways, and form, therefore, the text of this discourse. Having obtained powers, the tramway undertaker's obligations do not cease on construction, but continue during working, and the maintenance of his monopoly depends on the manner in which he fulfils his duties. *Public* and local advantage! Happily chosen—the words are in accordance with the spirit of highway law; the public road is the King's highway; free, peaceable unobstructed passage is the right of every wayfarer thereon, and the Crown, representing the whole State, safeguards that right. The road authorities have no right over the roads they maintain superior to those of the traveller from the most distant county or foreign lands. They have duties in respect to the roads; mainly to keep them open, safe, and unobstructed to all comers. They have certain legal powers given them to enable them to perform those duties and to meet the consequent expenses, but proprietary rights or powers to obstruct, tax, or detain the traveller are not in their possession.

These ancient elementary principles of English highway law apply to tramway politics in other directions, which lead me away from the present subject; but they are cognate to that, because, in the first place, a tramway is an improvement of the highway on which it is laid, increasing its capacity and utility, cheapening its use, and saving the time and strength of the traveller. It follows, in my view, that those to whom Parliament entrusts tramway powers hold substantially the same position towards the public generally as highway authorities so far as their powers go; that they are equally obliged to afford all travellers the maximum facilities within their power; and that Parliament is entirely justified in ensuring that "the public and local advantages" which the tramways authorised can afford shall not be limited by unreasonable conduct on the part of the undertakers, whether due to sentimental, selfish, or capricious motives. That tramway undertakers are authorised to collect fares for the use of the advantages they provide is an incident which does not affect my main principle. It means that the extension of travelling facilities is only available to those who can tender the legal fare, but this is a limitation in number, not in kind.

It has been my lot during the last two sessions of Parliament to hear many objections raised against running powers. It is difficult to treat any of them seriously, and it is, therefore, not surprising that the learned counsel, obtaining no solid grounds for rejection from the mouths of his witnesses, found himself forced to claim the application as unprecedented. "Precedent" is a magic word; parliamentary counsel, with no arguments against a proposal evidently for the public advantage, cry "What precedent have you for such a demand?" This was the continued cry of the learned counsel for Birmingham and for Newcastle-on-Tyne during the recent running-power cases brought before Parliament, and they busied themselves to show that there were no precedents, and that cases claimed by the other side as precedents lacked this or presented that important feature, and so differed entirely from the cases under discussion. The only other objection urged is founded altogether upon ignorance of what "running powers" really means. Again and again the objection has been raised that the running company is desirous of usurping the rights of the owners of the tramways, and confiscate to itself the management of the tramways run over. An idea, if it were not founded on gross ignorance, would be worthy only of the maddest inhabitant of Bedlam. I cannot do better than quote as an example the class of objection I mean—viz., a petition which was seriously and gravely presented to Parliament in the session of 1904 against the proposals made in the Bill of the Tyneside Company for running powers over the tramways of the Newcastle Corporation: "We, the undersigned citizens of the city and county of Newcastle-upon-Tyne, do humbly pray that your honourable House in considering the Bill intituled 'an Act to confer further powers upon the Tyneside Tramways and Tramroads Company, will refuse your consent to those clauses in the Bill in which the company asks for compulsory running powers over the tramways of the Newcastle-upon-Tyne Corporation, because we are strongly of opinion that the proposals in the company's Bill are objectionable, retrograde, and against the public interest by reason, amongst other things, of their interference with the principles of municipal self-government—the adverse effect which, if carried out, they would have upon the smooth and efficient working of the present excellent tramway system of the Corporation, the curtailment of the existing through fares in the city and loss of central control so essential to the working of a good tramway system, the making subservient of the great central system to the small outside system and the inconveniencing of hundreds in order to convenience a few individuals, and because we consider them an invasion of our rights as a self-governing community." Obviously the lack of a precedent or objections of the character indicated do not condemn a proposal, but as so much importance is attached to it, and there is some interest and guidance to be obtained from the history of running powers, I will just go over the matter briefly.

Very early in the history of railway working in this country it was found that railway companies whose lines junctioned with each other did not always give either the passenger or goods traffic the advantages that the physical junctions rendered possible. Rebooking, changing carriages, transhipment from truck to truck, with delays, additional terminal charges, and other inconveniences and monetary losses, resulted. It is not generally known that railways were originally intended as highways for accommodating the engines and carriages for the conveyance of passengers and goods by other companies or persons, and that this principle applied with equal force to railways or tramways constructed along a public road is instanced by the terms and conditions under which the promoters of the Swansea and Mumbles Railway obtained their powers. Section 92, Railways Clauses Act, 1848, reads as follows: "It shall not be lawful for the company at any time to demand or take a greater amount of toll, or to make any greater charge for the carriage of passengers or goods than they are by this and the special Act authorised to demand, and upon payment of the tolls from time to time demandable all companies and persons shall be entitled to use the railway, with engines and carriages properly constructed, as by this and the special Act directed, subject, nevertheless, to the provisions and restrictions of the Railway Regulation Act, 1842, and to the regulations to be from time to time made by the company by virtue of the powers in that behalf hereby and by the special Act conferred upon them." By the enactment of the Railway and Canal Traffic Act, 1854, Parliament obliged all companies whose lines junctioned to provide for through booking, through goods rates, and to permit the through running of carriages, wagons, and trucks. The arrangements between companies, generally known as "running powers," differ from "facilities" in that they permit a railway company to run over the lines and use the stations of another with its own engines and servants.

There are abundant examples of running powers by agreement between railways, sometimes one-sided, sometimes mutual, and there are a number of cases where Parliament has granted running powers by compulsion. In the latter case Parliament appears to have acted upon principles which may be classified generally under the following heads: to save the running company useless expenditure in duplicating lines or terminal accommodation; to meet an obvious public convenience which could not be left at the mercy of the possible unreasonableness of the company in possession; to remove the obstruction wilfully offered by a company to the traffic of another company, or where a company has failed to afford proper facilities; as a statutory confirmation of an agreement entered into between two companies, so that the public advan-

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tages so gained should not be at the mercy of future quarrels or divergence of interests between the contracting companies.

In such cases the principle seems to have been conceded that the running company should take no profit on fares earned on the owning company's lines. It pays its own train expenses, and very frequently some charge by the owning company for terminal services and facilities. There are a few exceptions to this rule of no profits. It can, therefore, fairly be stated that the principles regulating running powers are fairly established in most cases in railway legislation and traffic. I propose to show that there is not the slightest reason why similar principles should not be applied to tramways, whether authorised under the Tramway Act or as tramroads, or under the Light Railways Act, that there are abundant examples of running powers by agreement, mutual running powers, and compulsory running powers as between tramways, and to go a little further by showing that while "facilities" generally meet railway conditions, those of tramway traffic make facilities wholly impracticable for the attainment of the much-desired public advantage.

The earliest case of running powers that I am able to find as regards tramways was in 1874, when the Swansea Tramway Company obtained compulsory running powers over the Mumbles Railway, and for many years the curious spectacle was observed of a horse tramcar sandwiched in between the steam-cars of the Mumbles Railway, an obviously inconsistent mixture of traffic resulting in inconvenience, which was therefore discontinued a few years ago by agreement, subject to compensation. In 1882 powers for running into Dudley by the South Staffordshire and Birmingham and Midland were obtained; in 1882 running powers were obtained over the Walsall and Wednesbury and West Bromwich Tramways by the Staffordshire Tramway Company; in 1884 the London Street Tramways obtained running powers by agreement over the North Metropolitan system in Gray's-inn-road between Holborn and the junction of Theobald's-road with Clerkenwell-road; Plymouth Corporation over the Stonehouse Company's line, 1900; in 1900 Poole Light Railways and Christchurch and Bournemouth Tramways over the Bournemouth Corporation Tramways; Glasgow Corporation over Paisley Company, 1901; in 1901 the Spen Valley Light Railways over a portion of the Batley Tramways; Salford over Manchester, 1902; Metropolitan Electric Tramways over Walthamstow, 1902; South Lancashire over St. Helens, 1903; Brighton and Hove Company over Worthing Corporation, 1903; Tyneside and Newcastle, 1904; Wakefield Light Railways over Ossett, 1904; Leyton over Lea Bridge, 1904. Running powers have been arranged between Oldham, Ashton, and Hyde Company and the Stockport Corporation over portions of the two systems by agreement; Dundee and Dundee and Broughty Ferry Company; Manchester and Ashton, and other outside local authorities; Wakefield and Leeds; Aberdeen and Aberdeen Suburban; East Ham and West Ham; City of Birmingham Company and Birmingham Corporation Tramways.

The advantages of running powers, which enable two or more systems to be linked up and worked without any change of car, are so obvious, both on the grounds of public convenience and of financial benefit to the owners, that it is difficult to understand the existence of opposition. I have made many observations on the effect of a break of service on the traffic of tramway systems. In every case the effect of a break is to reduce the earning capacity on the routes immediately affected from 15 to 50 per cent., whilst there is frequently a much wider spreading of the effect than could be anticipated, and any gain on alternative routes between the same points is far less than the direct loss. Conversely, directly the connection is re-established, the traffic returns to the normal conditions. The favourable effect of a "through" connection established between two systems previously worked with a break of service confirms these cases. As an illustration, I may instance the well-known Newcastle and Tyneside case. By the courtesy of Mr. McLellan, I am able to quote figures obtained from his statistics of traffic. The Newcastle tramways terminate in open country about half a mile from Wallsend. The Tyneside Company's line runs up to the same point through Wallsend from North Shields. During the month of April, 1904, when a change of car was necessary to enable passengers to get from the Corporation's system to the company's system, or *vice versâ*, Newcastle brought 48,796 passengers up to the terminus, out of which the company carried on 11,414, leaving 37,382 passengers on the road. Now, from the nature of the country, practically the whole of that number must have been bound for Wallsend and preferred to walk the half-mile stage instead of mounting another car. During the month of September both the Corporation's and the company's cars ran through, and 48,409 passengers arrived from Newcastle at the point mentioned, 36,305 of whom went on to Wallsend, thereby reducing the figure of 37,382 passengers walking on to 12,104; and, mark you, this result was obtained immediately upon the through service being run. Similarly, travelling towards Newcastle in April, 16,070 passengers only were carried to the termination of the company's tramways, whereas in September 29,930 availed themselves of the through cars on this stage. Mr. McLellan further informs me that the through service has undoubtedly generally stimulated the tramway traffic. In considering these figures, it must be borne in mind that the month of April took in the Easter holiday traffic, and that between April and September the electrified service on the North-Eastern Railway came into operation.

Another typical instance I may take is the case of Birmingham and Aston. For a number of years a through service was run from the centre of Birmingham to Aston. During the last six months of this through service 449,853 passengers were carried monthly, and from statistics taken it was found that 72½ per cent. of this number (326,142) crossed the city boundary into the Aston district. Owing to the conversion of the tramways from steam to electric traction a break at the boundary was necessary, and it was then found that the number of passengers carried monthly in the Aston district averaged 178,671, showing a decrease, therefore, so far as Aston section of the tramways is concerned, of about 50 per cent. Now, I know it may be said that the Birmingham section of the line did not suffer at all from this break, but it is necessary for me to point out that the first 1d. stage on this line from the Birmingham end extended some distance over the boundary. When Birmingham started the electrical service to the boundary, they, of course, charged a 1d. fare, so their passengers had to pay the same fare for travelling a shorter distance by an improved method of traction, and at the same time had the undoubted inconvenience of walking a portion of their journey. The incident that the gain or loss of traffic may not be equally shared between the two undertakers does not affect the argument of public convenience. It may affect the terms.

Another instance is that of the Leith and Edinburgh Tramways. The break occurred at Pilrig when the Edinburgh section of the line was cabled. The loss entailed here was about equally divided between the two sections, totalling to £6,000 per annum. The length of route between Princes-street, Edinburgh, and the centre of Leith is about a mile and a half, so that the loss in money mentioned is equivalent to £4,000 per mile per annum, which is a good deal more than many tramways get as their rate of gross earnings.

There are marked differences between railway and tramway traffic conditions which materially affect the conditions and terms of running powers. Generally, compulsory running powers are exercised by one company over the line of another in respect to through traffic only, the local traffic being served exclusively by the owning company. Such an arrangement is clearly impracticable on a tramway; the foreign car must be available for the local traffic as well as the through traffic. This also applies on railways with a traffic similar to that of tramways; for example, the several railway companies who run trains on the railways of the District and Metropolitan Companies.

Another difference arises in respect to the utility of "facilities" in the railway sense as distinguished from running powers. On a continuous railway journey it makes little or no difference to the convenience of passengers that the locomotive is changed at a particular station, or that

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the guards of one company are relieved by those of another. But it appears to be found convenient by the companies themselves to employ through guards wherever the traffic is large. The tramway case is quite different. Changing car crews at a boundary must lead to some waste of men's time and to delay of the traffic, for clearly there must be a spare or overlapping crew available, or cars in opposite directions must await each other's arrival at the boundary. The fact that the car is also the locomotive, and that the conductor is also the booking clerk, introduce other objections to the exchange of crews. "Facilities" which only amount to the issue of through tickets with a change of cars at the meeting points need not be considered, as I have already shown that even where there is no change of ownership, and therefore every endeavour made to minimise inconvenience, a great loss of public advantage, and, therefore, of traffic, results.

I therefore take it that running powers between adjoining tramways are necessary for the full accomplishment of their public purpose, and, incidentally, for the best commercial results to the undertakers as fully proven; and submit that any tramway undertaker, whether municipal or company, who stands in the way of such conveniences, is abusing his position in just the same way as would a road authority who built walls or dug ditches across the roads at its boundaries, in order to compel every passenger to climb over or splash through them as the penalty for intruding on "our roads" or leaving the "sacred territory."

The justification of compulsory running powers is, of course, the public necessity. It ought not to be tolerated that parties entrusted by Parliament with tramway powers should be permitted by unreasonable conduct to prevent or hinder the full public use and advantage of any means of connection. Experience shows that, unfortunately, reliance cannot always be placed upon the reasonable conduct of the parties. Whether it has been a corporation or a company that has been unreasonable is not to the point, but there does seem a greater tendency on the part of corporations to object to through running on such sentimental grounds as that it is "an intrusion on our tramways," and on such "practical" grounds as that there are difficulties in controlling "foreign" car crews, that the town tramways are already pressed to their full capacity, that there will be ticket and account difficulties, and even, *reductio ad absurdum*, difficulties in apportioning responsibility for accidents. The only one of these "practical" objections worthy of discussion is that of the full occupation of the city tramways by the local traffic. If this is a fact, it shows that further tramway facilities are necessary, say, for example, by the construction of lines more or less parallel to the through routes, and I would submit that, given the maximum possible number of cars on the city lines, there will be a balance of advantage in having some of them running through, to and from the suburban districts, even though some short-distance or local passengers are displaced by long-distance or through passengers.

In the application for running powers into Birmingham the Corporation were prepared to give what they called "facilities," which I have already distinguished from running powers. This meant, as we all know, and as Mr. Bellamy was good enough to tell us in evidence, change of crews at the boundary, which in his opinion was all that was necessary and perfectly workable. Picture to yourself for a moment in the crowded streets of Birmingham a service of cars with a headway of every few seconds, and fresh conductors and drivers popping up and down from the cars arriving or leaving the city boundary, and you have a spectacle worthy of a Drury Lane pantomime. A few months after the rejection of the Bill for running powers, the Birmingham Corporation were fortunate in obtaining the advice and the co-operation of one of the best known and most accomplished tramway managers in this country. The following extract from a speech made by Mr. Alderman Beale, the chairman of the Tramways Committee of Birmingham, in May of this year, is far more eloquent and convincing than any words of mine as to the results: "Going on to explain to what extent the Corporation had given way, Alderman Beale said that when the Corporation went before Parliament it objected to the granting of powers to the company to run through the city. The Corporation rather favoured the Liverpool system of a change of crews at the boundary. The company did not like that, and the committee had given way to the extent of allowing the company's cars to run into Birmingham in charge of the company's servants. Really, on reflection, the objection to this seemed to be sentimental rather than practical, and in some respects the arrangement would be an advantage, because they had been able to provide that the whole risk regarding a certain car should be borne by the body to which it belonged."

The only cases where running powers have been settled by reference are those of the Swansea and Mumbles, and the Glasgow and Paisley of this year. The Swansea case, being a very peculiar one and a very ancient one, it is unnecessary here to consider it. It may be interesting, however, to quote the case of Glasgow and Paisley, recently determined by the arbitrator, Lord Balfour of Burleigh, who was appointed by the Board of Trade.

Glasgow in 1901 was granted running powers into the centre of Paisley, and having decided to exercise this power, and not being able to agree with the Paisley Company as to terms and conditions, the matter was referred to arbitration. The distance from Glasgow to Paisley is 7½ miles, one mile of which is owned by the Paisley Company. Glasgow proposed to charge a "through" fare of 3½d., and it was suggested that the company was only entitled to receive the proportionate fare in mileage less a sum for working expenses. The company, however, claimed their statutory fare with no deductions, and a sum representing 6 per cent. interest on the cost of constructing a siding that had by the Act to be provided for the accommodation of the Glasgow cars. The company obtained by the award their full statutory fare for local traffic, and inasmuch as they charged for their own "through" traffic 1d. for 1½ miles (being three ½d. stages), they were allowed ⅔d. for each "through" passenger from Glasgow, less 3 3d. per car mile for working expenditure Another interesting part of this case is that Glasgow have to pay for the current they use while on the Paisley lines. The principle is, therefore, established that the owning authority is entitled to receive a sum per passenger in excess of the proportionate mileage for the "through" fare, and, in addition, the Corporation have to pay the costs of terminal service and facilities. The decision seems fairly to represent the views held by railway managers of the past, such as Sir Edward Watkin, who explained to the Railway Companies Amalgamation Commission in 1872 that the owning company was entitled to receive something beyond the ordinary fare on account of the increased traffic receipts accruing to the running company due to the running powers and also a proper sum for terminal accommodation.

It has been already stated that running powers on a railway do not mean profit to the running company. In case of mutual running powers on two systems of tramways this practice should, I think, still prevail; but in cases where there is no mutuality in running powers, like Glasgow and Paisley, it is a very different proposition. Glasgow, by obtaining a through service into the centre of Paisley, with a population of 120,000, instead of having to stop at the boundary, is fructifying some miles of their barren line to the detriment of the Paisley Company; whereas, if Glasgow and Paisley had mutual powers, this one-sided advantage would not exist. It is clear that in all cases where an outside company desires to gain admittance to the centre of another tramway system it is proper that the local service should not be interrupted, and that, in adjusting terms and conditions, if running powers are granted into the centre of the existing system, the effect of the break at the centre ought to be taken in account as a set off against any advantage the owning company may be said to secure in extra traffic by the connection.

Having regard to the importance to the public of the advantages I have endeavoured to indicate, which experience shows cannot but result from the working of tramways connecting important districts as a through service free from obstruction, I venture to suggest that this association will perform a most useful function by making every endeavour to remove the many prevailing and unfounded misapprehensions which exist, by the dissemination of

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information bearing upon the subject, and so abolish what, I think, must be conceded to be a most mischievous obstruction to the better and more useful developments of interconnection by means of through traffic.

The following is a summary of the discussion:

Mr. Alfred Baker, the president, said that if compulsory powers really meant what the author indicated, he could see no very great objection to them. But did they? Had the seekers after compulsory running powers always been willing to forego all the profits from the lines over which they desired to run? He thought not. If the British Electric Traction Company had never wanted to make any profit within the city of Birmingham, everybody had been under a most extraordinary misapprehension; but he must congratulate the author upon his definite pronouncement that night, that through powers should not mean profit to the running party in respect of the other owner's area. Recalling the details of the Birmingham case, he stated that the company applied to Parliament to coerce the Corporation into granting through powers, and the learned counsel for the company laughed to scorn the Corporation's suggestion that the matter was quite capable of friendly arrangement. The Corporation were quite prepared to grant through powers voluntarily, but objected to compulsion. Happily, Parliament adopted the Corporation's view, and the sequel proved that the question could easily be adjusted by negotiation. The arrangement was working exceedingly well, as he believed all such arrangements would where both parties tried to do the right thing. Each party provide a number of cars proportionate to the route mileage in their respective areas; the total receipts are divided in proportion to the route mileage, except that 5 per cent., representing those passengers riding exclusively within the city, is reserved to Birmingham; each party pays its own expenses and is responsible for accidents through its own servants' negligence. In the case of two large systems joining each other, it would only be necessary to divide fares on the stage crossing the boundary. The author had criticised the evidence given by Mr. Bellamy in this case in regard to change of crews at the boundary. Mr. Baker strongly defended Mr. Bellamy's attitude so far as regarded rural districts where the service was comparatively infrequent. It would be fallacious to lay down hard-and-fast terms for inter-running, but he thought that those adopted at Birmingham might generally be followed with safety. He certainly did not believe in a dog-in-the-manger policy, but he did think it the bounden duty of every local authority to protect the system it had built for its citizens. The danger of compulsory running powers was that municipal lines might be exploited by unscrupulous promoters building lines in sparsely populated neighbourhoods, but this peril, he acknowledged, was less real than apparent, because if the principle that the running company should not make a profit over the other party's lines were established, there would be little inducement for such promoters to construct lines. The author justified compulsory powers on the ground of public convenience, but Mr. Baker believed that where there was a legitimate demand, public opinion would be quite strong enough to compel an unreasonable undertaker to come to terms.

Mr. Barber Glenn frankly confessed that he viewed the matter entirely from the company point of view, and could not participate in any feeling as to the "sacred" character of municipal territory. It was simply a case of public necessity. Whether the inside line was a city system and the outside one a suburban system did not matter, because terms could be adjusted. He quoted the case of a company of which he had been secretary for over 30 years. They had years ago made arrangements with an adjoining company for through running. The first agreement was that there should be a pooling arrangement on the basis of the respective number of cars. That did not work altogether satisfactorily, because, he remarked humorously, his manager wanted to exceed the receipts of the other party, with the result that there were suggestions of such irregularities as "hanging the road." Consequently an arrangement was substituted by which each party kept their own receipts and adjusted expenses fortnightly. This arrangement continued for years, and no difference ever occurred that was not settled in a few minutes. He also mentioned the case of a light railway with which he was associated. This line met a municipal tramway, and the authorities paid a certain sum for running over a mile of the light railway. The corporation were willing to pay a liberal sum for running over the whole of it, but they absolutely declined to entertain any idea of the other side running over their lines on any terms, presumably on account of the aforesaid "sacred" character of their territory. He deprecated threatening corporations that if they did not grant running powers the case would be taken before Parliament, but he thought there should be a general enactment that adjoining owners should negotiate. The case of Newcastle exemplified this, and he was sure that in a twelvemonth the Corporation would wonder why they ever opposed through running. In the case of busy towns the idea of changing crews would be ridiculous, but there were cases in which it would be simple.

Mr. E. F. Vesey-Knox, barrister-at-law, thought that where it could be arranged that the running party should pay an agreed sum per car mile and keep all the receipts, as in the case of the London County Council and the Bexley Urban District Council, it was a very simple way, and saved a lot of trouble. This was the arrangement between the London and North-Western and the District Railways in respect of the former running to the Mansion House. It was a reproach to our legislation that there was no provision for through running on tramways as on railways. Parliament had not legislated for tramways since the Act of 1870. It was all very well to say that public opinion would suffice to settle differences, but the public often divided itself into factions. He pointed out that it was not solely a question between municipality and company, as in Lancashire tramways were lying derelict because municipalities could not agree between themselves.

Mr. Blaine, manager of the West Ham Corporation tramways, lamented the absence from the paper of the question of terms. He then quoted the case of his system and that of the adjoining borough of East Ham. The obstacle had been relative earning capacity; but the parties had agreed as an experiment that each corporation should take the whole of the profit earned by its cars in the other district. He had since found that the traffic on the West Ham system averaged over 50 per cent. more than that on the East Ham system, but he considered the great object was to start through running, by a tentative arrangement if necessary, the results of which could serve as the basis of a permanent arrangement.

Alderman Ivey, chairman of the West Ham Electricity and Tramways Committee, pointed out that East Ham had compulsory powers for running over his Corporation's lines, and this, he was sure, acted as a useful lever in coming to terms. He strongly advocated that there should be compulsion on tramway undertakers to negotiate for through running. If necessary, the terms could be settled by some authority such as the Board of Trade, which, strengthened if need be on the technical side, would constitute a very suitable tribunal. The cost of a line was immaterial; its earning capacity should be the basis of an arrangement. Seeing that railways, which ran on their own land, had to grant through running, there was still more reason why tramways, which ran on public highways, should be compelled to do the same. Details of management could be settled afterwards. Why not let the respective managers discuss terms instead of holding a series of abortive conferences between the committees? The former, he believed, would be able to arrive at the basis of an agreement in a very short time. On the engineering side, the question of standard gauge and similar matters should receive most careful attention when applications for new systems were considered.

Mr. England, manager of the Wakefield Light Railways, stated that although he was a company man, and thought that everybody must agree that the policy of through running was not open to discussion, he strongly objected to compulsory powers. There was no need of a general enactment; the common sense of the managers would suffice. The manager of the Leeds Corporation tramways and himself had settled the heads of agreement at a single meeting, supplemented by a game of golf. A common time-table was agreed upon, and the service was accelerated, if necessary, by telephone. Leeds supplied the company with tickets in bulk, and as soon as the company's cars passed the boundary, journeying into Leeds, their conductors issued a Leeds ticket. The company gave a reduced through fare between Leeds and Wakefield, and issued a ticket which entitled the holder to travel between the two towns, but as Leeds was entitled to one penny of the fare charged for the through ticket, as soon as the car crossed the boundary the company's conductor issued a penny ticket to each holder of a through ticket. The company supplied tickets to Leeds in bulk, which were similarly dealt with by the Corporation. He objected to a change of crews, because when the men got off the cars, it needed an inspector to look after them and a superintendent to look after the inspector.

Mr. Sellon, in his reply, traversed Mr. Baker's view that there should be a change of crew where possible. Modern conditions would seldom permit of such a course. [A little passage-at-arms ensued here between the speaker and the president on this point, and on the question of the Birmingham negotiations, but after a few remarks on either side the misapprehension was removed, Mr. Baker explaining that he did not suggest change of crews for urban traffic.] Proceeding, Mr. Sellon stated that the granting of mere "facilities" had long ago been tried in the United States, and discarded as altogether futile. In reference to Mr. Blaine's comment about the absence of terms, he thought that gentleman had misconceived the purpose of the paper, which was to enunciate the general principles of through running. The terms only concerned the parties affected, who could arrange matters between themselves. He did not advocate a hard-and-fast decree for compulsory running, but simply a general enactment that if the parties could not agree upon terms, the matter should be referred to some authority such as the Board of Trade. This was absolutely essential. There would be no need to resort to it where the parties were willing to negotiate, but all owners were not, as witness Newcastle, which cost £10,000 for parliamentary proceedings, and was settled in a few days after the committee had expressed its views strongly. He welcomed Alderman Ivey's observation that attention should be given to such engineering matters as standard gauge when new systems were sanctioned.

Votes of thanks to the author and the president closed the proceedings.

THROUGH RUNNING—COMPULSORY OR OTHERWISE.

The importance of this question led us to ask the opinions of the numerous tramway chairmen, engineers, and managers throughout the country with respect to the advisability of through services, whether compulsory or not. The following are a few of the replies received, from which it will be seen that nearly all interested in tramways favour through running as a public boon. The opinions as to the methods of securing the advantages of through services are of great value at the present time. We have arranged the replies in groups, putting first those received from chairmen of

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municipal undertakings; next, those from companies; and, lastly, those from municipal engineers and tramway managers.

GROUP I.—LETTERS FROM CHAIRMEN OF TRAMWAY COMMITTEES.

Darlington, Dec. 5, 1904.

Dear Sir,—I have much pleasure in replying to your letter of the 29th ult., but you must please understand that the views I express are my own, and not those of the Light Railway Committee of the Darlington Corporation, over which I have the honour to preside. The question of running powers over light railways is a subject I have paid much attention to. All railways, like highways, are constructed and maintained for the public advantage, and, in my opinion, light railway authorities, equally with highway authorities, are obliged to afford the public the maximum facilities within their power, and this view receives confirmation by Section 92 of the Railway Clauses Act, 1845, which enacts that upon due payment of tolls all companies and persons shall be entitled to use the railway with engines and carriages properly constructed, subject to certain restrictions and to the regulations made by the company; and by Section 108 (authorising the company to make regulations), no such regulations shall authorise the closing of the railway, or prevent the passage of engines and carriages thereon at reasonable times. You will thus see that the public have the right to use a railway with their own engines and carriages. Further, it is provided by Section 76 of the Railway Clauses Act, 1845, that owners or occupiers of adjoining lands shall be entitled, subject to certain restrictions, to lay down branch railways to communicate with any railway for the purpose of bringing carriages to or from or upon the railway, and that the company shall, if required, make openings in the rails, and such additional lines as may be necessary for effecting such communication.

Why should light railways be any different from ordinary railways? The objection so often raised, that the running company was desirous of usurping the rights of the owners of the light railway, and arrogate to itself the management of the tramways run over, is an idea founded on ignorance of what running powers mean. The principles regulating running powers on railways are well established. The ordinary mode of adjusting the conditions on which running powers shall be exercised is by giving 75 per cent. of the rate to the owning company, and 25 per cent. to the company exercising the running powers, and the Railway Commissioners will not, save except under very exceptional circumstances, vary the proportions, constant usage having crystallised them into a rule. The disadvantage caused by break of service is to reduce the running capacity on the routes immediately affected very considerably.

A through connection gives a great stimulus to tramway traffic. Running powers on light railways are equally necessary with railways for the accomplishment of their public purpose, and for the best commercial results. Any authority standing in the way of such convenience is abusing its position.

I regard running powers as a public necessity. Light railways were established in order to act as feeders to the railways, and in Darlington I strongly urged that the gauge should be 4ft. 8½in. instead of 3ft. 6in, so that the wagons for goods traffic might be interchangeable, but I was outvoted. There is no doubt that if the Light Railway Commissioners had insisted upon a uniform gauge of 4ft. 8½in., light railways throughout the country would have been, as they ought to be, of immense advantage to the community, as in time they would all have been connected up into one large system, which is impossible under present conditions.—Faithfully yours, EDWARD WOOLER,

Chairman of the Darlington Light Railway Committee.
Corporation Tramways, Huddersfield,

Huddersfield, Dec. 2, 1904.

Dear Sir,—In answer to your enquiry, I have no hesitation in expressing myself strongly in favour of intercommunication between tramway systems. It is unfortunate that the four county boroughs in this portion of the West Riding have all adopted different gauges, so that where the systems join up to each other an exchange of running powers is an impossibility. It has always struck me that the commercial advantages of such connections were enormously reduced by the fact of passengers being compelled to change cars. It seems to be part of the creed of public authorities to entertain feelings akin to jealousy of their immediate neighbours, and this fact will always be a stumbling block to intercommunication between municipal systems. Where the territories of several urban or rural district councils come between two municipal authorities, I think it would be to the benefit of everyone concerned to encourage a company to form the connecting links and to give them running powers to the centre of each of the terminal large towns. The financial wisdom of corporations going any considerable distance beyond their own areas is becoming every year more open to question as the results are ascertained. But a company can work a line and pay a dividend where a corporation would have to go to its ratepayers for assistance.

The whole question resolves itself into this—to give the public all the advantages and facilities possible so long as you can make a profit out of them (for I submit you are not justified in engaging in municipal trading unless you make a profit out of it). It matters not to the passenger whose car he travels in so long as he is conveyed to his destination as quickly as possible, at a reasonable fare, and with some approach to comfort. The Commons Committee gave not only Newcastle but all municipalities a wholesome lesson, and in future I hope we shall give more consideration to public convenience and less to municipal sentiment. There need to be no insuperable difficulty in apportioning the receipts and expenses if each party is willing to take what rightly belongs to it without trying to score off the other.—Yours faithfully, T. H. MOORE,

Chairman of the Huddersfield Tramway Committee.

Town Hall, Blackpool, Dec. 2, 1904.

Dear Sir,—The mayor desires me to acknowledge the receipt of your letter of the 28th ult. We are unable to give you any information at present on the question of intercommunication between tramway systems, as it is not yet in operation within the borough. I may say, however, that the Blackpool, St. Annes, and Lytham Tramways Company, Limited, and the Corporation are in negotiation as to mutual running powers over the two systems.—Yours truly, T. LOFTOS, Town Clerk of Blackpool.

Ipswich, Dec. 2, 1904.

Dear Sir,—I beg to acknowledge your letter asking for my views on the commercial possibilities of intercommunicating tramway systems. I regret that I have not considered the subject, and inasmuch as this Corporation's system is most unlikely to be linked up with any other for a great number of years, we shall in all possibility never have to consider the question. I should think it would be a terrible nuisance from a manager's point of view, both mechanically and commercially.

A toll per car per car mile run upon the basis of a profit on cost per car mile, interest, and redemption, with a percentage for depreciation, would seem the only basis. To attempt a ticket system would be impossible of achievement. No strange cars should ever be allowed on a single-line system.—Yours faithfully,

HERBERT J. W. JERVIS,
Chairman of the Ipswich Tramways Committee.

Preston, Dec. 2, 1904.

Sir,—In reply to your favour of Nov. 29, while I fully recognise the importance of the question of intercommunication and all that depends upon it, I have so recently been appointed chairman of our Tramway Committee that I feel considerable diffidence in passing any opinion whatever upon the subject, but I presume some arrangement for division of receipts and expenses could be arrived at somewhat on the lines of the Railway Clearing House working.—Yours truly,

E. J. ANDREW,
Chairman of the Preston Tramway Committee.

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GROUP II.—LETTERS FROM MANAGING DIRECTORS AND ENGINEERS OF TRAMWAY COMPANIES.

16, Great George-street, Westminster, Dec. 1, 1904.

Sir,—In response to your letter of yesterday, I cannot, perhaps, do better than to endorse Sir John Dickson-Poynder's powerful plea which recently appeared in the columns of the *Times*, displaying a most searching consideration of the question of "through communication" in its relation to the greater question involved in respect to the housing of the people. There is much that I should like to say on the particular case of the Tyneside tramways, but I refrain from doing so because I might, as a representative of "private" (as distinguished from "municipal") enterprise, be regarded as prejudiced, and I prefer to maintain the controversy at the high level on which Sir John Dickson-Poynder has placed it. The issue is one of national importance, for the housing question lies at the root of a score of others. There would be greater efficiency, physical and mental, if the masses were enabled to live under healthier conditions than are possible in our great cities. The fundamental cause of overcrowding and its attendant evils are correctly described by him when he says, "there comes a stage in all city development when houses for the working classes cannot be provided at an economic rent by reason of enhanced site value," and, in my view, he is on equally safe ground when he adds, "the only remedy to hand is cheap and expeditious locomotion to the suburbs."

In the suburbs of London, and of all our great cities, there exists land and to spare on which houses for the working classes *can* be provided at an economic rent. The difficulty is that this land is remote—practically inaccessible A workman must live near his work. He—good fellow that he generally is—is willing to put up with many inconveniences for the sake of finding a healthy home for his family, but there are limits beyond which he cannot go. His wages do not provide much margin for travelling expenses. His daily journeyings must, therefore, be "cheap and expeditious," as Sir John concisely puts it. The question resolves itself, in short, into one of transit, in London inevitably of "through communication." Thanks to that combination of "tube," "rail," and "tram" to which I have pinned my faith, it is now possible for workingmen to live at Ealing, at Southall, or Hounslow, even as far afield as Hayes and Uxbridge, on the west, or at Richmond, Teddington, Twickenham, Hampton, and Staines in the Lower Thames Valley; for in these directions, and presently even far beyond, the electric cars of the London United will carry him swiftly and comfortably at a cost of something less than a farthing a mile.

In this connection I may, perhaps, quote some figures I recently submitted to the Royal Commission on London Traffic. In 1900 the passengers carried on the nine miles of horse tramway then existing in West London numbered some 8,000,000; and when, in promoting our first Electric Tramways Bill, I ventured to predict that, with the proposed extensions to Hounslow and Hanwell, we should carry at the rate of 25,000,000 passengers a year, it was thought I was over-sanguine. In point of fact, I under-estimated rather than exaggerated the figure, for the number of passengers in 1902 was 36,000,000, while last year, on the increased mileage, over 45,000,000 were carried. This was equivalent to our carrying 126 times over, in the course of the year, the entire population in the districts served. In 1900 there were only three workmen's cars running on the London United horse tramway system. We are now running daily upwards of 30 workmen's cars, and, on an average, we carry the passengers by those cars over five miles for 1d., the distance actually covered for that sum being in several instances over seven miles, and the average fare considerably under ½d. per mile. Whereas the total number of workpeople carried in 1900 under horse traction was only 142,000, the number has now risen to 2,562,000—an increase of 145 per cent. Concurrently with the expansion of our traffic there has been a remarkable growth of the suburbs in the West of London. Such is the demand for house property that estates where one dwelling formerly stood on its own acreage are now being cut up into building plots for houses that average from 20 to 30 to the acre, and land which a few years ago could not be sold advantageously is eagerly purchased and developed. Had these routes of which I speak not been continuous, had there been dual ownership with one of the owners of the exclusive mould of the Newcastle Corporation, it is inconceivable that this expansion of traffic and this extension of healthy residential areas could have taken place.

So much has been accomplished on this side of London that it is beginning to be possible for even those least richly dowered with imagination to realise how much more might be done if, not in the West of London alone, but in the North, the South, the East—and not merely in London, but in everyone of the great cities and towns of England—there existed such means of "cheap and expeditious and, what is essential to cheapness and expedition, continuous communication between the country and the town as electric tramways are capable of supplying. I use the phrase "capable of supplying" advisedly, for even in our own case the capabilities of electric traction as applied to tramways are only imperfectly realised in practice. Our undertaking is heavily burdened by the exactions of short-sighted local authorities; many miles of extensions which might to-day have been in operation have been delayed or abandoned because it was impossible for us to satisfy the rapacity of these bodies, and our connection with the underground electric railway system of the Metropolis is imperfect, and must remain so for the present, the London County Council having again prevented us from obtaining powers to carry out important connections between the London United and the Metropolitan District Railway. When the municipalities forget that they are tramway promoters, their views on housing questions and on intercommunication are sound enough. True, Mr. Benn spoke in the House of Commons on the Tyneside Bill as though it would be an intolerable grievance for the London County Council to be asked to grant running powers to tramway companies whose lines were prolongations of the municipal system. But Mr. Dickinson, representing the same Council, told the Traffic Commission that he anticipated no difficulty in arranging for running powers. "It is just as important for us to get people carried out to Middlesex as it is for Middlesex to get people carried into London." And again, asked if he proposed trans-shipment at the boundaries, Mr. Dickinson replied, "No, that would be absurd." The witness guarded his remark that companies should have running powers over the Council's tramways with the reservation that it was his personal view, but the personal view of a county councillor so prominent shows that the exclusive policy of the Newcastle Corporation is not universally approved in municipal circles.

The cheap, rapid, and convenient means of transportation in which lies the hope of improvement in the physical and moral condition of the people, can be provided only by the freest interchange of traffic, the most perfect physical connection possible between urban and suburban tramways, and in London between the tramways and the railways which have at present a monopoly of the congested heart of the City. Everywhere, in London and in the provinces, there is urgent need of recognition of the fact that "municipal" and "company" tramways must exist side by side for many years to come, and that as industrial enterprises, and as factors in the solution of pressing social problems, they will fail to achieve their highest possibilities if the "dignity" of corporation or the *amour propre* of individuals is allowed to stand in the way of effective combination for common ends. Effective combination means, so far as tramways are concerned, "mutual running powers," such as were sought last session for the Tyneside and will ere long be demanded by London.—I am, Sir, yours obediently,

J. CLIFTON ROBINSON,
Managing Director of the London United Tramways (1901), Limited.

Liverpool, Dec. 6, 1904

Dear Sir,—In reply to yours of the 29th ult., subject to equitable arrangements, through bookings and through workings would undoubtedly be to the advantage of everybody concerned.—Yours, etc.,

S. B. COTTRELL.
Engineer and Manager of the Liverpool Overhead Railway Company.

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A corporation engineer who has gone fully into the matter, but who, for business reasons, does not wish his name to appear, writes as follows: "Personally, I think intercommunication ought to be arranged, but in making arrangements it should be borne in mind that the town authorities generally have by far the better portion of any joint system, and that it is, as a matter of fact, very much more to the advantage of an outside authority—where the traffic is necessarily lighter—to have the advantage of running into the centre of a dense population, and if the outside authority would view the matter in this light I think it is desirable to have intercommunication. At the same time I think far too much noise is made, probably with a view to besmirching municipalities, as to the importance of through cars, as if the two services are worked so that cars meet each other, and there is outward communication so that nobody need be left, there is not much difference between this and through running.

"I think in a county like Lancashire, where tramway authorities are fairly numerous, and are likely to join up to each other, that intercommunication between them will ultimately have to come, and I think any arrangements so made should be made by a joint Board, on which each of the tramway authorities concerned should be represented. An arrangement like this, as a matter of fact, now exists in Lancashire. For some time since the Liverpool tramway authorities called together the tramway authorities of Lancashire, and appointed a joint committee, together with representatives of the South Lancashire Tramways Company, for the purpose of arranging through running for goods traffic. As far as I know, this committee is still in existence, but owing to the arrangements at Liverpool being blocked by their not obtaining powers for taking over the Bootle Corporation system, the matter has been somewhat in abeyance."

Blackpool, Nov. 30.

Dear Sir,—Yours of the 29th inst. *re* above subject to hand, for which I am obliged. The question of intercommunication between two undertakings is a very difficult problem to give any general opinion on, as every case requires its own consideration as to whether it would be wise in the interests of the owners to have compulsory running powers forced upon them. Generally speaking, I am of opinion it is desirable to give the general public all the advantages possible in using the tramways whenever it is practicable to do so. As to terms upon which interchange of traffic should take place, this could only be arrived at after knowing what the conditions of the systems were.—Yours, etc., JOHN CAMERON,

Secretary and General Manager, Blackpool and Fleetwood Tramroad Company.

Dublin, Dec. 6, 1904.

Dear Sir,—Replying to your letter of 29th ult., I am strongly of opinion that compulsory interchange of traffic is neither practical nor desirable, but that same could be advantageously operated under a mutual agreement.—Yours, etc., R. S. TRESILIAN,

Secretary to the Dublin United Tramway Company.

Dublin, Dec. 6, 1904.

Dear Sir,—In reply to your favour of 29th ult., I am strongly in favour of compulsory running powers being obtained wherever practicable, and my chief regret in connection with this company is that owing to a difference of gauge we are unable to avail ourselves of through communication with the Dublin United Tramways. Our passengers complain of the change of car which is necessary, and I am convinced that traffic which would otherwise be secured is now lost.—Yours, etc., H. HARRISON,

Manager, Dublin and Lucan Electric Railway Company.

Norwich, Dec. 2, 1904.

Dear Sir,—In reply to yours of Nov. 29 *re* interchange of traffic on tramways. This is not a subject to which I have given very much attention, as there is no likelihood, at present, of the matter affecting these tramways, this system being quite isolated.

In a general way, however, I am very strongly of opinion that, in the interest of the public, wherever two systems connect, interchange of traffic, without change of cars, should be arranged. If the parties cannot come to an amicable arrangement, compulsory powers should be applied for.

In my opinion, the difficulties of such an interchange are very much over-rated. Of course, the terms of such interchange would have to be devised on the merits of the case in each particular instance. I do not see how any general rule could be made to apply to all.—Yours, etc.,

ALAN N. BANISTER, M.I.M.E., Engineer and Manager, Norwich Electric Tramways Company.

Scarborough, Nov. 30, 1904.

Dear Sir,—In reply to yours of the 29th, I think the question of intercommunication where practicable is an important one, and should be arranged by a mutual agreement, as at Leeds, and not a compulsory arrangement, as at Newcastle.—Yours faithfully, J. E EDMUNDSON,

Manager, Scarborough Tramways Company.

Guernsey, Nov. 30, 1904.

Dear Sir,—In reply to your letter of Nov. 29, I fear I am unable to give you any serviceable information dealing with the points raised, the local conditions being very different to those existing in England. I, however, consider that intercommunication upon tramway systems is not necessary, and if adopted would lead to very heavy staff charges due to the greatly increased clerical labour in all departments. I do not consider the suggestion of compulsory interchange of traffic at all a necessity or even desirable.—Yours, etc., ALBERT L. DAVIS.

Guernsey Railway Company, Limited.

Bushmills, Nov. 30, 1904.

Dear Sir,—In reply to yours of the 29th ult., the experience on our tramway will, of course, be different from what may be deemed advisable in relation to town tramways.

We have interchange of traffic with the railway company with which we adjoin, both for passengers and for parcels. I consider the interchange of traffic—*i.e.*, through bookings—desirable under certain restrictions, but certainly not compulsorily so, the accumulation of many different classes of tickets in a conductor's hand being objectionable, while by the establishment of suitable issuing offices through bookings could be arranged.—Yours truly,

WILLIAM A. TRAILL,

Managing Director, Giant's Causeway Electric Tramway.

Chatham, Dec. 1, 1904.

Dear Sir,—As requested in your favour of the 29th ult., I have pleasure in stating my views as follows: I am quite sure in a great many cases interchange of traffic is both practicable and desirable, but as for the terms, that must entirely depend upon mutual agreement, as local conditions vary so much that it would be impossible to lay down hard-and-fast rules. H. JENSEN,

Chatham and District Light Railways Company.

Bath, Dec. 1, 1904.

Dear Sir,—I am in receipt of your circular letter of the 29th ult. with reference to intercommunication between tramway systems.

Personally, I am very much in favour of interchange of traffic, and think that it can always be made practicable and desirable, but, of course, the terms would have to be gone into in each separate case. I am, however, in favour of through traffic, so that no changing cars is necessary for passengers.—Yours, etc., R. D. MCCARTER,

Manager and Engineer, Bath Electric Tramways, Limited.

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GROUP III.—LETTERS FROM CORPORATION ENGINEERS AND MANAGERS.

Burton-upon-Trent, Dec. 3, 1904.

Dear Sir,—I am receipt of yours of the 29th ult. regarding the subject of intercommunication on tramway systems and parcel traffic. With reference to the former, I think that in many cases intercommunication is a mutual advantage to both tramway systems, and unquestionably a great public convenience.

I do not think that making this intercommunication compulsory is desirable; it should be more a matter of careful consideration and mutual arrangement between both parties. There are many technical and traffic points to be gone into before another system should be allowed to run over one's own system, and these should be amicably arranged instead of being compulsory.

In our case we are permitting the Burton and Ashby Light Railway to run over part of our track, so as to reach the centre of the town and the railway station. Their system comprises some 14 miles of track, and will bring the mining and pottery districts, having a population of about 40,000 or so, in close touch with Burton, this being the nearest largest town. This will unquestionably be a great convenience, and, it is hoped, of mutual interchange to both parties. The details as to how this advantage will take place have, however, not yet been settled.—Yours, etc.,

P. J. PRINGLE, Engineer and Manager,
Burton-upon-Trent Corporation Tramway.

Brighton, Dec. 2, 1904.

Dear Sir,—I have to acknowledge receipt of your letter of the 29th ult. with reference to the question of intercommunication between tramway systems. Personally, my views are that it is very desirable that intercommunication should be afforded, but I do not agree that compulsory interchange is desirable, but that in all cases it should be left to a matter of arrangement by agreement, as no doubt there would be special matters in connection with each special system that could only best be settled by mutual agreement.—Yours faithfully,

THOMAS B. HOLLIDAY, Tramways Engineer and General Manager, Brighton Corporation Tramways.

Barking, Essex, Nov. 30, 1904.

Dear Sir,—In reply to your letter of the 29th, my views *re* inter-running entirely coincide with those of Mr. Stephen Sellon, whose paper is being read to-morrow night on inter-running before the Tramways and Light Railways Association. I am entirely of opinion that in the interests of the public inter-running between neighbouring authorities, if unable to be arranged by agreement, should be arranged by compulsion. I am glad to say that in our case, between Barking, Ilford, East Ham, and West Ham, we are arranging through running on perfectly amicable lines, although the agreements are not drawn up at present.

I consider that the interchange of traffic is generally practicable, and most desirable, but the terms upon which such interchange should be arranged are affected entirely by the local conditions, and I do not see that it is possible to lay down a hard-and-fast rule.—Yours faithfully,

A. HUGH SEABROOK, Engineer and Manager,
Barking Urban District Council Tramways.

Hull, Nov. 30, 1904.

Dear Sir,—I have your letter *re* intercommunication and goods carrying. Regarding the first, we in Hull are in a position of isolation, as there is no tramway system within many miles of us; therefore, we are not called upon to face the question from an individual standpoint. So far as the broad principle of interchange of traffic is concerned, the convenience of tramway riders is the first consideration. This being so, it appears to me in the highest degree desirable that tramway authorities should set themselves, wherever possible, to adjust matters so that the public may reap whatever benefit may reside in facilities for intercommunication. A company or a corporation cannot take up a recalcitrant attitude, and in effect say to the public, "We can run cars to suit you, and give you the facilities you require; but to do so doesn't suit us, because such and such a thing stands in the way." Public opinion would not stand that sort of thing, and there is no doubt the Legislature would step in and summarily adjust the differences between the authorities. There appears to be such a spirit of compromise abroad that it is hardly likely that drastic measures will have to be employed in settling matters in dispute.

Re the question of terms, this, of course, is a matter to be settled upon the merits of the case, and no one could lay down a hard-and-fast line as to particulars.—Yours, etc., WILLIAM J. MCCOMBE, Manager,
Corporation of Kingston-upon-Hull Tramways.

Ipswich, Dec. 2, 1904.

Dear Sir,—In reply to your letter of the 29th inst., the question of intercommunication hardly concerns me at present, as Ipswich is so isolated from all other towns which have, or could have, tramways. Speaking generally, however, I should say that the public convenience should be the first consideration both with companies and corporations owning tramway systems, except in those cases where it is apparent that catering to the public convenience will entail a dead loss on the revenue account. I think, however, that it is generally found that the greater the effort made to meet the convenience of the public, the more popular is the system and the greater its success financially. On these grounds I should say that the interchange of traffic between different systems is most desirable where possible.—Yours, etc., FRANK AYTON, Engineer and Manager,
Ipswich Corporation Tramways.

Colchester, Nov. 30, 1904.

Dear Sir,—Referring to your letter of yesterday, I am of opinion that compulsory interchange of traffic where practicable and desirable should be common to tramways. The difficulty is as to terms, but why should there not be a clearing house as on railways? I have had 20 years' experience on one of the leading railways in this country, and I remember the time when this difficulty was thought to be insurmountable on railways. Through running is now general on all railways, and I do not see why it should not be the same on tramways adjoining each other.—Yours, etc., R. C. BULLOUGH, General Manager and Engineer,
Colchester Corporation Tramways.

Shipley, Dec. 7, 1904.

Dear Sir,—With reference to your enquiry of Nov. 29, I have to say that the Shipley Council have leased their lines to the neighbouring authority of Bradford, who now control the entire system both of the city and the out-districts. The Corporation pay adequate interest on capital outlay, and they also pay a charge for maintenance. So far as the limited experience in this district goes, it seems to show that the principle we have adopted is much better than the one of interchange of traffic.—Yours faithfully,

I. LINDOW,
Clerk, Shipley Urban District Council.

THE PREDETERMINATION OF THE DEMAND FOR ELECTRIC LIGHTING IN MODERATE-SIZED TOWNS.

In an article by F. Erens in a recent number of the *Elektrotechnische Zeitschrift* an interesting connection between the demand for electric lighting in a given town and the prosperity of its inhabitants is shown to exist, at least in the case of certain moderate-sized German towns. The writer, being confronted with the problem of deciding beforehand the probable lighting output required by a town of 60,000 inhabitants, attempted to obtain an average figure by investigating the records of numerous other towns. He found, however, that, taking the 1902 statistics of German towns having between 30,000 and 150,000 inhabitants, the results differed very decidedly, the extreme values being

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respectively 3 kw. and 25 kw. per 1,000 inhabitants. The higher values might be due to the high price of gas lighting, the low price of electricity, to special expedients employed by the station engineers or to general economical conditions, and in order to arrive at some satisfactory explanation a circular letter was addressed to the authorities of 10 of the towns which, in spite of a comparatively short time of service, had attained very high values for the lighting output. In this letter special enquiry was made as to the causes of the high values, and as to any special means adopted for raising the value. The replies showed that the price of gas in these towns was in no way unusual as compared with that of electricity. The authorities also placed little weight on the special means adopted (which consisted chiefly in the free installation of houses or their installation under easily fulfilled conditions), but all agreed that the chief cause of the high value lay in the financial condition or prosperity of the inhabitants.

In order to investigate this point, the writer assumed that the prosperity of the inhabitants was proportional to the income tax per head paid to the State. This assumption is only correct when all the towns are taxed under a uniform law and on the whole of the incomes, and these conditions

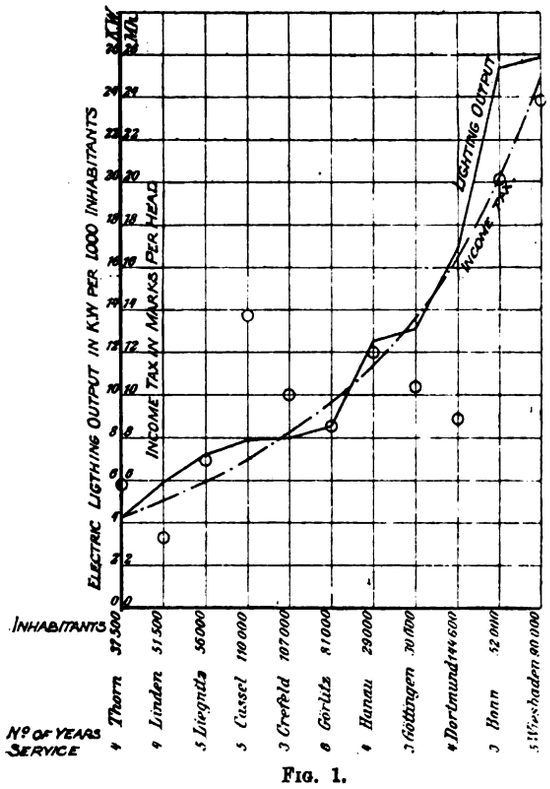

FIG. 1.

applied to the Prussian towns alone. As, besides this, all towns of more than 150,000 or less than 30,000 inhabitants, as well as towns with very widely differing lengths of service, had to be excluded, the comparison could only be applied to a small number of towns. In the curve (Fig. 1) the towns are arranged so as to form a rising curve of kilowatts per 1,000 inhabitants (shown by the angular solid line), and the values of the income tax in marks (shillings) per head are shown to the same scale of ordinates by the small circles. The dotted line is the approximate average for these circles. It will be seen that the one curve practically lies over the other, so that the two following conclusions may be drawn: (1) the prosperity of the inhabitants of a town is a measure of the electric lighting output; (2) the value in marks of the income tax per head under the Prussian law is, in the case of medium-sized towns, approximately equal to the kilowatts per 1,000 inhabitants used in electric lighting after five or six years' service. The latter rule, of course, cannot claim to represent the facts exactly, but the curves given may be of some service in deciding the probable relative values of the electric lighting outputs in different towns.

Diary.—Particulars of the "Practical Engineer" Electrical Pocket-Book and Diary for 1905 appear in another column.

NOTES ON PERMANENT WAY FOR TRAMWAYS.*

BY A. N. CONNETT, M I C E (MEMBER OF COUNCIL).

This subject may be somewhat hackneyed, but no one interested in tramways would be inclined to question its importance. Much has been written with advantage on the permanent way of steam roads without exhausting the subject. Considering the large capital invested in tramways, and the importance in both first cost and upkeep of the permanent way, no apology is necessary in submitting the results of observation and experience in the hope that some increase, however small, may be added to the common stock of knowledge. The variations in the first cost of permanent way are wide. This is largely due to differences in paving requirements. The figures for new track vary in general from £4,000 to £6,000 per mile of single line. There is naturally a wide variation in the proportion of cost of the various items entering into completed track, due to local or special requirements. The following analysis of proportionate costs will be found to be a fair general average for new lines: rails and fastenings, 22; special work, 10; paving material, 30; cement, sand, and broken stone, 14; labour, 15; bonds, 2; and cartage and miscellaneous, 7 per cent.

Rails.—One result of the report of the Standardising Committee on tramway rails has been to cut out an important amount of "copy" in articles such as this. The necessity of standardisation has been amply demonstrated by the unanimity with which the recommendations of the committee were adopted. The advantages, both to buyer and seller, are so evident in this instance that it is to be hoped that the principle may be carried further than is now contemplated.

I have no desire to say anything about the standard sections further than that I think them admirable, having regard to the conditions imposed upon tramways in this country. I am not, however, an advocate of too rigid an adherence to the specifications suggested by the committee; not but that they may be quite correct when properly interpreted—as a layman I would not suggest otherwise. The experts on the Continent differ from their brethren in Great Britain and the United States in that they consider that the physical tests show sufficiently whether the product is fit for its intended use, and they, therefore, limit themselves to such tests, leaving to the manufacturer a free hand in other respects. There is a risk that the engineer, who cannot always be expected to be an expert in metallurgy, may specify chemical requirements inconsistent with the physical tests. Again, the product may pass satisfactorily the required physical tests, but depart from specified limits in one or more comparatively unimportant elements in the chemical analysis. No particular harm should arise in any such case if the question is left to the discretion of the engineer for decision, but a municipal engineer may regard it as his duty to bring such a matter before his committee for settlement. It is needless to say that there is not one chance in a thousand that the committee would be in any way competent to consider, let alone decide, such a question.

An experience of this kind proved, to my satisfaction at least, that such a case can arise. In this instance the net result was a large increase in my knowledge of the effect of silicon in steel, and also to provide me with what my friends are pleased to call "a good story." But the case had potentially very serious possibilities. The result of the efforts of the Standardising Committee has made improbable for a long time to come changes in the sections of tramway rails of the ordinary girder type; still, this does not mean that finality has been reached in the design of tramrails. Many types of rails have been designed, and a number actually made and used. Some few have had a fair amount of success, but mostly they have turned out dismal failures. It is not stating the case too broadly to say that, all things considered, none of these have proved superior (and it is even disputable if any one has proved equal) to the ordinary well-designed girder tramrail.

Joints.—The question of joints is truly a difficult one. On no other detail of permanent way has so much thought

* Paper read before the Tramways and Light Railways Association

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been expended. It is well recognised that the life of the rails is limited by the wear at the joints. It certainly does not make for confidence in the economic future of electric tramways to see rails which should have many years' wear in them taken out and replaced by new ones, simply because they are battered down at the joints. It is well known that the greatest enthusiasts on the joint problem, apart from those who have joints to sell, are those having had the least experience. The more one has had to do with the problem, the less one feels on safe ground in recommending anything. All are familiar with the optimistic saying about a well-known stimulant; reversing this, the experienced tramway engineer is tempted to say that all joints are bad, only some are worse than others. If the experience gained on steam roads was more directly applicable to tramways, the tramway engineer would be a great gainer thereby, but the conditions differ to such an extent that, after giving due regard to the results of railway practice, the tramway engineer finds that his own problem is still far from solution.

When the permanent-way construction consists of rails laid on sleepers with ballast foundation, the tramway engineer may feel justified in adopting a splice-bar joint, either of the ordinary type or combined with some such feature as the continuous joint gives. Such a permanent way is at least fairly comparable with that of steam railways. If the sett paving is laid with sand joints, it is not a very expensive matter to have access to the joints when they need repairs. Such conditions largely exist in the United States. In this country the requirement of a concrete base for paving, with the setts laid almost directly on the base, makes the construction as above outlined hardly admissible. Having given a foundation of artificial stone, what more natural than to lay the rails directly thereon? Most of the tramway construction has been so made, and there seems to be marked tendency to depart therefrom. The conditions existing in permanent way so constructed must of necessity differ widely from those found with the elastic road-bed of a steam railway. For example, the wave motion which is so well known in railway practice must be, if not practically absent, at least much modified with the continuous rigid foundation of a tramline. There is thus no necessity for a tramway engineer to give much consideration to the possible bad effect of unduly stiffening the joint on account of prejudicially affecting the continuity of the "wave." On the other hand, the tramway engineer has a serious condition to meet that the railway engineer has not, in that the tram joint is inaccessible for inspection and repairs. This in reality is the vital difference. If tramway joints could have the same attention that they have on steam roads, the joint problem would have about the same relative importance in the one case as in the other.

Disregarding for the moment any other than mechanical joints, it will be found that splice bars of special form, or ordinary bars used in conjunction with some other device, form the great majority of joints, patented or otherwise. Therefore it is quite proper to give due consideration to the ordinary splice bar. A well-designed bar should have the following features: (1) Large area of bearing surface at top and bottom. The load from one rail to the other being transmitted by the joint, it is evident that this load should be distributed over a large bearing surface. (2) The maximum thickness of bar that circumstances will permit. Having given a determined depth of rail, the stiffness of the bar to resist flexure can only be increased by added thickness. It is, of course, evident that the stiffness is immensely increased by adding to the depth of the bar. This would explain why the ordinary form of fishplate has been so successful with the deep rails used in America. The thickness of metal also prevents deformation of the bar by the bolts. (3) The vertical member of the bar slightly convex in relation to the web of the rail. The advantage of this is twofold. It prevents the bar from being drawn inwards from the vertical position by the effect of tightening the bolts, and it also permits the use of concealed bonds. (4) A clear theoretical distance of from $\frac{1}{2}$in. to $\frac{3}{4}$in. on the fishing surface of the rail, top and bottom, to be left after the bars are finally fixed in place. This allows for slight inequalities in the rollings without destroying the fishing effect, and also permits taking up the wear which occurs in service on the flat fishing surfaces of rails and bars. (5) Long splice bars, say between the limits of 26in. to 32in. The great wear of the fishing surfaces of rail and splice bar appears in that portion near the joint. It is, therefore, of little practical utility to make the bars of an abnormal length. Personally I believe that 26in. is, all things considered, about the right length. This permits a good distribution for six bolts. The engineer should make rigid requirements in his specifications for accurate fit between the bars and the rails, and see that such are carried out by the manufacturers.

A well-designed and well-rolled splice bar may lose a large part of its efficiency if proper precautions are not taken in the fixing. It is evident that looseness or play between the bearing surfaces of the bars and the rails will have for effect a prejudicial "pounding" action at the joint. However small this may be at first, the continued shocks rapidly increase the wear between the surfaces, so that the trouble grows at a most alarming rate. It is clear, therefore, that nothing must intervene to prevent the best bearing possible between rails and bars. To accomplish this, the bearing surface of the rails should be thoroughly cleaned of rust and scale by using a hand hammer and file. If the splice bars have been dipped, the compound should be removed from the bearing surfaces in some suitable way. The splice bars should be put on "square," and at first only drawn up sufficiently to hold the rail snugly together. After the rails are surfaced, the bolts should be drawn up tightly, using not less than a 2ft. spanner, and at the same time tapping the head with a light hammer. As a final precaution, the bolts should be gone over in the same way, just ahead of the paving work.

The ordinary splice-bar joint, designed, made, and fixed in the manner above outlined, will give results far better than is generally believed. From experience, I feel safe in saying that such joints will give excellent service, provided they are opened up and refixed once a year. It is too often the case that the joints are not attended to until they are "pounding" badly. The result is permanent injury to the rail heads, and possibly a "set" in the splice bars. The repairs when undertaken are often limited to taking out a few setts and tightening up the bolts. It is forgotten that the bearing surfaces are not machined, and that the bars and rails fit only on the high places, so to speak. In consequence there is wear and actual abrasion of the bearing surfaces, the first effect of which is a slight "pound" at the joint. To make the repairs anything like effective, the splice bars should be removed, the bearing surfaces of bars and rails thoroughly cleaned, and the bars put back with the utmost care and attention. This is the reason why small boxes about the joints, which only permitted access to the bolts, were found to be of such doubtful utility. If boxes are provided, they should be designed with the object of permitting the removal and replacement of the bars.

The cost of repairs to such joints, including taking out paving, refixing plates, and reinstatement, should vary from 3s. to 4s. per joint. If 60ft. rails are used, the number of joints will average, say, 190 per mile of single line. The cost then will vary between £30 and £40 per annum. A common form of joint is a soleplate, riveted or bolted to the base of the rail in conjunction with the ordinary fishplates. Such a plate, if used alone, would be of little use to transmit the load from one rail to another. In consequence, the chief reliance must be placed on the splice bars. The joint known as the "continuous rail joint" has been extensively used with excellent results. It is in effect a soleplate joint without the bolts or rivets.

What is called the "anchor" joint is very largely used in this country. This type of joint might with advantage be called "girder soleplate" joint, the anchoring feature being merely incidental. Usually a piece of the rail is used, though any ordinary girder section answers quite as well. Such a construction has been used on steam roads, where it was called a "crop end" joint. It was found to give a stiff joint, so stiff, in fact, that it was a question whether the rails did not wear more from this cause than they would have with the ordinary flexible angle bar joint. This objection can have little weight for tramrails laid continuously

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on an unyielding concrete foundation. Such a joint should be of considerable assistance to prevent the initial loosening and consequent refixing, but wear will occur between bottom of the rail and the top surface of the girder soleplate. The experience gained by putting joints on extended yoke seats in cable railway construction demonstrated conclusively that such wear does occur. When once looseness at the joint commences, the subsequent maintenance of a good joint will depend upon the splice bars. Whether the presence of a stiff girder soleplate will affect the refixing of the splice bars to get a good joint I am unable to state, having had no personal experience to guide me.

In fixing the joint above described, it is necessary to take the precaution of careful examination of the rail heads. The slightest difference in level in the two abutting rails will cause "pounding"; the rail ends, consequently, should be filed or ground off, wherever necessary, before the tracks are used for car service. Many other forms of mechanical joints have been tried. Too many of these have some fancied advantage which necessitates sacrifice of one or more good features of the splice bars, the net result of which is prejudicial rather than otherwise. Scarfed or bevelled joints have been quite extensively tried on the Continent. If there is any advantage in these, it must be on the principle that the wheel drops into the space between the rails when the joint is square. How slight the drop is may be seen from the example of a 30in. wheel and a $\frac{1}{4}$in. joint, the drop in this case being less than $\frac{1}{1000}$in. If joints were damaged from this cause, the rail ends should be "battered." An examination of the rail heads at worn joints will quite invariably show a bright or battered spot an inch or more from the gap between the rails. On double lines the direction of travel of the cars can be determined by the relative position of this worn or bright spot, it being found on the entering and not the leaving side of the joint. This would indicate that the wheel jumps before arriving at the gap between the rails, and that this is due to flexure at the joint. It would appear, then, that the scarfing or bevelling of rail ends can have no beneficial effect. There is a class of joint quite distinct from these already considered which comes under the general head of "welded" joints. This class again subdivides into cast weld, electric weld, and thermit weld.

Cast Weld Joint.—This process was first exploited by the Falk Manufacturing Company, Milwaukee, U.S.A. Many thousands of these joints have been made with varying success. If the joints are made in the most careful manner by an experienced force under a capable superintendent, they are generally successful. It has been stated that the process of welding by using a large mass of molten metal changes the character of the steel rail ends, and that there is, in consequence, wear at the joints due to softer steel there than elsewhere. I had a large experience with this type of joint in France. The results, so far as I could judge, were satisfactory. The most serious objection is the plant required. It is expensive and most difficult to handle. The transportation and use of a miniature blast furnace along a public road is a thing one would avoid if possible.

Electric Weld Joint.—This process was at first a failure, but the determined confidence of the Lorain Steel Company has finally been rewarded with success. It is now being tried on a number of important lines in this country. It, however, has also the disadvantage of requiring formidable plant.

Thermit Weld Joint.—This joint, due to Dr. Goldsmith's alumino-thermit process, is the latest arrival in the field of welded joints. The chemistry of the process and the manner of its application to rail joints have been thoroughly described in the pamphlets of the company and in the technical Press. It has been tried in a number of places in this country, the most notable example being Leeds. The tramway engineer there appears to be thoroughly satisfied with the joints. The plant is quite a simple one, and in this respect there is a decided advantage over the other forms of welded joint, both in the case of first application and of subsequent repairs. If the present favourable indications are borne out by future results, it is not too much to say that welded joints will be largely used hereafter. In the case of new lines the engineer has to have implicit confidence in the joint, because, if failure results, he has ruined the rail ends for the application afterwards of any mechanical joint. In an old track, where the rail ends are worn out at the joint, the case is quite different—one can then afford to take a risk. With all forms of welded joints the work must be done well by an experienced man. Bad workmanship with mechanical joints is capable of rectification, but this is not true with welded joints. My experience has been that the process of welding limits materially the amount of line which can be laid by the platelaying gang, and therefore the progress of the work is determined by the rate of laying such joints. Personally, I believe in paving the track, except around the joints, using fishplates temporarily, and then welding the joints afterwards. In this way one can overcome in the safest manner the effects of expansion due to the heating of the rails at the weld.

Special Work.—There has been a notable advance in the past three years in the ideas of engineers as to the type of special work best suited to tramway requirements. Short castings with "baby" tongues and primitive arrangements for fishing the joints are being replaced on most work by much more suitable types. Long points, from 11ft. to 13ft. over all, are now being generally used, the tongue having a length of about 7ft. The tongues should be invariably curved on the curved side. The body of the casting is either of ordinary cast steel or manganese steel. The difficulty with both is to get a good joint with the abutting rail section. It is almost hopeless to expect to get as good a joint here as elsewhere on the track. The consequence is that these joints fail before the others. It is questionable, then, why such material as manganese steel should be used for the body of the casting. Outside of the joints, the real wear takes place on the tongue. These are made of annealed cast steel, manganese steel, or forgings. Either of the former will wear longer than the last-mentioned, but the cast tongues have the disadvantage of breaking more frequently from flaws or blowholes.

At all facing points, where the cars will take either one or another direction, it is preferable to use one tongue and one blind point. In this manner all mechanism is avoided to connect the two tongues, and pointsmen can be dispensed with. All that is necessary is to have a hooked end rod hung over the front dasher. The motorman stops over the points and unhooks the rod, which has a flat rectangular piece welded on its lower end. He can throw the tongue in an instant and resume his journey. The economy in dispensing with pointsmen will be perfectly evident to tramway managers. The blind point is designed with an inset piece to give it a long life. Even if it does not give as great a life as a double-tongue arrangement, certainly the difference will not by any means compensate for the outlay in providing pointsmen.

Crossings should by all means be of the well-known "iron-bound" type, with hardened inset placed at the junction of the grooves. This construction permits of as good a joint being made at each end of the crossing as elsewhere on the track. It is possible that in practice it will not be found feasible to renew the hardened wearing piece; nevertheless, it will give in itself a much longer life to the crossing, and should invariably be a part of the same. If, when it wears out, it can be successfully replaced by another one, so much the better. There is too great a tendency for these inset pieces to shake slightly loose after being in service but a comparatively short time. Manufacturers should pay great attention to overcome this defect. The raised floor of the hardened piece should be bevelled at the ends, but, nevertheless, so designed that its height from the rail head is the same as that of a new wheel flange. In this way the jolt to the car which is so often felt at the crossings will be avoided.

On any tramway system there is no necessity to have more than one radius for the points even for lay-outs. Immediately beyond the point the curve can be compounded into a greater or less radius, if necessary. This will mean that there will be only four patterns in use on any system, assuming that no double-curved tongues are used. For cross-over roads and turn-outs, standard angle crossings need only be used. If there could be some uniformity in

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the types of points and crossings used generally in the country, it would be of very material advantage. These could then be made up and kept in stock by the manufacturers, and construction work could be proceeded with in a much more satisfactory manner than at present. It is a well-known fact that in almost every case the date of completion of permanent-way work is dependent upon the delivery of special track work.

Of course, there can be no uniformity in the crossings of special lay-outs at junctions. On most tramway jobs, however, the greater portion of the special work occurs in turn-outs and cross-over roads, and if these can be had promptly the junction work can be manufactured during the construction period, so that they can be put in towards the last, and in this way the time of completion of the whole job materially hastened. If the type of iron-bound crossings is generally adopted, manufacturers can at any rate keep in stock the standard British sections, so that these can be put in hand without waiting for the rolling of rails for any particular piece of work.

Curves.—The wear of rail at curves is quite a serious matter in lines where the car traffic is heavy and the curvature considerable. A due consideration of how the wear is produced may not be inappropriate. Wellington, in his well-known work on railroad location, made an analysis of the problem, from which most of what follows is taken. If the rear wheels of the truck have no flanges, the rear axle would assume a radial position, and consequently the wheels would leave the rails, taking a place inside of the curve, the amount of which would vary inversely with the radius, and directly with the wheel base. On railways with bogie trucks and large radius curves, the rear axle does take this radial position, but with tramways where the radius of the curve is so small, comparatively speaking, the distance that the rail wheels tend to stand away from the rails is much greater than the play of the gauge; therefore the rear axle is prevented from taking its natural position, and in consequence the axle takes a position parallel to a radius drawn to the centre of the truck. In the case of the tramway truck, there is therefore a certain wear on the rear wheel flanges, and consequently on the rails also, due to the effort to keep the rear wheels on the rails. This wear is inversely proportionate to the radius of the curve, but is not considerable, because the displacement from the natural position of the wheels is not great, and the centrifugal force of the car on the curve acts in the contrary sense, thereby tending to diminish this wear. The real work in pushing the wheels laterally from the straight line direction, where they naturally roll, is performed by the front inner wheel. If the axles could assume the radial position the wear would be slight, but the angular position of wheel and rail, which increases with the wheel base and with the sharpness of the curve, produces rubbing friction between rail and flange. If the wheel base is short, practically the whole work will be performed by the inner front wheel. With long wheel base the rear outer wheel will do a portion of this work—*i.e.*, the total amount of the work will be greater, but the distribution of the wear will be better. Of course, there is a limit in length of wheel base, which, if exceeded, will not permit the flanges to enter the groove in the angular position of the wheel with respect to the groove. A section should be made of the proposed flange in the minimum curve, in the angular position determined by the wheel base, to see that the flange will roll in the groove. If it does not, the wheel base must be shortened, or the flange made narrower. This is not a plea for long wheel bases, but only an effort to show that, within certain well-defined limits, they are not so prejudicial as is generally supposed.

In a paper recently read, it was shown that bogie cars of the maximum traction type have a largely increased current consumption for about the same carrying capacity car body. The statement was made that the test conditions were favourable to the bogie cars in that the route had an excessive amount of curvature. I believe, on the contrary, that the difference would not have been so marked on a straight route. With the bogie truck, the flange and rail has to overcome the friction of the centre plate for pivotal trucks, and for maximum traction trucks, the very serious side-plate friction.

The experiment above referred to was made with side-bearing maximum traction trucks against single trucks. If centre pivotal trucks had been used, in all probability the difference in current consumption would not have been so great. I know of an instance where single and maximum traction trucks are used, and where the wear of flanges and curve rails is excessive. This is attributed to the single trucks, because the wheel base is 7ft. I believe, on the contrary, that the maximum traction trucks are the worst offenders.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, DEC. 9.

Electro-Harmonic Society.—At 8 p.m., smoking concert.

Northampton Institute.—(And Saturday). At 6.30 p.m., prize distribution and conversazione.

Physical Society.—At 8 p.m., at the Central Technical Institute, "On Rapid Method of Approximate Harmonic Analysis," by Prof. S. P. Thompson; "A High-Frequency Alternator," by Mr. W. Duddell; experiments to show the retardation of the signalling current on 3,500 miles of the Pacific cable between Vancouver and Fanning Island; exhibition of Ayrton-Mather galvanometers, universal shunts, and electrostatic instruments.

SATURDAY, DEC. 10.

Junior Institution of Engineers.—At 3 p.m., visit to the International Gas Exhibition at Earl's Court.

Corps of Electrical Engineers (R.V.)—At 7.30 p.m., annual mess dinner at Anderton's Hotel.

Glasgow Technical College.—At 7.30 p.m., "Electro-Metallurgy—Some Notes on its Present Position," by Mr. J. D. Mackenzie.

Birmingham and District Electric Club.—At 7.30 p.m., inaugural address by the president.

MONDAY, DEC. 12.

Institution of Mechanical Engineers (Graduates' Section).—"Gas-Engine Testing," by Mr. A. C. Hess.

Institution of Electrical Engineers (Newcastle Section).—"Batteries with Reversible Boosters," by Mr. C. Turnbull.

TUESDAY, DEC. 13.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., "High-Tension Switchgear," by Mr. L. Andrews.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., "Armature Reaction in Alternators," by Mr. J. B. Henderson and Mr. J. S. Nicholson.

Metropolitan Railway.—Run from Baker-street to Uxbridge and back.

Institution of Civil Engineers.—At 8 p.m. "The Construction of a Concrete Railway Viaduct," by Mr. A. Wood-Hill and Mr. E. D. Pain.

WEDNESDAY, DEC. 14.

Society of Arts.—At 8 p.m., "The Patent Laws," by Mr. Chas. D. Abel.

Institution of Electrical Engineers (Birmingham Local Section).—At 7.30 p.m., "Stand-by Charges and Motor Load Development," by Mr. A. M. Taylor.

Society of Engineers.—At 7 p.m., annual dinner at the Hotel Cecil.

Chemical Society.—At 5.30 p.m., general meeting.

THURSDAY, DEC. 15.

Institution of Electrical Engineers.—At 8 p.m., continuation of discussion on Mr. Searle's paper, "Studies in Magnetic Testing." Mr. W. P. Adams will read (time permitting) a paper entitled "The Combination of Dust Destructors and Electricity Works economically considered."

Rugby Engineering Society.—At 8 p.m., discussion on "Premium System v. Piecework System," to be opened by Messrs. G. T. Wood and J. P. S. Glover.

FRIDAY, DEC. 16.

Institution of Mechanical Engineers.—At 8 p.m., "Heat Treatment Experiments with Chrome-Vanadium Steel," by Captain H. R. Sankey and Mr. J. Kent-Smith. Messrs. Seaton and Jude's paper on "Impact Tests on the Wrought Steels of Commerce," which was read at the last meeting, will be further discussed jointly with the above paper.

North-East Coast Institution of Engineers and Shipbuilders.—General meeting.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., "The Working of Batteries under Reversible-Booster Control," by Mr. E. D. S. Shelmerdine.

Institution of Civil Engineers.—At 8 p.m., students' meeting, "Folkestone Harbour: Cylinder-Sinking at the Root of the Old Pier," by Mr. R. H. L. Pennell.

SATURDAY, DEC. 17.

Glasgow Technical College.—Anniversary dinner.

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THE
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TO CORRESPONDENTS.

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TRAMWAYS—THROUGH RUNNING.

At the first blush the question of through running on tramway systems seems simple, and the answer to be in the affirmative, yet in practice experts do not find the solution of the difficulties so very simple. It is, perhaps, a peculiar situation for us to deal with, who for years have advocated every increase of convenience possible for the travelling public and the necessities of the business public. We have shown that in railway work increased convenience has been consistently followed by increased receipts and by a more pronounced success. Further, the advocates of the electrification of tramways have used as their main argument the undisputed and indisputable fact that such a measure has always been followed by increased receipts—receipts in most cases more than sufficient to warrant the outlay incurred by the change over. Electrification meant increased convenience, and the response of the public has usually been very marked. Through running undoubtedly means increased convenience; hence, as we say, at first sight it would appear a welcome development. There is no mental reservation in our remarks, nor is there any intention to deprecate the action of anybody. The simplification of railway through running is due to the fact that companies have to deal with companies. Each concern is controlled by business men, who have only one object—the success of their own company. When tramways are considered, we have a mixture of municipal and company control, and the ultimate aim of each party may differ very considerably. It is easy to assume conditions which almost prevent any solution of the problem when the parties are municipal and companies, and when the parties are both or all municipal, local jealousies are often worse to arrange than in the majority of cases where antagonism is direct. It was unfortunate that the Institution dinner clashed with the discussion on Mr. Sellon's paper, for the subject merits the fullest consideration. We welcome the specific examples of the value of through running given by Mr. Sellon, especially as they go to prove a point we have insisted upon for many years. Interurban communication—like water distribution and similar problems—to be dealt with satisfactorily, must be dealt with over the whole natural area by one combined authority, and not merely over the isolated portions termed boroughs or urban districts, or what not. What an absurdity it seems in these early days of the twentieth century that conterminous tramways have different gauges, the differences being almost entirely due to the desire of one or the other control to prevent through running. In such cases no attempt was made to consider the convenience of the user. We are not now discussing the desirability to have tramways at all at a particular spot. We assume they are there, and agree with Mr. Sellon "it ought not to be tolerated that parties entrusted by Parliament with tramway powers should be permitted by unreasonable conduct to prevent or hinder the full public use and advantage of any means of connection," always provided the different undertakings are honestly undertaken. It would be an intolerable nuisance if Parliament were to give "compulsory" powers to a concern with a mile of line, and with a capital of ten thousand pounds, claiming connection with one or two undertakings with a hundred times the mileage and the capital. When a railway projects an extension or a new system, the expenditure and return are duly considered upon a purely business footing, but this cannot be altogether the case with tramways, because of conflicting local interests. Mr. Sellon's paper gives a mass of information, and compares railway management, but the two things are not on

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all fours; hence, if running powers are contemplated, it will be better to thrash out the whole question of division of receipts per car mile or per passenger from the conditions prevailing on tramways, and not assume them too similar to those prevailing on railways. In consideration of the importance of this question we have endeavoured to ascertain the opinions generally of those most interested, and the series of letters and extracts given elsewhere will show the prevailing idea to be for the extension of running powers.

THE CHAIR OF ELECTRICAL ENGINEERING AT THE BIRMINGHAM UNIVERSITY.

Appointment of Mr. Gisbert Kapp, M.I.C.E., M.I.E.E.

We congratulate the council of the University of Birmingham on their appointment of Mr. Gisbert Kapp to the above appointment. Every electrical engineer who has the pleasure of knowing Mr. Kapp will approve of his selection to this position, and will agree that he fully meets the many and onerous qualifications for the post. We are pleased that it will be the means of bringing back to England a man who ranked so highly amongst the pioneers of electrical engineering. When Mr. Kapp left England in 1895 to become the general secretary of the Verband Deutscher Elektrotechniker, it was felt that the profession was losing one of its best men, and his welcome back to this country will be a warm one. According to the terms of the appointment, we shall see Mr. Kapp again practising as a consulting engineer amongst us. As far as the Birmingham University is concerned, Mr. Kapp's organising skill, coupled with his cosmopolitan electrical experience, renders the success of his department assured. It will be difficult, however, to attach the title of "Professor" to one who for so long has led us in the practical side of electrical engineering.

NOTES ON MOTOR-STARTING SWITCHES.

[CONTRIBUTED.]

(*Concluded from page 803.*)

While in hotels, clubs, and other public buildings it is necessary to have a lift attendant always present for working the hoist, yet in many private works this course is not adopted, and it is then desirable to arrange a form of control by which the lift can be operated from any floor, while at the same time, if any person is travelling in the lift, it shall be impossible for anyone outside to control the lift in an opposite direction. The Sturtevant Engineering Company provide for such cases with their push-button lift controller, shown in Fig. 16. Suppose that the lift travels between six floors, then inside the cage are placed six push buttons, numbered respectively for the various floors, and there is also fixed inside the cage an extra push button, known as the "emergency button." Outside the lift on each floor is fixed a push button. It will be noted from the illustration that the control is effected in reality by a form of compound solenoid switch. Anyone wishing to use the lift will push the button on the floor on which he happens to be, when the controller will start the motor in the direction necessary to bring the cage to that floor; and also, as soon as the cage reaches the floor in question, the controller will cut off the supply of current, and the cage will come to rest. After the passenger has entered the cage, he will push the button corresponding to the floor to which he desires to travel. This will operate the controller so that the car will travel only to the floor desired, where it will stop; while at the same time it will be impossible, until the car has reached this floor, for the cage to be operated by anyone outside the car. Should the passenger find that he wishes to stop at an intermediate floor, he has only to push the emergency button, for if he does this the car will stop at once, whether at a floor or between two floors, for the result of pushing this button will cause the controller to cut the current off the motor, and also off the brake solenoid, thus bringing the car to an immediate standstill.

It would appear possible from the above description for an accident to occur through a person on some other floor starting the car when the passenger was either entering or leaving the cage. To prevent this, the apparatus is so arranged that it is impossible to operate the controller when any one of the lift gates is open. This entails the necessity of so arranging the gates that each is automatically locked except when the car is directly opposite to it.

A study of the illustration will enable the method of operation to be readily grasped. The controller is, first, a form of the ordinary solenoidal starting switch previously described. In addition to this, there are the supplementary solenoids—one for each floor. These are so connected with the reversing switch as to provide the correct direction of rotation, and as the button marked No. 1 in the car is connected with the leads from the button on No. 1 floor, and the button No. 2 is connected to the leads from the button on No 2 floor, exactly the same effect is produced whether the button on No. 1 floor or the button marked No. 1 in

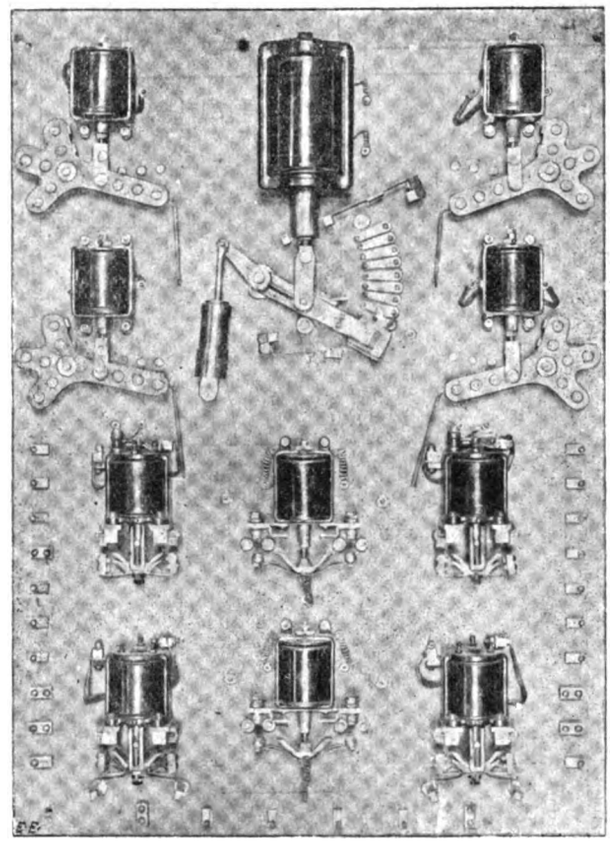

FIG. 16.

the car is pushed. The first effect is to energise the reversing switch in the right direction; then the main solenoid is energised and the motor is started, while the supplementary solenoid connected with the button pushed will cause the motor to stop at the desired floor.

A simpler form of the same type of switch is used when it is desired to operate a crane from various floors. Take the case where a jib crane is used to convey goods to the various floors of a five-storey building. It is then desirable that the crane shall be operated from any floor, while at the same time it shall be impossible for any person at another floor to interfere with the process of raising or lowering that may be carried on at the time from a different floor. A diagrammatic illustration of the arrangement is given in Fig. 17. Here we have two solenoids, A and B, through the centres of which pass an iron core, on which is mounted a lever which operates a reversing switch. Either of the two solenoids can be energised from any number of points, and the same current can also energise the ordinary form of solenoid switch. If we take the case when the operator on any floor wishes to raise the hoisting tackle, he closes the switch which controls solenoid A, and the iron core is drawn towards this solenoid, and the reversing

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switch is then thrown over into the proper position to give the correct direction of rotation. If, now, some other person wishes to operate the motor in the other direction, he cannot do so until the first person opens his switch, because when the iron core has been pulled towards A this solenoid will more strongly attract the iron core than will the solenoid B, and hence the motor will not rotate in the reverse direction until the solenoid A is de-energised. The switch directly operated by the lever attached to the iron core can either be the main reversing switch, or it can operate this through a solenoid auxiliary switch.

As a general rule, for all private installations, whether supplied with current from the public supply mains or from an isolated generating plant, it is better to insert a separate speed-regulating switch apart from the starting switch whenever speed variation is required; but in the case of printing presses, tramcars, and other special cases this

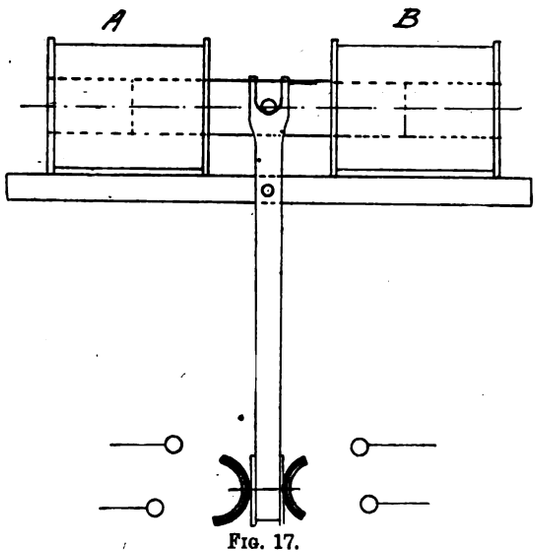

FIG. 17.

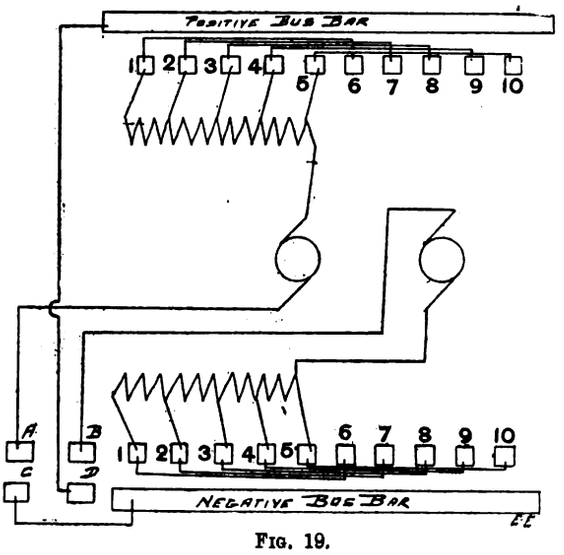

FIG. 19.

course cannot be adopted owing to the special nature of the requirements, and in these cases a more complicated type of starting switch, or what is more correctly termed a controller, is necessitated by the special needs of the apparatus.

Fig. 18 gives an illustration of the general form of the tramway controller as made by Messrs. Royce, Limited. In tramway work, as a general rule, two motors at least are placed on each car, and these must be connected up in series or parallel at will in order to obtain the necessary variation of speed. At the same time, it is important that the operation of starting always follows a proper course, so that it be impossible to suddenly throw the machines in parallel when they are running in series and *vice versâ*. The method adopted to obtain the requisite results are shown diagrammatically in Fig. 19. It will be noted from this diagram that the speed variation is obtained partly by means of rheostatic control in the armature circuits and partly by means of series and parallel running of the two motors. When the machine starts from rest the two armatures must be in series, with all the resistance in circuit; this resistance must then be gradually cut out, until the armatures are directly connected across the mains in series. Afterwards they must be thrown into parallel with all the resistance reinserted; and, again, this resistance must be gradually cut out in order to obtain the top speed, until finally the two machines are running in parallel with the armatures directly connected across the supply.

To obtain this result the controller is made having the equivalent of two (positive and negative) 'bus bars with an equal number of contacts to each, so arranged that when the positive contact 1 is joined to the positive 'bus bar the corresponding negative contact 1 is also joined to the negative 'bus bar, and so on. In addition to this there are four additional contacts, marked A B C D, required for coupling up the armatures in series or parallel. The first motion of the starting switch or controller energises the fields of the motors and closes the connection between A and B, and thus connects the two armatures in series. The next motion closes the armature circuit through all the external resistance, the next motion cuts out a

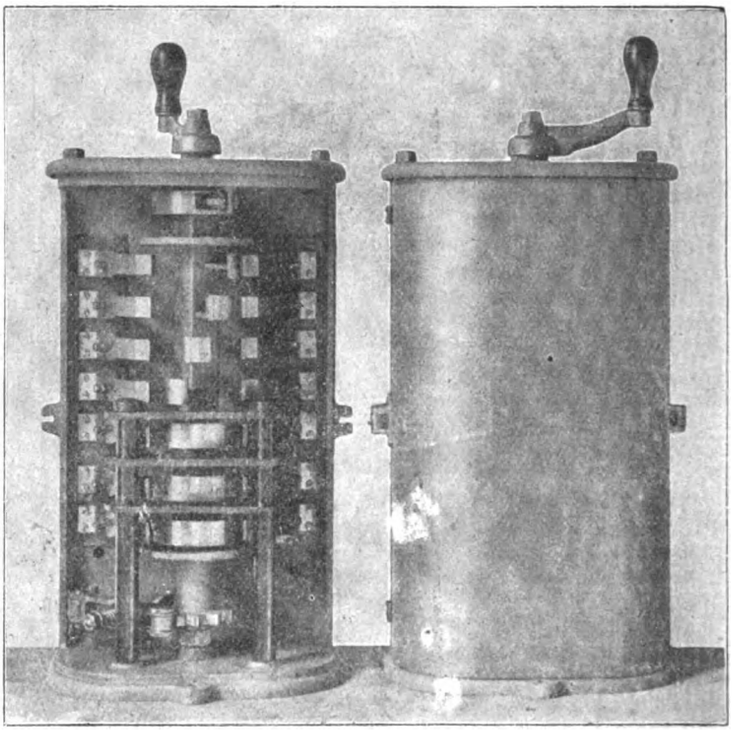

FIG. 18.

certain portion of the resistance, and this is continued until contact 5 is reached, when the armatures are directly connected in series across the points of supply. Upon moving the controller so that the movable contact pieces join contacts 6 6 to the 'bus bars simultaneously, the circuit is opened between A and B and closed between A and C and B and D, thus joining the armatures in parallel across the mains; then as the motion of the controller is continued, the resistance which was inserted when contacts 6 6 were reached is gradually cut out. The operation is simple, but the controllers must be well made and every care must be taken to obtain a quick break, so as to minimise the risk of arcing; this is a most important point, as it must be remembered that the motors will operate at probably 500 volts.

In the teazer systems of control the same general principles have to be adopted. Here the actual operation is somewhat different. There are two generally-accepted systems of motor-teazer control—viz., the Bullock and the Holmes-Clatworthy. In the first the auxiliary machine consists of a small motor-generator, and the first operation consists in starting the motor of the teazer portion of the equipment through an external armature resistance; the motor commences to rotate slowly, and the current given

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out by the generator is supplied to the main motor; the speed of the teazer motor is gradually increased by the controller cutting out the armature resistance, and consequently the E.M.F. generated by the dynamo is raised, and the main motor rotates at a higher speed. As this speed is increased, the circuit between the main motor and the supply is closed through an armature resistance, and this main motor is then taking current partly from the mains and partly from the generator of the teazer equipment. Finally, the circuit through the teazer is opened, and the main motor takes current only from the mains, at first through an armature resistance, and at last direct. If a higher speed be required, this is obtained by inserting a resistance in the field circuit.

In the Holmes-Clatworthy system the device adopted is slightly different, as there is no alteration in the value of the E.M.F. Here the auxiliary motor drives the main motor through gearing when the equipment is first started. Gradually the speed of the auxiliary motor, and consequently that of the main motor, is increased by cutting out the resistance in circuit with the teazer armature. The circuit is then closed between the main motor armature and the supply through a resistance, and as this resistance is cut out the speed increases, until finally the teazer motor automatically drops out of gear and is stopped. Final adjustments of speed are made in the same manner as is the case with the Bullock equipment.

It will be noted that the general arrangement of the controller in either case is very similar to that of the tramway controller already described. There is thus no necessity to describe the construction or function of them in any detail. The object of referring to them was to emphasise the remarks made in the first article on the necessity for sound and well designed starting switches for operating every size and type of motor. It is a matter of the rarest occurrence for one of these controllers, whether for tramway use or for use in connection with a teazer equipment, to break down or to give any trouble, and yet it is apparent that they are far more complicated than any type of starting switch used in ordinary practice with isolated motors. The reason is not far to seek. The manufacturers of the teazer sets and of the tramway motors are fully aware of the trying conditions under which their equipments have to work, and will only supply these motors on the understanding that proper controlling apparatus is installed with them. It is necessary to see that not only the controllers but also the whole plant is kept clean. The necessity of this is impressed on the users, who soon learn that the plant is so delicate that if it does not receive proper attention it will refuse to work, and therefore this class of equipment does receive proper attention, but not more than any piece of machinery should receive. Let the contractor for a motor installation and the purchaser of the same compare these results with the reports of the various insurance companies who insure and inspect electrical machinery. They will see from these reports that at least one machine in nine breaks down annually, and in 90 per cent. of the cases the cause is put down to dirt or to faulty, poor, and defective starting apparatus. Then if they consider that nearly every morning newspaper is printed by electrically-operated presses, and that even the large London dailies do not keep any stand-by plant either in the form of spare motors or controllers, and that such a case as the failure to publish through the breakdown of the electrical equipment is unknown, they should be forced to the rational conclusion that it is one of the greatest mistakes to reduce the cost of an installation by adopting a cheap and inefficient form of starter, and so to court certain breakdown of the plant and dislocation of work in the near future, but that, on the other hand, the money is well expended that is spent in installing the best—not necessarily the most costly—starting switches, which should be designed for the particular class of work the motors are called upon to do.

Erratum.—We regret that when dealing with "Electric Lighting for the Inexperienced," which we reviewed in our issue of the 11th ult., the author's name was given as "Herbert Walton," instead of Hubert Walter.

THE USE OF IRON IN ALTERNATE-CURRENT INSTRUMENTS.*

BY W. E. SUMPNER, D.SC., MEMBER.

(Continued from page 809.)

I now pass to the consideration of wattmeters. The introduction of electromagnets into these instruments is naturally a more difficult problem. With the exception of electrostatic instruments, all accurate wattmeters are of the dynamometer type. Iron, and, indeed, all metal parts, are severely excluded, with the result that these instruments are insensitive, lacking in range, and subject to disturbances caused by external fields. It has, nevertheless, become necessary to use transformers in conjunction with them, owing to the high potentials and heavy currents now common. These accessories, of course, contain iron, and introduce errors, due to small differences in phase, which are as serious, I believe, as those which would arise from the use of well-designed electromagnets in the wattmeter itself.

The error in wattmeters due to the lag of current in the pressure coil has frequently been theorised about, but I think a somewhat exaggerated idea exists as to its nature and extent. A commercial wattmeter is intended to work on circuits of fixed voltage and for a maximum load current. I have calculated in the accompanying table the wattmeter error caused by 1deg. lag in the pressure coil for a fixed load current corresponding, say, with 1,000 volt-amperes and for loads of different power factor.

TABLE I.—Wattmeter Error for a Load of 1,000 Volt-Amperes (for a Lag of 1deg. in the Pressure Coil).

Power factor.	True watts.	Error.	Error per cent.
1·0	1,000	·3	·03
·9	900	7·6	·85
·8	800	10·5	1·31
·7	700	12·5	1·78
·6	600	13·9	2·32
·5	500	15·1	3·02
·4	400	15·9	3·98
·3	300	16·6	5·54
·2	200	17·1	8·55
·1	100	17 3	17 3
·02	20	17·4	87·2

The error increases the reading if the load current lags, and diminishes it if it leads. If the power factor of the load is cos ϕ, the error in the reading is proportional to sin ϕ, while tan ϕ represents the error per cent. of the true reading. It will be seen that the error in the reading, instead of indefinitely increasing as the power factor diminishes, rapidly attains a maximum value, which is less than 2 per cent. of the reading corresponding with the same current if non-inductive. The error per cent. may be enormous for low power factors, but the error as a deflection may all the same be unreadable unless the instrument has a wide scale. (The theory of this error, and the application to wattmeters used on three-phase circuits, are given in the appendix.)

The lag in the pressure coil can be easily reduced to one-tenth of a degree, and the error caused by it is proportionately diminished. It is not so well known that the phase differences introduced by current and voltage transformers can, if these are properly designed, be reduced to similar small values. Of course, the errors due to such phase differences are of the same nature and importance as if they were all due to lag in the pressure coil.

Electromagnets may be introduced into wattmeters either by putting the magnetising coil in series with the current or by connecting it in shunt across the mains. In the former case, owing to hysteresis, eddy currents, and varying permeability, the induced magnetism will not properly follow the variations of the current, even when the magnetic circuit contains an air-gap and only low magnetic densities are needed. On the other hand, if a shunt coil is used to produce the magnetism, not only is there an error due to the resistance of the coil, but the flux of magnetism is practically in quadrature with the voltage producing it. The resulting errors can, perhaps, be made negligible in either case, but it is the latter method I have tried

* Inaugural address of the Chairman, delivered before the Birmingham Local Section of the Institution of Electrical Engineers.

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experimentally lately, in order to bring the question before you.

If N is the magnetic flux in the core of a transformer or electromagnet produced by a current, C, through a winding of n_1 turns of resistance, R, the voltage, V_1, necessary to produce this current is given by

$$V_1 = R\,C + n_1 \frac{d\,N}{dt}.$$

We also have $$V_2 = n_2 \frac{d\,N}{dt},$$

where V_2 is the voltage on open circuit of a secondary winding of n_2 turns (assuming no magnetic leakage). For large transformers on open circuit the term R C may be less than one-ten-thousandth part of V_1. For magnetic circuits of small dimensions, suitable for instruments, especially if an air-gap is introduced to allow a moving coil to cut the flux, the term R C is much larger compared with V_1, but may still be a small proportion of it. As a rule the copper drop, C R, is by no means negligible compared with V_1. This is only too noticeable when testing small masses of iron for hysteresis losses by the wattmeter method, since the losses in the magnetising coil are often an appreciable fraction of the whole. In such cases I have often found it convenient to use two windings (as shown in Fig. 5), one of a few turns, n_1, suitable for a considerable magnetising current, C, passed through the current coil of the wattmeter, W; the other of a large number of turns, n_2, connected with the pressure coil of the instrument. The reading of the wattmeter must then be divided by the ratio n_2/n_1 in order to get the watts wasted in the iron circuit. This method has several advantages. Only the core losses are measured,

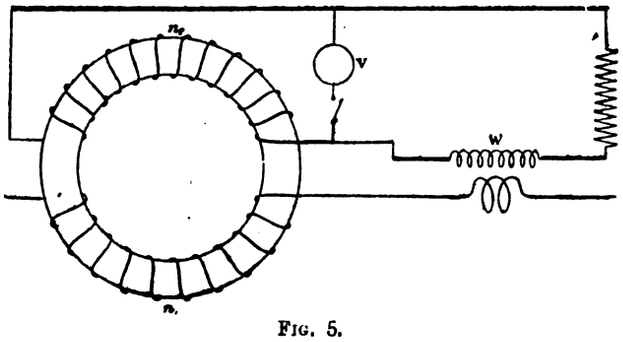

FIG. 5.

the losses in the magnetising coil becoming a matter of indifference. A wattmeter suitable for heavy currents, and the measurement of large amounts of power, may be utilised for the estimation of only a few watts; and the flux can be calculated independent of the copper drop in the primary coil, by attaching a voltmeter, V, to the secondary coil, the resistance of this being allowed for, if need be, by the ordinary fall of potential method.

Unfortunately, there does not appear to be any similar method of eliminating the copper drop when the electromagnet is to be used as part of the wattmeter itself. The effect of hysteresis, eddy currents, and variable permeability is to alter the R C term; but if we assume that by suitable design this term R C can be made negligible compared with V_1, we have

$$V_1 = n_1 \frac{d\,N}{dt},$$

and hence, whatever the nature of the iron, the strength of the flux, N, and, therefore, the magnetic density in each part of the air-gap is strictly proportional to V_1, and in perfect quadrature with it. If now the load current, A, be passed through the primary of an air-core transformer (shielded, if necessary, from external fields by a shell of suitably laminated iron), the voltage induced in the secondary coil will be proportional to A in magnitude, and in quadrature with it as regards phase. It may thus be used to produce a minute current, a, through a large non-inductive resistance, and the moving coil of the instrument. Theory then shows (see appendix) that if a is in quadrature with A, and if N is in quadrature with V_1, the torque on the moving coil is proportional to the average value of the product $V_1 A$, and, therefore, measures watts, independently of frequency and wave-form, and of the nature of the iron used in the electromagnet.

The first instrument using this principle which I had made was of the reflecting type, having a metallically suspended coil as in ordinary moving-coil galvanometers. Its action was promising. I have since constructed two

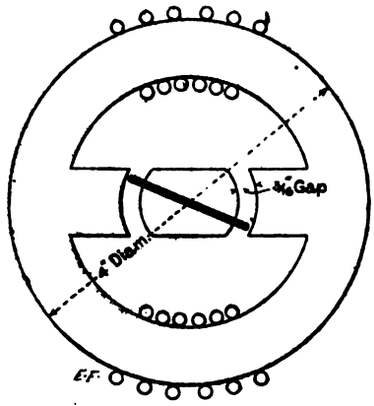

FIG. 6.

non-reflecting instruments (illustrated in Figs. 6, 7, and 8) which I now show you. In each of these instruments the moving coil is exactly similar to those used in commercial moving-coil instruments for direct currents. They are pivoted and controlled by helical springs of the usual kind The magnetic circuits are indicated in Figs. 6 and 7. That of the earlier instrument is of the Manchester dynamo type and contained two air-gaps. The later instrument has a magnet of the Lahmeyer type, but arranged to have only one air-gap, the moving coil turning about an axis coincident with one of the long sides of the coil, and placed outside the magnetic field, the opposite side moving through the air-gap. The magnetic circuit is jointed along the line J J to allow the insertion of the coils. The complete instrument with its current transformer and resistance is shown

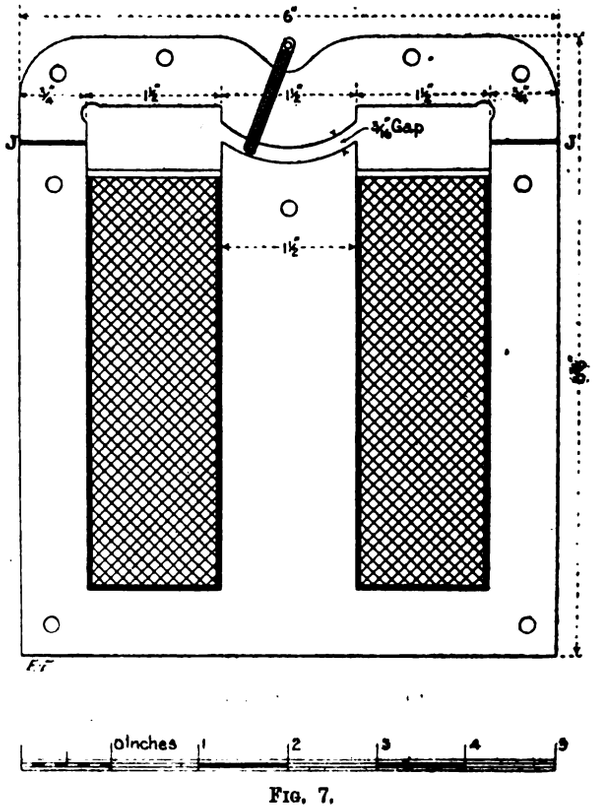

FIG. 7.

in Fig. 8. By winding the magnetising coil on the centre limb as in Fig. 7, instead of on the two side limbs as in Fig. 6, the effect of an ampere-turn is doubled, and by reducing the number of air-gaps from two to one the effect is again doubled. To further reduce the copper drop, C R, as compared with V_1, the voltage on the magnetising coil,

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this coil should be liberally supplied with copper, and should fill as much winding space as possible. Of course, the air-gap should be a minimum. In the instruments shown each air-gap is $\frac{3}{16}$in. across. It is quite possible to halve this and still allow plenty of room for the free movement of the coil.

The calibration curve of the instrument outlined in Fig. 6 was tested by passing direct currents through the fixed and moving coils. For magnetising currents producing air-gap densities similar to those found in direct-current moving-coil instruments, the calibration curve obtained by varying the current in the moving coil was always of the same shape. When the deflection was interpreted by means of this calibration curve, the reading was found strictly proportional to the product of the currents in the two coils. The instrument was then tested with alternate currents against a standard wattmeter on a non-inductive load of lamps. A voltage transformer was used to reduce the voltage of the circuit to one suitable for the instrument. The minute current through the moving coil (having 50 turns and a resistance of six ohms) used in series with a non-inductive resistance of 300 ohms, was taken from a few turns of thin wire forming the secondary of a small iron-cored transformer, the primary of which consisted of two turns carrying the load current. The experiments

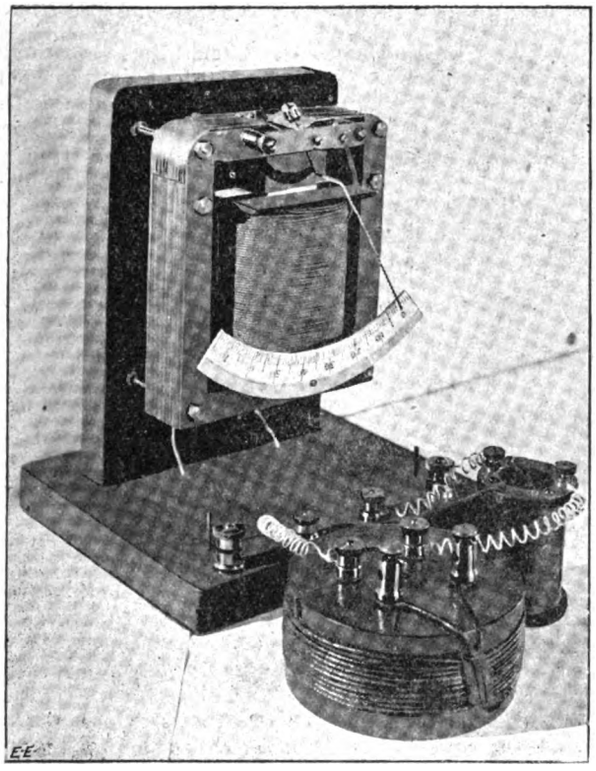

FIG. 8.—Wattmeter, with Current Transformer

showed that the calibration curve, or the relation between deflection in degrees and watts, was exactly the same as that obtained with direct currents, the load being non-inductive throughout the tests. When the power factor of the load was suddenly altered from 1·0 to about 0·1, it was, however, found that the constant of the instrument was considerably changed. This result was due partly to the fact that the copper drop in the magnetising coil was not negligible compared with the applied voltage, but it was also largely due to the phase differences introduced by the two transformers, each of which had closed iron magnetic circuits. These transformers were, indeed, quite unsuited for the purpose, and the copper drop in the magnetising coil of the instrument was (at 40 cycles) about 20 per cent. of the total voltage applied. But even under these circumstances the deflection of the moving coil, as interpreted by the calibration curve obtained with direct currents, was strictly proportional to the watts for a load constant in power factor and frequency.

No further experiments were made on this instrument, which was constructed simply out of such stampings as were to hand, while waiting the arrival of special stampings ordered for the instrument shown in Fig. 8. In this instrument much more space was allowed for the magnetising coil, and in other ways already mentioned the construction was modified with the view of reducing the copper drop. The magnetising coil consists of 1,051 turns of No. 18 wire, having a resistance of 3·68 ohms. The section of the middle limb of the magnetic circuit is a trifle over two square inches, the length of the winding bobbin is about 4in., the air-gap is $\frac{3}{16}$in. The moving coil consists of about 60 turns, having a resistance of 5·4 ohms. The structure is such that the moving coil can turn through an angle of 80deg. without leaving the field. Testing with currents of 80 cycles per second, it was found that 54 volts produced a current of 0·13 ampere through the magnetising coil. It follows that the copper drop is only 0·88 per cent. of the applied voltage, when the frequency of the current is 80. This means that, even supposing there are no hysteresis or other

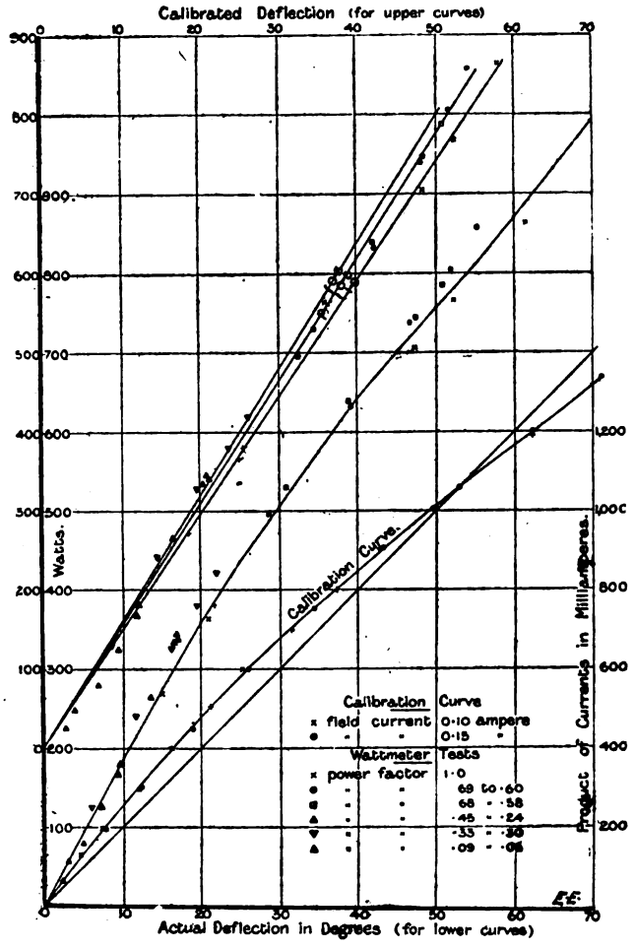

FIG. 9.

losses in the iron circuit, the phase of the applied voltage cannot differ from that of the induced voltage due to the flux in the coil by more than ½deg. If there are hysteresis losses, this phase difference will not be increased, but diminished, since the vectors representing the copper drop and the voltage due to the magnetic flux will no longer be at right angles to each other. In fact, hysteresis is an advantage from this point of view, although, of course, it increases the losses involved in producing the electromagnet. The losses in the magnetising coil are quite trifling. The copper losses for 0·13 ampere only amount to 0·062 watt. The iron losses I have not measured, but they must be small owing to low induction density and the small volume of iron. For the current transformer for this instrument I have simply wound a coil of 10 turns (resistance 0·0163 ohm) so as to surround a secondary coil of about 600 turns having a resistance of 8·5 ohms. No iron was used with this transformer. The copper losses for 20 amperes through the primary are 6·4 watts. These could easily be made negligible by using thicker wire.

The results of several tests on the instrument with a resistance of 500 ohms in series with the moving coil and

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the current transformer are shown in Fig. 9. The calibration curve was first found by taking two sets of tests with direct currents. In one of these the magnetising current used was kept constant at 0·10 ampere, and in the other set it was made 0·15 ampere. Various currents were passed through the moving coil, and the corresponding deflection in degrees shown by the pointer was noted. When the product of the two currents, each measured in milliamperes, was 1,006, a deflection of 50deg. was obtained. The observations are plotted to form the calibration curve, the two sets of points being distinguished by different signs, as shown. It will be noticed that both sets of points lie well on the same curve. A straight line is drawn from the zero through the point corresponding with 50deg., in order to show the deviation of the calibration curve from strict proportionality. Six sets of tests with alternating currents were then made on loads of different power factor, but with the current frequency kept constant at about 80 cycles, and the voltage of the circuit in all cases being about 60. In each set of tests, except for the non-inductive load, the power factor of the load diminished as the current and deflection increased, the limiting values being indicated, and the points corresponding with different sets of tests being separately distinguished (as shown in Fig. 9). The line drawn among the points is a reproduction of the calibration curve, the ordinates of the latter being all increased by 50 per cent., in order to show how far this curve indicates the relation between the deflection and the watts. It appears from these tests, and from numerous others which I have made, that the same calibration curve holds for the instrument under all circumstances, or, in other words, that for a specially prepared scale determined from this calibration curve the reading of the pointer will be proportional to watts for a varying load of any fixed power factor and frequency. The constant to be used with such a scale is the same for all currents and voltages if the power factor and frequency are unaltered, assuming, of course, no change in the transformer circuit. The constant of the instrument does change to some extent for alterations of frequency and power factor. For the tests shown in Fig. 9 the frequency was kept at 80 cycles, but the power factor of the loads used in the experiments ranged between 1·0 and 0·06. The divergencies of the plotted observations from the calibration curve drawn among the points indicate the alteration of constant with the power factor of the load. To show this more clearly the observations have been replotted as shown in the upper curves of Fig. 9. In these curves the observed power in watts is plotted, not with the actual deflection of the instrument, but with the calibrated deflection as determined from the calibration curve for a scale properly graduated, and such that the reading is 50 for a deflection of 50deg. Under these circumstances all the observations for loads of the same power factor should lie on a straight line drawn through the zero, and this proves to be the case. It appears from these tests that the constant for unity power factor loads differs by about 4 per cent. from that for loads of power factor 0·6, and by about 8 per cent. from that for loads of 0·3 power factor. These changes are much greater than correspond with the phase difference of about 0·5deg. due to the copper drop in the magnetising coil, since reference to Table I. will show that for the power factors mentioned the changes in the constant should be respectively only 1·16 per cent. and 2·27 per cent. This shows that the main part of the alteration of constant is caused by the current transformer, which was not specially designed for the purpose, and the errors caused by which I have not yet had time to investigate. This view is confirmed by tests showing the effect of alteration of frequency. With the same resistance, of 500 ohms, in series with the transformer secondary circuit, as used in the tests shown in Fig. 9, I found that for non-inductive loads traversed by currents the frequency of which varied from 93 cycles to 43 cycles, the alteration of the constant was 1·4 per cent. This change is very much greater than corresponds with the phase difference of half a degree at 80 cycles caused by the copper drop. The error due to the transformer can be reduced by diminishing the number of secondary turns, by increasing the number of primary turns, or by increasing the secondary resistance. Similar tests made, with a resistance of 750 ohms in the transformer circuit, showed a change of constant of less than 1·0 per cent. for frequencies varying between 100 cycles and 45 cycles. A set of tests on the effect of power factor made with this resistance in series with the moving coil, and at a frequency of 80 cycles, showed no measurable alteration of constant for power factors ranging between 1·0 and 0·1. Of course, there must have been some error, but in such tests as I have as yet had time to make I was unable to detect it, and there seems no doubt that the error is much less than in the previous tests.

Now, in my opinion, no wattmeter should be considered a satisfactory instrument if it has errors like some of those mentioned. Though it will hardly be denied that many commercial instruments present greater errors in practice, I am not concerned to-night with any claim that the instrument shown you is accurate under all conditions. Still less am I concerned to show that the use of transformers with wattmeters must necessarily introduce grave errors. On the contrary, my belief is that however faulty some wattmeters may be when used with transformers, a little attention given to the design of the latter will reduce the resulting errors to a negligible amount. This will, I believe, also prove true for transformers of the particular type needed for the instrument I have described. The chief importance attaching to the tests referred to is due to the light they throw upon the question of the possibility of constructing good wattmeters with iron-cored electromagnets.

The greatest errors arising in practice in wattmeter readings are neither due to transformers nor to intrinsic faults in the instruments. They arise from the presence of heavy currents in neighbouring conductors. Some wattmeters are protected from such influences by surrounding the coils with a shield of suitably laminated iron. Iron is used for the transformers, and is used for these surrounding shields. Iron is used anywhere and everywhere, except in the place where it is most efficient—namely, within the coils of the wattmeter itself. In the instrument I have shown you iron has been put in the wattmeter, and has been removed from the transformer coils. The shield may still be needed to protect these coils, but not for the instrument itself, since this will be even less affected by external fields than ordinary permanent-magnet voltmeters and ammeters.

I foresee no difficulty in rendering negligible the error due to the transformer, and the instrument itself can be much improved upon. The length of the air-gap can be reduced, and other arrangements made to further diminish the copper drop as compared with the voltage applied to the magnetising coil. There is a discrepancy between the flux density in the air-gap as calculated (1) from the number of turns, the applied voltage, the frequency, and the section of the circuit; and (2) from the number of ampere-turns on the coil, the length of the air-gap, and the other particulars of the magnetic circuit. This is possibly caused by undue eddy currents, which reduce the effectiveness of the ampere-turns and increase the copper drop. If so, the use of thinner stampings will improve matters. But as the instrument stands, it is as good a wattmeter as many using current and voltage transformers, while it possesses greater range and is more sensitive. My main object is to show that the errors arising from using iron magnetic circuits in wattmeters are not necessarily greater than those involved in the use of transformers with such instruments. I consider that the action of the instrument shown justifies this view.

If it be once granted that the errors can be rendered sufficiently small, no one will doubt the great advantage of an iron-cored instrument, or dispute its supremacy in regard to sensitive qualities. It must necessarily be as delicate as a permanent-magnet, moving-coil instrument, since the magnetic field can easily be made as strong, or even stronger. An instrument such as illustrated in Figs. 7 and 8 can be utilised for the detection of very small alternating currents or voltages. Of course, phase difficulties arise, but these can be overcome by making use of phase-changing devices for applying a voltage of the right phase to the magnetising coil.

The influence of small differences of phase on the action of alternate-current instruments can generally be calculated

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if the phase differences are known, but these are difficult to determine experimentally. In order to investigate the action of transformers for instrument purposes, I have devised voltmeter methods for measuring small phase differences. It would take too long to explain these now, but I have set forth in Table II. the results of a number of recent measurements. In carrying out these tests I have had the benefit of the able assistance of my colleague, Mr. David Owen. The phase differences measured are given in the column headed θ.

TABLE II.

Apparatus tested.	Load—Amps.	Load—P.F.	Phase tested of	θ (degrees)	$10^6 \times (1 - \cos \theta)$.
Lead plates in weak acid	8	—	V_1 A	0·38	22
Platinoid wire spiral.....	7	—	,,	0·27	11
Direct-current arc.....	8	—	,,	0·17	4·5
0·1 unit Tr. at full voltage ..	0	—	V_1, V_2	0·34	17
1·0 unit Tr. for 50 V_1 to 50 V_2	0	—	,,	0·021	·068
,, ,, ,, (All tests at 80 cycles and 70 volts)	21	1·0	,,	0·34	17
,, ,, ,,	7	0·09	,,	0·115	2
,, ,, ,,	23	0·09	,,	0·39	23
2·0 unit Tr. fully loaded	10	1·0	,,	1·04	1,650
3·0 unit Tr. for 100 V_1 to 1,000 V_2	0	1·0	,,	0·054	0·4
Two identical Tr. used to step up volts from V_1 to V_2 and down from V_2 to V_3; the value of θ found between V_1 and V_3 being halved. Normal full load 30 A.	10	1·0	,,	1·85	—
	20	,,	,,	3·4	—
	30	,,	,,	4·7	—
	40	,,	,,	5·3	—
	50	,,	,,	5·8	—
	24·8	0·09	,,	1·08	1,770
	25·4	,,	,,	0·18	5
,, ,, ,,	27·0	,,	,,	1·00	1,540
,, ,, ,,	40	low	,,	4·3	—
,, ,, ,,	50	,,	,,	5·2	—
10 A current Tr. for oscillograph	10	—	A_1, A_2	0·088	1·2
,, ,, ,,	7	—	,,	0·144	3·1
5 A current Tr. as supplied commercially for wattmeter	5·7	—	,,	2·32	—

The last column shows for the smaller values of θ the number of parts in *one million* by which cos θ differs from unity. The first number given relates to a common water resistance, and implies that its power factor may be taken as 0·999978. This should bring comfort to anyone who has doubted the non-inductiveness of such resistances. The values of θ given for the wire spiral and for the direct-current arc are the minimum values I could detect with certainty with the voltmeters I had at disposal when the tests were made; consequently all that these numbers prove is that the power factor in these cases does not differ from unity by more than corresponds with the figures given. Then follow a number of tests on voltage transformers of various capacities, with the secondaries, in some cases on open circuit, and in others supplying currents of various magnitudes and power factors. The last three tests were on current transformers with secondaries closed on the circuits for which they were designed. It will be noticed how exceedingly small the value of θ is for some of the transformers on open circuit. This is of special interest in regard to electromagnets for wattmeters, since such electromagnets are essentially transformers on open circuit, and the phase difference measured is that caused by the copper drop in the magnetising coil. For the one-unit equal-ratio transformer this value of θ is only 0·02deg., and cos θ differs from unity by less than seven parts in *one hundred million*. On full load θ is only $\frac{1}{3}$deg., and is much the same for a load of power factor 0·09 as for unity power factor. The three-unit transformer shows a lower phase difference for inductive loads than for non-inductive, and it is noteworthy that a very sharply-defined minimum value of θ of 0·18deg. occurs at about 80 per cent. of the full-load current, with a secondary circuit of power factor 0·09. The small 10-ampere transformer was supplied by the British-Thomson Houston Company to reduce current in the ratio of 20 to 1, for any secondary resistance not absorbing more than two volts or 0·5 ampere. The phase difference between the primary and secondary currents at full load is less than $\frac{1}{10}$deg. The five-ampere current transformer was supplied by a firm of the highest standing for use with one of their own wattmeters. The large phase difference found of 2·3deg. would seem to imply great error in use, yet on fully considering all the conditions of the instrument, I find that the error in reading works out to be only 1·7mm. on the scale, even when the full currents—*i.e.*, such as to produce full deflection on a non-inductive circuit—are flowing in the coils, and the power factor of the load tested is the lowest for which the instrument is guaranteed—viz, 0·6. For smaller load currents this error is proportionately diminished, and it disappears altogether on high power-factor circuits.

My object in bringing these numbers before you is to afford evidence for my belief that while transformers as supplied commercially for wattmeters may in many cases be such as to cause phase differences of more than one or two degrees, it nevertheless seems true that a little care spent in designing them would result in reducing these angles in practice to about $\frac{1}{10}$deg. Even as matters stand, the errors caused by them are less than is generally supposed. They are, however, greater than those which need result from the introduction of iron-cored electromagnets into wattmeters and other alternating-current instruments. Under these circumstances my contention is that such instruments should be designed on the lines of the permanent-magnet moving-coil instrument, and that well-considered efforts in this direction will command success.

The object in view is no small one when we consider how much electrical advance, which has all been based on exact measurement, really owes to the introduction of sensitive galvanometers and voltmeters for direct currents; and that, in all probability, similar instruments for alternating currents will lead to important developments also. At all events, when we think of electrical progress in the past, it is only fitting for us to remember how greatly this has been dependent upon the work of one man. When most of us commenced to study electricity, the name of Sir William Thomson was already historic. When *he* first started the subject, the instruments available for testing were of a kind such as are only now used for class teaching of the most elementary description. But at a time before most men now living were born, and at an age younger than most of us now present, Sir W. Thomson applied for the first time to the structure of instruments skilful engineering design. He altogether revolutionised them, and brought them to such a state of perfection that, except in comparatively small details, they have not been improved upon since. The Thomson reflecting galvanometer, the siphon recorder, and the quadrant electrometer represent the best instruments of to-day, as they did when first introduced as long ago as the middle of the last century. The sudden increase of sensitiveness then secured constituted a step in advance quite unexampled either before or since. It is as difficult now to properly realise its magnitude as to truly estimate its influence on electrical development. But we are all glad that Lord Kelvin has been able not only to take a great leading part in, but also to watch, the *whole* of this progress, and that we can still congratulate him on possessing the enthusiasm and mental activity of younger men.

(To be continued.)

Action of Radium Emanations on Diamonds.—The *Proceedings* of the Royal Society contain Sir William Crookes's contribution on this subject. An "off colour" diamond, of a very pale-yellow colour, was put inside a tube with radium bromide, and after 78 days the diamond had darkened and become bluish-green in tint, no yellow colour being apparent. When heated at 50deg. in a mixture of nitric acid and potassium chlorate for 10 days, the diamond lost its dull surface colour and was bright and transparent, but its tint had changed to a pale bluish-green. The radium emanations have accordingly a double action on the diamond. The β-rays effect a superficial darkening, converting the surface into graphite in a manner similar to, but less strongly than, the more intense electrons in the cathode stream. In the presence of radium, the diamond is extremely phosphorescent, and continues to shine during the time of the experiment. The diamond which had been submitted to the action of radium was still strongly radio-active after it had been away from radium for 35 days, for 10 of which it was being heated in a mixture powerful enough to dissolve its outer skin of graphite.

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TRADE NOTICES AND NOVELTIES.

Improved Ball Bearings for Electric Motors.

In order to improve the efficiency of electric motors, the Lahmeyer Electrical Company, Limited, have recently given special attention to the design of the bearings, and are now introducing small motors fitted with ball bearings of an improved type, whereby the losses due to friction are reduced to a minimum, great saving is effected in the consumption of oil, and the space occupied is less than for motors fitted with

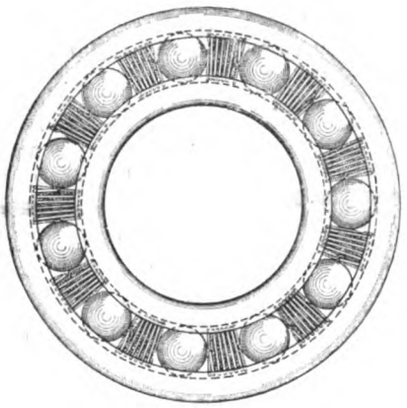

FIG. 1.

ring lubricated bearings. Instead of filling the whole space between the inner and outer rings with balls, as hitherto, a smaller number is provided, the spaces between the balls being fitted with springs, as shown in the accompanying illustration (Fig. 1). If, in consequence of the bend of the shaft there is a tendency of the outer ring to get out of truth with the inner ring, the variation in the speed of the balls, due to their running on a periphery of smaller radius at the upper and lower parts of the bearings than in the lateral parts, is counterbalanced by the

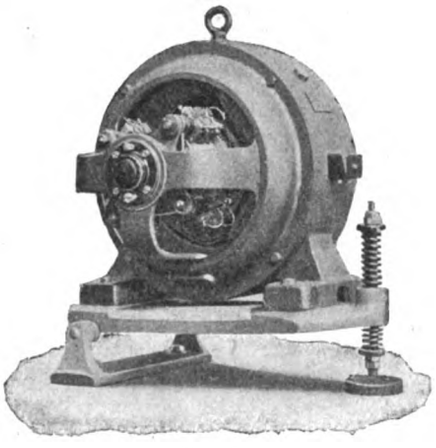

FIG. 2.

action of the springs, so that the balls will not be damaged. A further advantage of this design is that the springs are filled with felt, which forms a rotating lubricating machine. Easy access to the balls for the purposes of inspection, etc., is provided for. Fig. 2 shows a Lahmeyer continuous-current machine fitted with ball bearings. Single-phase alternating-current, two-phase, and three-phase small motors similarly fitted are also being constructed by the firm.

Enclosed Arc Lamps.

From the Union Electric Company, Limited, 151, Queen Victoria-street, E.C., we have an advance copy of their new list of "E. V." and "E. V. S." type enclosed arc lamps for direct-current circuits. The "E. V." lamps are made both single and double enclosed, and of two burning periods—viz., 100 hours and 300 hours. In each case the remains of the positive carbons are used up when trimming as the negative carbons, thus effecting a very great saving in the cost of the carbons. With the 300-hour type a special arrangement has been introduced, securing a minimum consumption of carbons and ensuring practically no deposit on the inner globes. The "E. V. S.," or traction type, lamp, is specially constructed for burning in long series, and for remaining unaffected by instantaneous and large changes in voltage.

Comstick.

Mr. S. W. Cuttriss, M.I.E.E., Prudential-buildings, Park-row, Leeds, has sent us a sample of a preparation known as Comstick, which he has been manufacturing some years for the specific purpose of lubricating the commutators of dynamos and motors having metal brushes. It is claimed that Comstick will keep the commutator in good condition, prevent cutting, and promote that high gloss which is so desirable. Graphite apparently enters largely into its composition. The valuable properties of this material as a lubricant are well known. There is no doubt that the judicious use of a preparation such as Mr. Cuttriss supplies in the handy form of a stick will greatly help to maintain a commutator in good condition. Too much pressure of the brushes on the commutator, coupled with the absence of suitable lubrication, is responsible for much of the turning up which has to be done. We should have been glad to have tested the merits of Comstick ourselves, but the machines at our disposal for the purpose do not happen to be fitted with metal brushes.

Model Dynamos, Motors, etc.

"Electrical Novelties" is the title of a catalogue recently issued by Messrs. F. Darton and Co., Clerkenwell Optical Works, London, E.C. The contents of the catalogue comprise a large number of model dynamos, motors, and gas-engines, besides accumulators, medical coils, and sundry apparatus, in which we understand the firm are doing a large and increasing business.

Calendars and Catalogues.

CALENDARS.—Wm. Augs Gibson, Limited, makers of hydraulic and electric lifts, 28, Fleet-street, E.C. An ornament to any office.

CATALOGUE.—Heathman and Co., Parson's Green, Fulham, S.W., patent extension ladders, folding steel ladders, wheeled ladders, telescopic trestles, etc.

PERSONAL.

The Bridlington Corporation have appointed Mr. Arthur J. Beckett as resident engineer at the new electricity works, at a salary of £210, rising by £10 per annum to £250. Mr. Beckett has been acting as clerk of the works during the installation.

The Glasgow Corporation Tramway Sub-Committee have agreed to recommend that the salary of Mr. James Dalrymple, the new manager of the tramways, be fixed at £1,000 per annum.

The Bury Tramways Committee have resolved to increase the salary of Mr. W. A. Turnbull, overhead equipment clerk of works, from £2 to £2. 5s. per week. We also understand that the salary of Mr. Clough, as tramways manager, has been fixed at £250 per annum.

Mr. Walter Binns, A.M.I.E.E., A.M.I Mech.E., engineer and manager of the Reading Corporation tramways, has had his salary increased from £300 to £400 per annum, rising by two annual increments of £50 to £500 per annum, upon his agreeing to remain in their service for a period of three years.

Mr. E. Moxon, mains superintendent to the Huddersfield Corporation, has been appointed mains assistant to the Blackburn Corporation electricity department out of 80 applications.

Mr. R. B. Leach, assistant engineer to the Aston Manor electricity works, has been appointed assistant electrical engineer to the Farnworth Urban District Council.

The Leigh Electricity Committee have selected the following short list—W. Ainscough (Leeds), H. C. Caldwell (Altrincham), D. A. Hamilton (Lancaster), B. S. Hornby (Bolton), and A. T. Smith (Bury)—out of the 147 applicants for the post of electrical engineer to the Corporation at a commencing salary of £250 per annum, rising by annual increments of £20 to a maximum of £350.

APPOINTMENTS VACANT.

Electrical Engineer, Worcester Corporation. Salary £400, rising by instalments of £20 per annum to a maximum of £500. Applications by 10 a.m. on 19th inst. See advertisement.

Improver, Peterborough Corporation. Salary 20s. per week. Applications by 16th inst. See advertisement.

Assistant, City and Guilds Central Technical College. Salary commencing at £150 per annum. See advertisement.

Assistant, thoroughly experienced in estimating for switchgear, arc lamps, and the like. Apply to Box 202, *Electrical Engineer* Office. See advertisement.

Draughtsman for high and low tension electrical switchboard apparatus, for large electrical engineering firm in Manchester district. Apply to Box B 76 *Electrical Engineer* Office. See advertisement.

Electrical Foreman, Manchester Education Committee. Wages, £2. 5s. per week. Applications to Mr. J. H. Reynolds, principal, Municipal School of Technology, Sackville-street, Manchester.

Distributing Assistant, Belfast Corporation, £200 per annum Dec. 15.

Junior Assistant Engineer, Hebden Bridge Urban District Council. Dec. 13.

Assistant Shift Engineer, Horsham Urban District Council, £100 per annum. Dec. 13.

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LEGAL INTELLIGENCE.

MANCHESTER TRAMWAY ARBITRATION.

The Court of Appeal gave judgment on Saturday on the appeal arising out of the arbitration between the Manchester Carriage and Tramway Company and the Swinton and Pendlebury Urban District Council.

The latter appealed from a judgment of Mr. Justice Channell on a special case by the late Sir F. Bramwell as to whether the District Council were to purchase any of the company's depôts outside their district. The purchase clause of the Tramways Act provides that the promoters shall sell to the purchasing authority their undertaking, or so much of the same as is within such district, upon the terms of paying the then value of the tramway and "All lands, buildings, work, material, and plant of the promoters suitable to be used by them for the purposes of their undertaking within such district."

The motion which rose upon the appeal was whether the words, "Within such district," qualified the word "undertaking," so that a depôt outside the Council's district, but suitable to and used for the purposes of such part, was within such district. The special case found as a fact that the Church-street depôt in dispute was "suitable and used" with the undertaking, and Mr. Justice Channell upheld the special case. Hence the present appeal.

Their Lordships allowed the appeal, holding that it had not been shown that the District Council were under an obligation to pay £24,000 for the Church-street depôt.

NERNST ELECTRIC LIGHT COMPANY.

Reduction of Capital.

Mr. Justice Swinfen Eady last week heard a petition by the company for reduction of capital. The original capital of £320 000 consisted of £140,000 preference shares and £180,000 ordinary shares. Upon the acquisition of patent rights the company had spent £270,000, of which £65,000 was paid in cash and the remainder in shares. The whole of the £320,000 stock had been issued, but 260 preference shares had been forfeited through non-payment of calls.

Mr. Eve, K.C., stated that the price paid for patent rights seemed out of all proportion to their intrinsic value, and as the company hoped that they had now entered upon a dividend-paying career, they were desirous of getting rid of the incubus of a large amount of capital which was not represented by available assets. Resolutions had been passed in favour of reducing the capital to £90,000, in 90,000 ordinary shares, preference shares to be extinguished. In regard to the patents, the royalties paid by licensees in this country were estimated to be worth £20,000, leaving £258,000 for the original patent, according to which the company were practically unable to manufacture saleable lamps at all. What they had to do was to purchase them from a Berlin company, who had some secret process by which marketable lamps were made. The value of the patent, which expires in 1915, was estimated at £40,000 beyond the £20,000 from royalties.

Documentary evidence having been read, his Lordship sanctioned the reduction.

TRAMWAY ACCIDENTS.

In the Civil Court of Leeds Assizes Mr. Justice Darling heard three cases in which negligence was alleged against the servants of the Bradford Corporation.

The first of these actions was brought by Harry Dexter, who claimed damages for personal injuries caused on May 26 last by a collision between a tramcar and a furniture van that he was driving. It was stated that the driver of the car disregarded the plaintiff's warning not to attempt to pass the van at a narrow part of the road, and the collision ensued, with the result that the plaintiff was thrown to the ground and rendered unconscious. For the defence it was contended that there was room for the car to pass, and that the accident happened through the plaintiff allowing his horse to swerve. A verdict for the defendant Corporation was returned by the jury.

In the next case a youth named Arthur Phillips Hampshire sought to recover damages for personal injuries caused by a tramway accident on May 4 last at Shipley. On that day the Bradford Exhibition was opened, and Bradford trams were running over the line from Shipley to Saltaire, which had been taken over from a private company two days before. The plaintiff, it appeared, was riding on the top of the car along this line, on which the overhead wires were 2ft. higher than in Bradford, so that the trolley pole did not hold tight up to the wire. While passing over the points the trolley pole came off the wire and caught in a span wire, and the iron standard was wrenched off the top of the car. The plaintiff was knocked down and had his nose broken. Liability was admitted, and the jury assessed the damages at £150.

The third action was brought by John Gerrard Hogan, a retired mill manager, who claimed for the loss of his wife, 72 years of age, who was run over by a tramcar on Aug. 19. The case was withdrawn, the plaintiff agreeing to an amount of compensation offered by the Corporation.

TRAMCAR INSPECTOR ASSAULTED.

At Cardiff Police Court last week Charles Morris, labourer, was summoned by William John Davenport, an inspector of the Cardiff Corporation tramways, for assault.

Mr. F. W. Ensor (from the town clerk's office) conducted the prosecution.

According to the complainant's evidence, defendant's conduct was offensive and brutal. Complainant said that on the afternoon in question he was on a car from Clarence-road to town. Witness was inspecting the tickets, and defendant, when it came to his turn, used abusive language. Although told that if he didn't behave he would have to leave the car, defendant continued his objectionable conduct and language. At Penarth-road junction defendant refused to leave, and struck witness in the face and then on the side of the head. Detective Harris and Police-constable Rich appeared upon the scene, and in their presence defendant again caught hold of him and dealt him several hard knocks in the ribs. He fell against a hand truck, his head striking the wheel. Defendant refused his name and address to witness and to the police.

Defendant was fined £5, including costs, or one month.

HEAVY DAMAGES.

At Liverpool Assizes on Tuesday Dr. Hall, medical officer of Prescot Union, was awarded £1,000 damages for injuries sustained by his forcible ejectment from a tramcar belonging to the Corporation, whereby his leg was fractured. The plaintiff's offence consisted in holding in his hand a cigar which was smouldering, which the conductor alleged was an infringement of the by-law against smoking. The plaintiff refused to put out the cigar or quit the car, and was forcibly ejected.

Mr. Justice Walton held that the plaintiff's conduct was obstinate and stupid, though it did not justify recourse to unnecessary violence.

AUTOMATIC TELEPHONE PATENTS.

A public enquiry was held before Mr. Registrar Hood on Tuesday into the promotion and failure of the Automatic Telephone Company (1903), Limited, against which a winding-up order was made last March upon the petition of shareholders. The statement of affairs shows liabilities £1,175, against assets £4,185, but a deficiency of £10,051 as regards shareholders. Mr. H. Brougham attended as official receiver, Mr. Harry Dobb for shareholders, and Dr. Counsel for Mr. Max Margowski (the late managing director). After evidence had been taken from Mr. Margowski, the enquiry was adjourned *sine die*.

COMPANIES' MEETINGS AND REPORTS

BRITISH WESTINGHOUSE.

The fifth annual general meeting was held on Tuesday at Hamilton House, Mr. William I. Buchanan presiding. The report for the year ending July 31 appeared in our last week's issue.

The Chairman, in moving the adoption of the report, stated that what he might say in this connection would be based upon two or three points. In the first place, the formation of their Company and the building of their plant at Trafford Park were evidently not the result of immature thought on the part of Mr. Westinghouse or of his associates, but of their well-considered, careful thought, founded on their experience in like enterprises; secondly, the Company was evidently not formed or the works built for the present, or for the next two or five years, but upon what must have been a conscious belief on the part of those who initiated the undertaking, and who still believed in the correctness of their view, that it would not be found too large for the work which would one day come to it; and in the next place results secured during the early years of the "life" of any large industrial enterprise were not conclusive as to what its future would be. The expected development which had been anticipated had not yet taken place, and an abnormal expenditure both in the original outlay for the plant and in its completion and operation had, therefore, naturally resulted. It was believed at the time that important electrical developments in Great Britain—especially in methods of transportation and in connection with electrical power distribution—were within sight. While this belief had not yet been fully borne out by results, he did not think any person conversant with the trend of affairs to-day would deny that a radical change in the present methods of transportation in this country—within certain wide limits, at least—was to-day a "self-evident certainty"; but whether this would take place within the next year or within the next two, three, or five years, he was not willing to hazard an opinion. The character of some of the chief work undertaken by the Company more than a year ago had also been a factor in the results attained; he referred particularly to the great turbines now being completed, the first of which were just beginning in London to do their work of furnishing power for the underground railways. This work was so entirely new in every way, and involved such great risks in construction and operation, that every precaution which prudence could suggest was demanded of their staff at the works. The development charges thus brought about were of necessity large. The production of similar work in the future would become but a matter of manufacturing, instead of one of origin, development, and manufacturing. Industrial conditions had been very adverse during the last year or so. But there was another competitive element, far-reaching in its results, which had entered into this matter of the prices the Company had been obliged to meet—namely, competition from manufacturing concerns outside Great Britain. His own view of this phase of competition and of its results was that it was not so much the amount of business contracted in Great Britain by German and other Continental electrical manufacturing concerns—very large as that was—but rather the influence which the presence of this competition in all important tenders exerted upon prices quoted by British manufacturers, since the logical sequence to be drawn from such a condition was that it became necessary for the sales department of a British company to try in advance to discount this unknown outside price, with the net result that much lower prices were made by

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British companies in such circumstances than would be the case were the competition they had to meet limited to Great Britain alone. This feature of competitive business at home being embodied in their public policy was hence beyond the control of any Board. He could not, however, refrain from expressing his individual belief that it was a matter of more importance to manufacturing interests here, and especially to such as their own, than appeared to him to be realised by many. To those who directed large specialised companies like theirs, which had to meet this wide competition to a greater extent than did others, there was but one course left open—namely, courageously to use their very best endeavours to meet the situation by economical work, and then to go ahead and secure, at the best obtainable price, as large a proportion as possible of the work offered. Alluding to the Company's investments in other concerns, he referred especially to the Traction and Power Securities Company (in which this Company hold shares to the amount of £250,000, of which £175,000 has been paid up) and to the Clyde Valley Electrical Power Company—the largest power development company, he thought, which had been thus far undertaken in Great Britain—and remarked that it was on the building of such large electrical undertakings as these that electrical manufacturing concerns such as the Company's must in a considerable measure depend for their success. He had been asked to say something with regard to the condition of the Company's property at Trafford Park in view of the auditors' reference to the matter of depreciation thereon. Concerning the buildings and grounds, he had already stated that in the accounts under review a considerable sum had gone into their completion, but quite apart from this special care had been exercised in the upkeep of the buildings. He held that the opinion of the Board was justified, in the circumstances, that no depreciation was necessary in making up last year's accounts. With regard to their large machine tools and their general plant equipment, these had also been maintained at a very high degree of efficiency, and during the year £25,490 had been charged to general expenses in connection with their maintenance and with improvements in them. Many new tools were also added during the year. The Board, therefore, thought that the £10,500 charged for depreciation under this heading was a fair adjustment. In the matter of patterns and dies and small tools, quite outside the sum of £19,033 charged against their upkeep during the year, the Board in the middle of the year adopted the policy of charging all dies, patterns, small tools, etc., direct to factory expenses or to a particular contract. The sum thus charged to factory expenses during the six months referred to amounted to £20,346. It was, moreover, clear that the general subject of depreciation would more properly come up for consideration when the profit warranted the payment of a dividend. He afterwards referred to the measures which had been taken for reducing general expenses and the cost of manufacturing, and stated that much had been accomplished in this direction. The cost price at which work was now being produced in the factory was steadily dropping in all cases, and it was nearing a normal mark in several. This was because the workmen were now becoming efficient units in a whole, and the organisation more coherent and better co-ordinated for the work in hand through the decrease in its *personnel* which had been found possible. As to what the future might bring in the way of business he could not say, nor would he hazard an opinion. It seemed fair to assume, however, that if the development in electrical traction in Great Britain to any measurable degree kept pace with the present outlook in the same direction in the United States, there should be, with the gains which seemed likely to take place in the demand for electrical apparatus in the British Colonies, sufficient work in the near future for the electrical manufacturing concerns in Great Britain. Their plant and organisation at Trafford Park were equipped to this end, The American shareholders had during the last year invested £900,000 more in the business without asking a penny from the British shareholders.

Mr. J. H. Lukach seconded the motion.

The **Chairman**, replying to questions, stated that he was unable to say whether another company which had been mentioned were buying stock in this Company or not, but, so far as he knew, he could absolutely deny the statement. The average interest paid to their bankers and others had been 4½ per cent. On July 31 last their sundry creditors were £374,678, and their temporary loans stood at £200,750; on Oct. 31 the sundry creditors were £248,562, and there were no temporary loans. The cash at the bankers now amounted (on that morning) to £90,006, and there were unpaid vouchers in the offices representing £45,776. The goods in process of manufacture on Oct. 31 amounted to £334,397, and they had in finished products at the factory that day a very much larger amount than they required or than they ought to have, and every effort must be made to reduce this amount, which now stood at £251,846. A great deal of this work had been ordered by those who, owing to lack of accommodation, had so far not been able to accept delivery.

The report was adopted.

WEST INDIA AND PANAMA TELEGRAPH.

The ordinary general meeting was held at Winchester House, Mr. W. B. Kingsford presiding. Particulars of the report for the half-year ending June 30 appeared in our last week's issue.

The **Chairman**, after reviewing progress, moved the adoption of the report and the payment of 7s. per share on account of arrears of dividend on the first preference shares.

Mr. Henry Holmes seconded the motion.

A short discussion followed, in which **Mr. W. H. Birks** and **Mr. Edmonds** supported the policy of the Board in transferring the interest on the reserve fund investments to revenue.

Mr. Thorpe suggested the advisability of placing the interest to reserve, observing that in view of the depletion of that fund year by year to provide for the renewal of cables, it was desirable to adopt some such automatic mode of maintaining the reserve at a proper level.

The **Chairman** pointed out that if the interest were placed to reserve, as was formerly the practice, the effect would be to cause the dividends on the first and second preference shares to fall yet further into arrear. In reply to a question, he stated that up to June 30 last the Company's traffic receipts showed a decline of about £500, and he was informed by Mr. Quick that so far during the current half-year there had been a decrease in the receipts of some hundreds of pounds.

The motion was agreed to unanimously.

ARON ELECTRICITY METER.

The seventh ordinary general meeting was held at Winchester House. Particulars of the report for the year appeared in our issue of the 25th ult.

Mr. H. Hirst, who presided, moved the adoption of the report, which, he said, was a record of progress. The profit and loss account showed a gross profit on trading of £23,256. The business which the Company had done since Oct. 1 justified the Board in anticipating a continuance of sound trading during the coming financial year.

The report was adopted.

GENEVA TRAMWAYS.

The second annual general meeting was held at Salisbury House, the Hon. Arthur G. Brand presiding. An abstract of the report appeared in our issue of the 25th ult.

After reviewing the history of the Company during the past two years, the **Chairman** predicted a substantial increase in receipts during next year, as the traffic was showing great improvement. It would, however, be necessary to rearrange their finances before long.

BRITISH ALUMINIUM.

An extraordinary general meeting of the shareholders was held for the purpose of considering resolutions authorising the funding of the arrears on the 7 per cent. preference shares, the borrowing of £300,000 on debentures to be called "Loch Leven Debentures," and the creation of £190,000 additional ordinary capital.

The resolutions were carried.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING.

The Company report that the total receipts for the year ended Sept. 30 were £37,620, and the net profit £13,493. In order to pay interest, the dividend on the preference shares, and a few minor charges, an additional sum of £2,454 was required, which was taken from the unappropriated balance, reducing it to £1,558.

NEW COMPANIES REGISTERED.

Birmingham and Midland Motor-Omnibus Company, Limited. Capital, £60,000. Objects: to adopt an agreement with the Birmingham Motor Express Company, Limited, and to carry on the business of motorcar, omnibus proprietors, and vehicle builders, engineers, manufacturers of accumulators, dynamos, and other apparatus for the manufacture and equipment of such vehicles, etc. Registered office: Winchester House, Colmore-row, Birmingham.

Liens Registered.

United Electric Light and Power Supply Company, Limited, Manchester.—Lien registered Nov. 25 for £450 6 per cent. debentures, part of £3,000. Amount previously issued, £2,375. No trustees. Charged on the undertaking and all the property, present and future, including all the buildings, machinery, and other property at Guimarães, Portugal, and also the uncalled capital.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Guirgia (Roumania).—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Salamanca.—The Municipality require tenders for public electric lighting of the town. Tenders by Dec. 12 to above or to Direccion-General de Administracion, Madrid.

Edinburgh.—The Corporation invite tenders for the electric lighting installation at the branch free library, Morningside-road, Edinburgh. Tenders by Dec. 14. See advertisement.

Erith.—The Urban District Council invite tenders for motorcars, trucks, motors, and equipments, track sweeping and watering car. Tenders by Dec. 19. See advertisement.

Almendrajo (Spain).—Tenders are invited for public electric lighting for 10 years. Particulars may be obtained from the Secretary of the Ayuntamiento of that town. Tenders by Dec. 22.

Swindon.—The Corporation invite tenders for the supply and erection of one 300-kw. steam dynamo, or, alternatively, one 400-kw. steam dynamo. Tenders by Dec. 20. See advertisement.

Madrid.—The Public Works Branch of the Department for Agriculture require tenders for construction and working of an electric tramway between Azeritia and Zumaya. Tenders by Dec 10.

Bradford.—The Corporation invite tenders for the supply of miscellaneous stores required by the tramways department during the year ending Dec. 31, 1905. Tenders by Dec. 17. See advertisement.

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Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Stoke-upon-Trent.—The Guardians invite tenders for proposed electric lighting of a portion of the workhouse premises. Tenders to be delivered to Mr. C. Daniel, clerk, Union Offices, Stoke-upon-Trent, by 9 a.m. on Dec. 14.

Rochdale.—The Corporation invite tenders for high-tension three-phase switchgear and extensions to the low-tension continuous-current switchboards. Tenders to Mr. Wm. Henry Hickson, town clerk, by 27th inst. See advertisement.

Madrid.—The call for tenders for the service of the electric lighting of Almendralejo was without result. The conditions of contract have, therefore, been modified in certain respects, and tenders are to be called for to be opened on Dec. 22.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient fo the number of lamps required. Tenders by Jan. 15, 1905.

London, S.E.—Tenders are invited for the erection of an electrica traveller to lift 12 tons over a span of 40ft. Persons desirous of tendering should send their names on or before Dec. 10 to B. E. Nightingale, Albert Works, Albert-embankment, Lambeth, S.E.

Fulham.—The Council require tenders for the supply and erection of a 3,000-volt steam alternator of 1,000 kw. capacity, coupled to a Belliss engine, at their generating station, Townmead-road. Tenders to Town Clerk not later than 12 noon on Dec. 20. See advertisement.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Pontefract.—The Guardians invite tenders for extensions to present installation of electric light at the new workhouse buildings. Tenders to be delivered or sent to Mr. T. J. Amies, clerk, by 9 a.m. on Dec. 10, at the Poor-Law Offices, Pontefract.

Southend-on-Sea.—The Corporation invite tenders for additional plant for their generating station, comprising the following: two boilers, one steam dynamo, one fuel economiser, two electrical feed pumps. Tenders to be delivered at the offices of Mr. William H. Snow, town clerk, Southend-on-Sea, by Dec. 21.

Glasgow.—The Corporation invite tenders for the supply of 100 electric motor equipments and spare parts for same. Specification, etc., can be obtained on application to Mr. James Dalrymple, general manager, 102, Renfield-street, Glasgow. Tenders must be lodged with Mr. James G. Monro, town clerk, City Chambers, Glasgow, by 10 a.m. on Dec. 22.

Stockport.—The Guardians invite tenders for providing and fixing electric light (wiring only), telephones, and bells required at the new infirmary, Stepping Hill. Plans and specification may be seen and all other information obtained from Mr. W. H. Ward, architect, Paradise-street, Birmingham. Tenders to Mr. Charles F. Johnson, clerk, and to be delivered by 10 a.m. on Dec. 12.

Valladolid.—Tenders are required for the public lighting by means of electricity of the city of Valladolid. Fifteen hundred incandescent lamps of 17 c.p. will be required. The concession will terminate on Dec. 31, 1911. The annual payment to the concessionnaire will be about £965. A deposit of £48 is required to qualify any tender. The adjudication will take place at 11 a.m. on Dec. 26, at the Casa Consistorial, Valladolid.

Ilford.—The Urban District Council invite tenders for the installation of a telephone fire-alarm system on the double or metallic principle. Particulars and form of tender may be had on application to Mr. H. Shaw, A.M.I.C.E., surveyor, Town Hall, Ilford, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders, addressed to the Chairman, must be sent to Mr. John W. Benton, clerk, town Hall, Ilford, by Dec. 19.

Perth (Australia).—Tenders are invited by the Duputy-Postmaster-General for the supply of the following telephone material; 19½ miles 26-pair lead-covered cable, dry core, to standard specification No. 7; 5,000 paper sleeves, 3in. long by $\frac{3}{16}$in. diameter; 350 yards paper strips, 2in. wide. Conditions, etc., may be obtained at the General Post Offices at Perth, Adelaide, Melbourne, Sydney, Brisbane, and Hobart. Tenders by Dec. 28.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

Bromsgrove (Worcs.).—The Visiting Committee invite tenders for the supply and erection at their new lunatic asylum of the following plant: (Section A) engines, dynamos, booster, and steam services; (B) storage battery and accessories; (C) main switchboard, ring main, feeders, distribution boards, wiring, lamps, and accessories. Specification, etc., may be obtained from Mr. Robert J. Oliver, clerk of the Visiting Committee, Shirehall, Worcester, on payment of £5 for each section of the work as above, which will be returned on receipt of a bona fide tender.

Cardiff.—The Corporation invite tenders for the following plant for the extensions to their power station on the extra high-tension three-phase system—viz.: two 1,600 slow-speed vertical engines, two 1,100-kw. three-phase alternators, four Lancashire boilers with accessories, steam and other piping, switchboard gallery and staircase, extensions to central service gangway, extra high-tension three-phase feeder cables. General conditions, specification, and form of tender may be obtained on application from Mr. Arthur Ellis, M.I.M.E., M.I.E.E., borough electrical engineer and manager, Central Offices, The Hayes, Cardiff. Tenders to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by Dec. 19.

Madrid.—Tenders are invited for the public lighting by means of electricity of the town of Villanueva y Geltru for a term of 10 years. Twenty-four arc lamps of 500 c.p. and 239 incandescent lamps of 20 c.p. will be required. The concessionnaire will be allowed to supply private individuals without payment of a municipal tax subject to his supplying, free of charge, the Casa Consistorial with 75 kw. per month. He will be required to maintain a duplicate set of machinery in order to avoid the possibility of the town being left in darkness through a breakdown. The annual payment (upset price) to the concessionnaire will be 23 145 pesetas (about £678). The adjudication will take place on Dec. 24. A deposit of £68 is required to qualify any tender.

Madrid.—The *Gaceta de Madrid* of Nov. 9 publishes a notice inviting tenders for the construction and working for 60 years of an electric tramway between Azcoitia and Zumaya (Province of Guipúzcoa), in accordance with certain conditions set out in the *Gaceta*. An application for this concession has already been received from Don Dionisio Sorseta Garcia who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on the reduction of the tariff fixed for the conveyance of passengers, etc.; in the event of equal terms being offered, it will turn on a reduction of the period of concession. Adjudication of tenders will take place before the Director-General of Public Works, Madrid, on Jan. 10. A deposit of 16,297 pesetas (about £475) is required to qualify any tender

Manchester.—Tenders are invited for (Contract C) switchboards, mains, feeders, etc., for supply of electric current for power and lighting, and for arc lamps, etc., in connection with the new dock works, Salford, for the Manchester Ship Canal Company. (Contract D) for mains, feeders, etc., for the supply of electric current for power and lighting, and for arc lamps, etc. Drawings for both contracts can be inspected and copies of specifications, bills of quantities, and forms of tender can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester, on payment of a sum of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders to be addressed to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Dec. 22.

RESULTS OF TENDERS.

Hammersmith.—The Council have ordered eight additional 100 kw. transformers from the British Electric Transformer Manufacturing Company, Limited, at £120 each.

Cheltenham.—The tender of the Pfluger Accumulator Company has been accepted for the supply of a battery of 265 cells at £827. 12s. plus £3. 3s. 6d. for each extra cell required.

Rotherham.—The Corporation have accepted the tender of Messrs. Smith Bros. (Rotherham), Limited, High-street, Rotherham, for wiring the new isolation hospital buildings in Badsley Moor-lane.

Southwold (Suffolk).—The Hart Accumulator Company, Limited, Stratford, E., have been awarded the order to supply 110 of their standard lighting type cells to replace the existing battery at the electricity works.

Woolwich.—The tender of Callender's Cable and Construction Company, Limited, at £8,493. 6s. 8d., has been accepted for the supply, laying, etc., of the extra high-tension mains required for the Shooters Hill and Eltham extensions.

Hammersmith.—The following tenders have been recommended for acceptance for the electrical installation at the new workhouse and infirmary buildings: Scott, Anderson, and Co., Royal Insurance-buildings, Sheffield, electric wiring, £6,700; Suter and Co., 66, Berners-street, W., transforming apparatus, etc., £2,061. 12s. 6d.

Belfast.—The City Council have decided to accept Messrs. J. G. White and Co.'s entire contract for the electrification of the tramways at £543,404. 4s. 9d., which is £5,500 more than the same work would have cost had the contracts been placed in separate sections as recommended by the Tramways Committee, and reported in our last issue.

Aberdeen.—The Electricity Committee have recommended the following tenders for acceptance (but the whole matter has been referred back) for the proposed alterations on the municipal buildings: Pratt and Keith, electric lighting, £255; Aberdeen Electrical Engineering Company, Limited, telephones and bells, £161; Otis Elevator Company, Limited, electric lift, £540.

Hammersmith.—The Borough Council have received the following tenders for cables and street boxes:—

Western Electrical Company (accepted)	£2,375	5	10
Henley's Telegraph Works Company, Limited	2,465	3	0
Callender's Cable Construction Company, Limited	2,493	6	8
Imperial Engineering Supplies Company, Limited	2,533	4	0
Siemens Bros. and Co., Limited	2 604	9	0
Electrical Company, Limited	2,656	5	0
W. F. Dennis and Co.	2,905	0	0
St. Helens Cable Company, Limited	3,196	1	8
Lucy and Co., Limited	3,485	6	8

Sale of Plant.—In consequence of the opening of the new borough electric lighting station, the Bridlington Corporation have for sale the electrical plant which has been in use in connection with the lighting of the Prince's-parade. Full particulars appear in another column.

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BUSINESS NOTES.

TRACTION.

Leeds.—It has been decided to extend the Swinnow-road lines.

Kilmarnock.—The Corporation tramway system is to be opened to-morrow.

Portsmouth.—A service is to be run between the Floating Bridge and Copnor.

Bradford.—The Tramways Committee contemplate measures for materially expanding their parcels traffic.

Islington.—The Borough Council refuse to assent to the London County Council employing the overhead system.

Spain.—The Bilbao Santander Railway Company, which owns the line from Bilbao to Las Arenas, proposes to transform same to electric traction.

Barking.—An important extension of the electric tramway system is being made by the Barking Council, which is linking up through Barking the tramways of East Ham and those of the Ilford District Council.

Crewe.—Rival promoters have applied for the Council's approval to the introduction of an electric tramway and a service of motor omnibuses respectively. A decision has been deferred pending enquiries.

Electric Traction on Railways.—It is now reported that the Brighton Company have practically decided upon the electrification of their suburban lines, and that the experiment will first be tried on the Victoria-to-Peckham section.

Leith.—The Electric Lighting Committee have resolved to extend the Leith electric lighting station, at an estimated expenditure of £7,000 or £8 000, for the purpose of accommodating additional plant for the working of the tramway system by electricity.

Tipton.—It is stated that, as the result of communication between the District Council and the company, the electrification of the line may be expected before long, as the company do not propose to wait until the route from Wednesbury to Dudley has been completed.

South Shields.—The Tramways Committee recommend that the company be given 12 months' notice to terminate its lease (dated Sept. 5, 1900) of the existing tramways on Feb. 1, 1906. The lease was for seven years, terminable by the Corporation at the end of five years.

Croydon.—In reference to the Corporation's opposition to the British Electric Traction Company's application for an extension of time to complete the Mitcham Light Railway, the Board of Trade, in granting a year's enlargement, intimates that no further extensions may be expected without very cogent reasons.

Wednesbury.—Replying to a question at last week's meeting of the Town Council, the Mayor stated that he had been informed that the electrification of the system between Wednesbury and Darlaston would be commenced forthwith. He was also informed that tenders were out and contracts had been entered into for the commencement of the work.

Gorton.—At a meeting of ratepayers a resolution was unanimously carried in favour of promoting a provisional order to construct tramways along Wellington-street, Gorton-lane, and Reddish-lane. The meeting was convened by the District Council. The proposed tram route, when completed, will have the effect of connecting the system of tramways between Stockport, Reddish, Gorton, and Openshaw.

Shoreham.—At the meeting of the Urban District Council a letter was read from the British Electric Traction Company, Limited, to the effect that the company were desirous in every way possible to meet the Council's views. Regarding the commencement of the work of reconstructing the tramways, the Council's wishes would receive most careful attention. It is possible that the company may commence work next month.

Calais.—The Calais Tramway Company are going to convert their system to electric traction, and to extend it. Financially, the proprietors of the Calais lines are working in conjunction with the Dunkirk Tramway Company, who transformed their lines to electricity last year, since when their earnings have increased by 30 per cent. They, too, contemplate an extension of their lines, and also the purchase of more cars.

Musselburgh.—A trial has been made over the entire system, three miles in length, and the result was completely satisfactory. The points were smoothly negotiated, and the spurts of speed and the application of emergency brakes were satisfactory. Mr. W. Bain, local manager, and Mr. F. E Stanley, track and overhead equipment engineer, were in charge of the trial. The Board of Trade inspection takes place to-day, and the inaugural ceremony has been fixed for Monday afternoon.

Bournemouth.—At a meeting of the Corporation a motion was brought forward that the trams should run on Sundays. After considerable discussion, in which strong opposition was manifested towards the proposal, the motion was defeated by a large majority, only four votes being recorded in favour. The Council also decided not to light the main thoroughfares by electric light on Sundays, as this would entail additional Sunday labour at the Corporation generating station, but continue to light the streets with gas on those days.

Colchester.—The receipts from the Corporation tramways, like those from the neighbouring system of Ipswich, seem to be on the down grade. For the week ending Aug. 4 (when the system was opened) the receipts totalled £604. The next week they were £333. Later they reached £361, but since then there has been a progressive decline, and the week ending the 1st inst. produced £133 only. This is a large drop allowing that conditions have not been favourable to travel of late. The diminished receipts have been counterbalanced in a measure by reduced expenses.

Aston.—The report of the Public Works Committee states that the reconstruction of the tramways is now complete. A councillor called attention to the lack of through communication between Birmingham and Aston. In reply, the Chairman stated that there was a 10 minutes' service between Steel House-lane and Witton, but so far as he could understand the Tramway Committee had not come to an arrangement with Birmingham, and was not likely to until the matter of the station bridge was settled. When the bridge was altered he thought they would quickly get over the present difficulty.

Middlesex County Council.—The tramway route from Cricklewood to Edgware, a distance of five miles, was opened on Saturday. The new line has been constructed by the Middlesex County Council, acting with the Metropolitan Electric Tramways Company, which is working the line under an agreement with the Council. The cars will hold 30 passengers inside and 38 out, and the fare for the entire distance is 3d., with intermediate 1d. and 2d. stages. The system adopted is that of the overhead trolley, and the speed laid down by the Board of Trade regulations varies from 12 to 14 miles an hour.

Bath.—At the meeting of the Rural District Council a member asked that the Council, when giving their attention to the plans of the proposed tramway extensions, should draw the attention of the company to the promise which was made when the plans of the existing routes were approved, that some means of communication should be afforded to those districts which lost their 'bus services through the trams coming there, and were not covered by the present tramway routes, particularly the district of Bathampton. It was resolved to assent to the plans, and to refer in the covering letter to the question of communication with other districts.

Bury.—The Town Council have sanctioned a scheme for the collection and delivery of parcels on the tramway system. Conductors of cars travelling into Bury will now receive parcels at any stopping-place at a charge of 2d. up to 7lb. weight, 3d. up to 14lb., and 4d. for 28lb. Parcels will be distributed from the central office to within half a mile of any part of the system, or forwarded by parcels post or train. Railway parcels will also be collected within half a mile or a mile of the system at additional charges. Many parcels have already been carried. As an alternative route to that along Brandlesome-road for the Ramsbottom tramway scheme, powers are to be sought to construct lines from Tottington by way of Greenmount.

Inquest.—At the Southwark Coroner's Court on Friday last Dr. Waldo held an enquiry into the circumstances attending the death of Christopher Lockley, a cabman. Deceased was killed in an electric tramcar collision. Mr. Preston appeared for the London County Council and Mr. Fowler appeared on behalf of the widow. The deceased was crossing the road in Newington-causeway when an electric car, coming from St. George's Church, smashed into the cab. The cab wheel was struck and the driver thrown to the ground, and the tramcar went over him. According to one witness, there was little traffic at the time. The tram was going at the rate of 12 miles an hour. A passenger stated that the car was going at the rate of six miles an hour. The jury returned a verdict of accidental death, and expressed the opinion that the tram-driver was guilty of some negligence.

Penarth-Cardiff.—At Monday's meeting of the Penarth Urban District Council a resolution was moved that the approval of the Council be given to the scheme of the Penarth Tramways Syndicate for running a service to Cardiff, subject to their agreeing to the conditions already laid down by the Council. There are 11 conditions in all, the chief of which refer to the lowering of Cogan-hill 7ft., the laying of a double line, and the rebuilding of the Ely Bridge. A communication was read from Messrs. Herbert Lewis and Fletcher, the consulting engineers, in regard to the conditions laid down by the Council, which stated that they had not been able to obtain the consent of Lord Bute for the widening and lowering of Cogan-hill. A lengthy discussion ensued, and it was ultimately decided by the casting vote of the chairman that the Council were not prepared to reopen the question under existing conditions.

Glasgow and Paisley.—The decision of Lord Balfour of Burleigh on the claims of Glasgow Corporation and the Paisley and District Tramways Company regarding the proportion of fares payable to each for passengers carried between Hawkhead and Paisley Cross is to the effect that the company are to receive £250 from Glasgow for constructing the siding. The Corporation are to pay to the company the whole fare for each local passenger carried between Hawkhead and Paisley, and, in the case of through passengers, they are to pay two-thirds of a penny on each fare. On the other hand, the Corporation are to receive from the company 3½d. per car mile for working expenses—that is, about 7d. for each car run from Hawkhead to Paisley and back. Beside paying this, the company are to bear the cost of the electric current. The extra expense of checking tickets, etc., is to be borne equally. This award is to last till Dec. 31, 1914. The arbiters' and clerks' fees are to be borne equally.

Dover.—At a meeting of the Town Council the following report was read: "Gentlemen,—I beg to report that I have made a survey and taken levels for the light railway from Buckland Bridge to Minnis-lane, River. In preparing my estimate of the cost of the work, I have included for a double line with the exception of a short length in the narrowest part of Crabble-road. The permanent way in the public streets to consist of a bed of concrete and granite pitcher paving, and the portion through Mr. Edward Coleman's property to be laid on sleepers

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and ballast. I estimate the cost of the work as follows: land, £750; permanent way, electrical equipment, fencing, etc., £13,892; four new cars, £2,400; providing slipper brakes to existing 18 cars and new trolley standards to eight cars, £624; paving, forming, metalling etc., the streets to be laid out for Messrs. Flint and Tritton, £1,394; cost of obtaining provisional order, legal expenses, etc., £1,500; contingencies, £440—£21,000.—Henry E. Stilgoe." In the course of a discussion which followed, the town clerk said the figures showed a loss of £756 a year. It was eventually decided to apply for borrowing powers.

Blackpool.—The St. Annes and Lytham Tramways Company has intimated to the Corporation that the deposit of a Bill by the company asking for compulsory running powers over the Corporation lines is only a precautionary measure, and the company trust that an agreement may be arrived at which will enable the Bill to be withdrawn. The proposed terms are as follows: The company would, as a temporary arrangement, be prepared to accept running powers over three of the Corporation routes for the period of two years from Jan. 1, 1905, on the basis of all the terms in every respect whatsoever with regard to such running powers being settled by mutual agreement between representatives of this company and representatives of the Corporation, and that any points in difference as to the terms of such running powers and the wording of the agreement should be settled by the sole arbitration of either the manager of the Manchester tramways or the manager of the Liverpool tramways, or if the Blackpool Corporation have some objection to either of these gentlemen, then some other equally competent and experienced person to be agreed upon, who should have power in his sole discretion for the purposes of such two years to determine and settle such differences and the form of the agreement. The period of two years is suggested because the first season would give both sides an ample opportunity of testing such running powers and the terms thereof in actual working, and would afford an opportunity at the close of the 1905 season to either side to bring forward any suggestion for alteration which circumstances might disclose to be advisable, having regard to the experience that one whole season thus obtained and the further period of 12 months would enable the temporary arrangement to be continued until any such new suggestions on either side could be arranged or receive the necessary sanction.

Birmingham.—At the meeting of the Corporation, Alderman Beale, chairman, submitted the report of the Tramways Committee, and moved the approval of their recommendation that the amount included in the Birmingham Corporation Bill of 1905, in connection with the purchase of land for, and the execution of, street widenings, should be increased to £202,200. The Council might possibly look upon this recommendation as something in the nature of an after-thought, but such was not the case. It related to the widening of a portion of Dale End, which both the Tramways Committee and the Public Works Committee had hoped they would be able to do without. There was a short length of street between the junction of Masshouse-lane and Moor-street, and the junction of Chapel-street and Dale End. The Council had sanctioned the proposal to widen the upper portion of Dale End, and also to widen Coleshill-street at the junction of Chapel-street. They originally left this piece out because it was expensive. The Tramways Committee could manage with a single line, which would not necessitate widening, and the Public Works Committee also wished to study economy, but after further consideration by both committees they were convinced that they would not be making a good job by leaving a bottle neck between two portions of the street, and since the Tramways Bill was approved by the Council they had ascertained that one of the largest interests which would have to be acquired for the widening could be so acquired at a figure which the surveyor advised was a reasonable price. The cost of the street widening would be divided between the Public Works and the Tramway Committees. The resolution was approved. Replying to questions, Alderman Beale stated that the Coventry-road route was to be equipped upon the Bristol-road terms. The company would supply the cars, and at the end of the lease the Corporation would take them over at their then value. The Tramways Committee would therefore exercise supervision over the class of cars to be provided. It was quite different on the Dudley-road route. There the Corporation did not take over the cars, and did not exercise the same strict supervision. These cars, when the lease terminated, would go out of Birmingham into outside districts. With regard to the opening of the Coventry-road route he could not give a date. The Corporation had fulfilled its obligation as regarded converting the road some time ago, but he understood the tramways company were waiting for their own electric department to complete its work. It had been understood that the line would be opened before Christmas, and he hoped such would be the case. At a meeting of citizens at the town hall on Wednesday, the Bill to sanction tramway extensions was unanimously approved.

London County Council.—The agenda for Tuesday last contained a recommendation by the Highways Committee that £750 should be voted for a full range of specifications, drawings, and designs covering every detail of tramway rolling-stock with a view to the standardisation of same so as to secure economy and efficiency. The receipts from April 1 to Nov. 26 total £440,811, against £346 552 for the corresponding period last year. Three of the Council's motormen were convicted last week for driving at an excessive speed. The petition of Sion College presented to the City Corporation against the proposal to bring the tramway lines over Blackfriars Bridge states that the petitioners have at considerable expense erected large premises on the Thames Embankment, close to the corner of Blackfriars Bridge, for the purposes of their college; that the site was selected for its comparative quietude, which would be broken by trams; and that the report of the Royal Commission should be awaited. The petition was referred to the Streets Committee. A conference has taken place between representatives of the Highways Committee of the County Council and the members of the Streets, Bridge House Estates, and Special Committees of the Corporation. At a precinct meeting of the parish of Farringdon Without Mr. J. Lewis objected to the proposal to bring the trams across the river. If, he said, trams were once brought into the City, they would never be able to get rid of them. The traffic down Fleet-street and Farringdon-street was sufficient already without adding to it. Mr. J. W. Gaze said he was absolutely opposed to the tram scheme. It meant ruination to the Embankment and to the bridges—Blackfriars Bridge in particular—and was, in his opinion, the thin end of the wedge to start a system of tramways running in the City. Further, if the scheme were adopted, they might be sure that it would mean an addition to the county rate of 3d. in the £. Mr. N. Fortescue, C.C., in dealing with the same matter, said they must be in a certain sense progressive, and study the convenience and wants of the population. One of the first means of doing this was to give every facility for going from one part of London to another. As to the particular question of bringing the lines over Blackfriars, he would not agree to it while the bridge was constructed as at present. Without any difficulty, however, and at a comparatively small cost, the acute angle of the roadway at the juncture with the Embankment might be done away with, and the width of the road at that point nearly doubled, simply by setting back the first stretch of the balustrade at an angle so as to join the Embankment some yards further down, and filling in the space. The entire cost would be borne by the Bridge House Estates Committee. The trams could then be brought over the bridge, and he was sure, would prove a great boon to the public. The ruination of the Embankment had been spoken of, but they should remember that very little of it actually belonged to the City. He intended to put a motion on the paper asking the Corporation to instruct the Bridge House Committee to bring up a scheme on those lines, and he had every hope that it would be well supported. It would be one of the best improvements in the neighbourhead that had been carried out for some considerable time.

Hastings.—The work of construction is about to be commenced, if it has not already started. The whole of the system is expected to be finished by June or July, with the exception of the front line, and when that is started it will only take a week or two, or a month at the outside. The promoters will not wait for this, however. As each section is completed it will be inspected and opened. A line, for instance, might run between Bexhill and Bopeep with those places as termini, until the front line is connected. An employment bureau in connection with the work has been opened, and applications have been numerous. Messrs. Dick, Kerr, and Co.'s wages account for labour only is estimated to come to something like £2,000 a week. A rumour has been current that the gasworks in Queen's-road were to be utilised as a power station, but this is understood to be erroneous. Negotiations are in progress to secure a place for this purpose, but have not yet been completed. There will also be several sub-stations, probably at Ore, Hollington, and Bexhill. The Town Council debated last week the proposal of the company to use the overhead system. The following report was presented by the Tramways and Railways Committee: "The committee have had before them the communication from Messrs. Ashurst, Morris, Crisp, and Co. on the subject of the Hastings tramways, intimating that they are instructed to apply to Parliament next session for a Bill to authorise the front line being worked by overhead traction uniformly with the rest of the system, and at the same time to seek to modify the terms of the Act of 1903 so far as to permit of the lines along the front and London-road being constructed, notwithstanding that the lines 'A' in Upper Church road, and 'B' from Bexhill to Kewhurst, have not been constructed; or, in other words, that the construction of those two lines may be postponed—which communication was referred to them for consideration and report at the meeting of the Council in committee held on Nov. 18, and recommend that Messrs. Ashurst and Co. be forthwith informed that the Council object to the proposal to work the tramways along the front line by overhead traction, and that the committee had decided to defer the consideration of the proposal to postpone the construction of the tramway in Upper Church-road until they have had an opportunity of seeing the Bill." A letter was also read from the Hastings and St. Leonards Ratepayers' Association enclosing a resolution against the overhead system. The report was carried without opposition. Councillor Bones, in seconding, said that the majority of the men in the street agreed in objecting to overhead wires on the front. One councillor drew attention to a clause in the new Bill by which the promoters appeared to be asking for power to do lighting along the route, which, if granted, would greatly affect their own electric lighting operations. The company contend that there is no system in existence which can be successfully worked on the Hastings front line except the overhead wire system. With regard to the decision arrived at by the Town Council, the company's opinion is that it is manifestly unfair of the Corporation to come to any decision on the question of overhead wires on the front before it has received the representatives of the company to explain the purpose of the Bill. The company is going to be the largest ratepayer in Hastings, and during the next six months will spend something like £400,000, and it considers that at the least it is entitled to some consideration. The Bill seeking permission to use the overhead system has not been deposited yet, but the question of the use of overhead wires for the front line does not require the consent of the Corporation. To oppose the Bill in Parliament would doubtless involve heavy expenditure on counsel's fees and other disbursements. The promoters are quite prepared, without any cost to the Corporation, to put up poles of any design the Corporation like, and to put arc lamps on the top of the poles, and so do away with the hideous monstrosities at present along the front. The promoters have not put the clause about overhead wires on the front in the Bill without serious consideration. The company quote the precedents for the overhead system set by other towns. They are desirous of an opportunity of explaining their ideas to the Council, as they think the method they propose to employ for constructing the overhead system along the front will remove any objections on æsthetic grounds.

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LIGHTING AND GENERAL.

Hammersmith.—An extension of cables, estimated at £222, is to be made for private supply applied for.

Macclesfield.—The Town Council have now decided to adopt a municipal electricity scheme forthwith.

Private Installation.—The London India Rubber Works are to be lighted electrically. Mr. Frederic H. Taylor is the consulting engineer.

Loughborough.—Twenty-eight applications were received last month for the supply of current, amounting to the equivalent of 2,362 8-c.p. lamps.

Woolwich.—Loans of £5,196 with regard to the gross overspent balance in the electricity works and £16,275 for electricity purposes are to be applied for.

Ramsgate.—A number of letters appear in the local Press urging that at present there is an excellent opportunity for proceeding with the electric lighting scheme.

Wednesbury.—Application is to be made for sanction to a loan of £1,000 for necessary extensions of the main in connection with the electric lighting undertaking.

Bath.—We understand that the Rural District Council have received an offer regarding their powers under the electric lighting provisional order concerning Monkton Combe, Freshford, and Claverton.

Electric and General Investment Co.—The directors have declared an interim dividend at the rate of 10 per cent. per annum on the capital paid up on the ordinary shares, being 1s. per share for the six months ended the 30th ult., payable, less tax, on Jan. 9.

Arbroath.—Further correspondence with reference to the proposed introduction of the electric light into the burgh with the company which has recently been in negotiation with the Council for the undertaking, will be dealt with by the Electric Lighting Committee in the course of next week.

St. Andrews.—The Electric Supply Corporation, Limited, have obtained the Town Council's consent to lay cables for the supply of electric light on both sides of certain streets in the burgh. This is for private lighting, the Town Council not having decided upon street-lighting by electricity at present.

Croydon.—The Lighting and Electricity Committee have re-elected Alderman Miller chairman of the committee and Councillor Rogers vice-chairman for the current year. Mains are to be extended through Elmwood and Lodge roads to Greenwood-road in due course as suggested by the borough electrical engineer.

Kensington.—Notices from the undermentioned electric lighting companies relative to proposed extensions of their mains etc., in the borough have been agreed to: Kensington and Knightsbridge Electric Lighting Company, Kensington Court-place and St. Albans-road; Brompton and Kensington Electricity Supply Company, Stratford-road.

Ashington.—The Northern Electric Supply Company have decided to put electric installations into private dwellings in the Ashington and Hirst district free of cost. A number of the inhabitants have availed themselves of this concession. The large power station in course of erection at Ashington will be completed in the course of a few weeks.

Change of Address.—Owing to the completion of his engagement as consulting electrical engineer with the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, we are advised that after Dec. 16 all communications of a personal nature to Mr. Alfred H. Gibbings should be addressed, Lynton, Wellington-road North, Stockport.

Burgess Hill.—The Urban District Council have formulated a scheme for the establishment of electric lighting works in the district, and have obtained tenders for the works; but in consequence of the large amount of capital expenditure involved, no further progress has been made in the matter. Under the circumstances they have requested the Board of Trade to allow the provisional order still to remain in force.

Acton.—With regard to the loan of £54,091 for electric lighting purposes, an offer from the Metropolitan Electric Supply Company to advance £25,000 at 3¾ per cent., repayable in 25 years, has been accepted. The clerk is to report to the next meeting as to the taking up of the balance of £29,091. He has also been instructed to apply for sanction to borrow £10,000 for wiring of houses and the supply of electrical fittings.

Retford.—At a meeting of the Town Council on Friday a recommendation to adopt a scheme for supplying the borough with electricity was defeated. Mr. A. B. Mountain explained the scheme, and recommended a minimum expenditure of £5,375. A vote of thanks was passed to Mr. Mountain for his admirable explanation of the scheme, and in replying, he said he hoped the Council would not have cause to repent of the decision they had made.

South Shields.—The statement of sales of current and receipts in connection with the electric light undertaking for the three months ended Sept. 30 shows that the units consumed were 137,250, as compared with 137,148 in the corresponding quarter of last year. The total amount of sales, including public and private lighting and meter rents, was £3,664, compared with £3,470, an increase of £194. The number of consumers advanced to 1,055.

Stock Exchange.—The Stock Exchange Committee has appointed Dec. 9 as a special settling day for the Telephone Company of Egypt, Limited, £60,000 4½ per cent. debenture stock, and also ordered these securities to be quoted in the official list. Application has been made to the committee to allow the Auckland Electric Tramway Company's further issue of £85,100 5 per cent. first mortgage debenture stock, redeemable, to be quoted in the official list.

Ashton-under-Lyne.—The Corporation and the Oldham, Ashton, and Hyde Electric Tramway Company have concluded a renewal of the agreement by which the Corporation supply the whole of the energy for working the tramway for 14 years, commencing next July. The company use over 800,000 units per annum, and we understand that they have recently expressed their entire satisfaction with the supply given them by the Corporation during the past six years.

Economical Combustion.—Erith's Engineering Company, 70, Gracechurch-street, E.C., have just published an interesting pamphlet, entitled "Smoke Prevention and Fuel Economy as a Paying Investment," with the object to explain the principles involved, and the simplest and most efficient methods of attaining success. Amongst the illustrations we note a typical installation of Erith's underfeed stokers on Lancashire boilers at Burnley Corporation electricity works.

Lytham.—An agreement is being drafted between the Urban District Council and Messrs. Foote and Milne, Limited, who are applying for a provisional order to supply electricity. The Urban District Council have decided to inform the Board of Trade that no steps will be taken by them to carry out their obligations under the Lytham Electric Lighting Order, 1900. Consideration of the terms offered by the St. Annes Council to supply electricity has been deferred.

Gloucester.—The City Council have approved a scheme for the extension of electric lighting, and resolved to apply for authority to borrow £15,000 in order to carry out the work. During the first half last year there was a net loss of £1,050, but in the second half a profit of £570 was made. During the first half of the current year the loss was reduced to £290, and the electrical engineer estimates that the profits on the second half will be £767, leaving a net profit of £477 for the year.

Middlesbrough.—The Electric Lighting Committee have re-elected Councillor Charles Dorman chairman for the ensuing year. The electrical engineer (Mr. H. M. Taylor) in his last report states that during November 91,000 units were sold, compared with 66,000 for the corresponding period of last year, 352 tons of coal being consumed against 230 last year. The income amounted to £1,258, and the cost £457, against £919 and £368 respectively a year ago. The cost per unit was 1·2d., as compared with 1·32d. last year. The estimated profit was £801, exclusive of interest.

Edmonton.—The District Council held another special meeting on Friday night to further consider the electricity offers received from the North Metropolitan Electric Power Supply Company, Foote and Milne, Limited, the Industrial Engineering Company, and the National Electric Construction Company, Limited. To a motion that the offer of the first-mentioned company should be accepted, an amendment was proposed in favour of the National Construction Company. Upon a vote being taken, the amendment was defeated by 11 votes to 10. A further amendment was then proposed that the Council should themselves take steps to supply the compulsory area, and this was under discussion when, by the operation of the standing orders, the meeting was adjourned.

Northern Section of Electrical Contractors' Association (Incorporated).—Meetings of the Northern Section of the Electrical Contractors' Association were held at the Queen's Hotel, Stockton-on-Tees, on Saturday, Dec. 3, when Mr. J. McDermott, J.P., Manchester, presided over a representative attendance of members, including Messrs. Cross, Robon, Usher, and Andrews (Newcastle), Hirst (Leeds), Taylor (Huddersfield), Harford (Liverpool), Steinthal and Shaw (Manchester), Brown (Sunderland), Tattersall (Middlesbrough), Geipel and Prescott (West Hartlepool), Watson (Stockton), and W. Cross, hon. secretary. It was reported that the membership was increasing rapidly since the incorporation of the association, and very many matters of interest were discussed.

Edinburgh.—The Town Council on Wednesday agreed to apply for consent to the borrowing of a further sum of £90,000 for capital works under the Edinburgh Electric Lighting Provisional Order, 1891. Their total capital expenditure to May 15 was £845,366. The expenditure for the current year was £60,820, or a total of £906,156, or £46,156 in excess of the amount for which consent to borrow had already been obtained. The additional £90,000 will be sufficient to carry them on very probably for the next two years, bringing the amount sanctioned up to £950,000. The accounts for the past year showed a remarkable progress all along the line. There was an increase of over 1,000 consumers, an increase of over 100,000 8-c.p. lamps, and the output has been increased by 1½ million units. Along with this remarkable increase of business there has been effected a still further reduction in the cost of production, which now stands at ·89d. per unit, although the Council have not the advantage of a traction load.

India.—The Madras Municipal Commissioners have adopted the report of the committee appointed to consider the applications of Messrs. Crompton and Co. and Messrs. Burn and Co. for electric licenses to light Madras and supply power. The committee, after discussing the relative merits of the offers of the two companies decided in favour of Messrs. Crompton and Co., and recommended that the option of purchase should be exercised at the end of 21 years instead of 42 years, renewable every subsequent seven years. The Commissioners forwarded the report to the Government, inviting the latter's attention to the necessity for satisfying themselves by security or otherwise that the licensee is in a position to discharge the duties and obligations imposed on him by license. The proposal for the provision of high-tension transmission from the E. I. R. shops at Lillooah to Howrah railway station yard, and also for the provision of plant for lighting the new joint passenger station and the goods yard with electricity, as also the construction of step-up transformer house at Lillooah, has been provisionally sanctioned at an aggregate cost of about 1 lakh and 24,000 rupees.—*Indian Engineering.*

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Fulham.—It is proposed that the necessary electric mains for public lighting be laid in Bishop King's-road, and six Nernst lamps substituted for the present gas lamps at an estimated cost of £42. 10s., and that Nernst lamps be substituted for the present gas lamps in Edith-road, between North End-road and Gliddon-road, at an estimated cost of £27. 10s.

Bradford.—The Electricity Committee last night discussed an exhaustive report on the distribution of electricity by the city electrical engineer (Mr. Alfred Blackman), which contains recommendations involving an expenditure of over £40,000. It is estimated that £26,165 will be required for the tramways distribution, including a spare 500-kw. feeder laid into each sub-station; £10,250 for transforming plant at the works; and £4,452 for high-tension feeders for general supply.

Spain.—It has been decided to instal electric lighting at Iznar, Pedrajas, and Olmedo, in the Province of Segovia. The Electro-Minera de Valdemorillo Company has obtained the concession. The three electrical companies at Saragossa—viz., Aragonesa de Electricidad, Electra Peral Zaragozana, and Fuerzas Motrices del Gállego—are about to combine. The shares of the former company will rank for a preference dividend of 6 per cent. for six years, after which the shares of all companies will rank equally.

Dudley.—It has been decided to extend the electric lighting to Hall-street and Dixon's-green, and to apply for sanction to the borrowing of a further £21,000 to cover excess of expenditure of old loans and on account of expenses to be incurred for additional boilers, engines, dynamos, cables, and electrical plant. The result of the working of the first two years was a loss of £390, and of the second two years a profit of £1,452. Last year's profit was £650, of which £505 consisted of the difference between the cost of the gas lighting and the electric lighting of the streets.

Bridgend.—A curious matter came before the District Council last week. The clerk read a letter from the South Wales Electrical Power Distribution Company protesting against the action of a private customer who had connected the lighting mains of his house with the company's mains which are supplying power to the works. It was explained that the customer had been misled by his electrician, who had since left the district, that the estimated loss in revenue had been paid to the Council, and that the Council's electrician having reconnected the place in question with the Council's mains, the matter was now dispensed with.

Hampstead.—The Borough Council have adopted a report of the Lighting Committee stating that they had had under consideration the desirability of using slack coal in the furnaces in connection with the superheaters at the station. They had received a report from the electrical engineer thereon, and had found that a saving would be effected by burning the slack coal mixed with 33 per cent. of coke, instead of using the best Welsh coal. They recommended that 200 tons of small coal and wharf screenings be obtained at the price of 9s. per ton, and that a quantity of coke, not exceeding 50 tons, be obtained at the price of 15s. per ton.

Mexico.—The *Diario Official* of Mexico of Nov. 2 notifies an application by Señor David Reyes Retana for the appropriation of 60,000 litres of water per second from the River Mexcala, State of Guerrero, half this quantity to be used for irrigation, and half for the production of power. The *Diario* of Nov. 4 notifies an application by Señor Gustavo A. Lilliendahl for the appropriation for the production of power of 8,000 litres of water per second from the Rivers Casillas and Pilon, Municipality of Rayones, State of Nuevo León. The *Diarios* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

Hastings.—The Electricity Committee have received from the borough electrical engineer a report in which he stated that the high-tension feeder cables which carry the high-tension electricity from these works to the hospital sub-station, and thence to the Shepherd-street sub-station, are becoming too heavily loaded to be safe. On Nov. 18, he said, there was a load of 667 kw. at these works, against the maximum load of 610 kw. on Christmas Eve last year, an increase of 57 kw., and at the same time an increase of 90 kw. on the load for the corresponding evening of last year. To get over the difficulty he proposed to run a $^{37}/_{18}$ cable (this being the largest size that could be got into the present iron pipes) from the works to the hospital sub-station, the length being 1,300 yards, and the cost £450 if all the pipes were in good order; if not, it might be necessary to open at the bad places and repair the pipes, but this cost could not be estimated. The cause of the work was due to the number of consumers that were coming on to the mains in St. Leonards. There are at the present time as many consumers in St. Leonards as there are in Hastings. It has been agreed that the additional cable be put in as suggested, and that the cost be defrayed out of the loan already sanctioned for mains extensions. The Council have made arrangements for the expenditure of £3,417 for purposes of electric lighting and alterations to and extensions of plant. Mr. Alderman Dighton has been appointed chairman of the Tramways Committee.

London Gazette.—At a general meeting of the Cross Electric Engineering and Manufacturing Company, Limited, held at 153, Farringdon-road, London, it was resolved that the company be wound up voluntarily. A general meeting of the Sheffield Electric Advertisements, Limited, will be held at 4, York-street, Sheffield, on Jan. 5, 1905, to receive the liquidator's report, showing how the winding up of the company has been conducted and the property disposed of. The partnership between Walter E. Wort and Charles Hyde Beadle, carrying on business as consulting engineers, etc., at Arctic-chambers, Cowes, Isle of Wight, has been dissolved by mutual consent. A first and final dividend of 2s. 7d. in the £ has been declared in the estates of Frederick William Parkes and Edward Sadleir, electrical engineers and fitters, carrying on business under the style of Parkes and Sadleir at the Dingle, Colwyn Bay, Denbigh. A first and final dividend of 20s. in the £ has been declared in the estate of Frederick William Parkes, electrical engineer and fitter, Etwall, Grove-park, Colwyn Bay, Denbigh (separate estate). A winding-up order has been made out in the estate of the Sir Hiram Maxim Electrical and Engineering Company, Limited, 44, Gillingham-street, Westminster. The partnership between Ernest Gandy and Robert Henry Dewbery, carrying on business as electrical and general engineers at 71, Parliament-street, Nottingham, has been dissolved by mutual consent. The first meeting in the estate of Harry Cooke, electrical engineer, 102, Buccleugh-road, Normacot, Longton, will be held at the Town Hall, Stoke-on-Trent, at 2 p.m., on 19th inst. The last day for receiving proofs in the estate of Albert Smith, electrical engineer, and lately trading as the Electric Motor Supply Company at 54, Houndsgate, Nottingham, is 22nd inst.

West Bromwich.—At a meeting of the General Purposes Committee of the Town Council last Friday, a report was presented by the Electricity Committee with reference to the complaints made against Alderman S. Pitt (chairman of the Electric Lighting and Power Committee) and the foreman fitter. This, according to the *Birmingham Post*, stated that the memorial received from the men at the electricity works on the subject might be divided into two heads—viz: (1) the chairman's alleged interference and annoying visits to the works; and (2) the alleged undue preference given by him to certain employés. In reference to the first head, the committee had to remember that the electrical department was a new undertaking, and whatever chairman had been appointed he would have felt it incumbent upon him to pay very close attention to the establishing of so important a branch of municipal work. The chairman had given an immense amount of time to the development of the undertaking, and they could quite understand he might have been over-anxious for its financial success. The committee could further understand that some employés who had worked in stations where it had not been necessary for the chairman to take so active a part had found his visits not exactly to their taste. However, this difficulty had now been met by the chairman voluntarily consenting not to make his visits to the works so frequent. They (the committee) felt that the men had absolute cause for their complaints. With regard to the second head, the committee had had before them the man who they had reason to believe was the prime mover in the memorial, and he admitted that if he had known all the facts with reference to the appointment of the foreman fitter, he would not have penned the clause in the memorial alleging undue preference, and he thereupon withdrew it and promised to inform the other men who had signed of what he had done. During the course of the enquiry the committee found that many of the complaints were trivial, and it became very apparent that much of the friction was due to the duties of the men not being properly defined. The report was adopted. Alderman Pitt has again been elected chairman of the Electric Lighting Committee.

Cheltenham.—In order to afford supply to the light railway company to work the extensions now being made, a storage battery and booster is to be purchased, and application made for sanction to a loan of £2,000 for the purpose. The Lighting Committee will be guided by the following policy: (1) no capital expenditure outside the compulsory area without the minimum income being secured, or in the case of new streets, unless the builders undertake to wire the houses which, if connected up, would at least secure that minimum income, or in the case of works extensions or alterations with a view to economy in working, but the committee except from the above special or exceptional circumstances; (2) they will endeavour to reduce cost of production if possible; (3) no further extension of street electric lighting at present; (4) to secure a remunerative return from the light railway, having regard to the capital invested; (5) periodical visits to the works, so as to keep in touch with the concern; (6) no capital expenditure without first obtaining the sanction of the Local Government Board. The light railway company will be charged for traction purposes a flat rate of 2½d. The report of Mr. James Swinburne (which appeared in a previous issue) upon the electric undertaking was considered at the last Council meeting. It was resolved: (1) that in view of the heavy burden upon the ratepayers in order to comply with the statutory requirements as to the provision of sinking fund and payment of interest and the discharge of the accumulated deficit upon the undertaking, the committee cannot at present recommend the Council to provide additional sums by way of depreciation, which they are not legally required to do; (2) that this committee recommend that a rent of £8 per annum be charged the electricity department in respect of the land occupied by the central station; (3) that before deciding as to the expediency of appointing a canvasser, the local wiring contractors be invited to attend a conference with this committee with a view to increasing the demand for the electric light; (4) that further consideration of the recommendations and suggestions contained in the report be adjourned until the committee have before them certain information to be obtained by the electrical engineer. The question as to whether the borough electrical engineer should be required to devote his whole time to the service of the Council, and not be permitted to engage in private practice, also came up for consideration. Mr. Kilgour said that, while not required by the terms of his appointment to devote his whole time, as a matter of fact he had necessarily been compelled to do so during the last five or six years, and he was quite willing to undertake to devote his whole time to the duties of his office. This offer was accepted.

PROVISIONAL PATENTS, 1904.

Nov. 28.

25811. Improvements in means for adjusting the height of pendant electric lamps. Arthur Charles Keeping, 3, Tamworth-road, Boscombe, Hampshire.

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25801. **Improvements in reversing controllers for use in connection with electromotors.** The Electric and Ordnance Accessories Company Limited, Robert Frederick Hall, and Joseph Richardson Garner, 24, Temple-row, Birmingham.

25817. **Electrical incubator alarm.** Walter James, The Rookery, Thurmaston, Leicester.

25829. **An improved composite material for architectural and other analogous purposes and for electrical insulation.** Salo Wohle and Alice Marian Hart, 27, Chancery-lane, London.

25833. **Apparatus for regulating the voltage of alternate-current generators.** Miles Walker, 7, Skerton-road, Old Trafford, Manchester.

25839. **Improvements in and relating to electrolysing apparatus.** Edgar Leslie Thorp, 139, Queen Victoria-street, London.

25898. **Improvements in and connected with switchboards for telegraphic, telephonic, and other electrical systems.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (William Pierson Hammond, United States.) (Complete specification.)

25900. **Improvements in safety fuses.** Arthur George Bloxham, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Roburitfabrik Witten a. d. Ruhr, Germany.) (Complete specification.)

25902. **Improvements in and relating to secondary batteries.** The Ekstromer Accumulator Company, Limited, and Emil Laurence Oppermann, 1, Queen Victoria-street, London.

25903. **Improvements in apparatus for the distribution of electric current.** Claude William Atkinson, 1, Queen Victoria-street, London.

25905. **Improvements in and relating to electromagnetic change speed gear for motor vehicles and boats and other purposes.** Percy William Smith, Norfolk House, Norfolk-street, Strand, London. (Count Alain de Kergorlay, ———.) (Complete specification.)

Nov. 29.

25933. **Improvements in or appertaining to junction and disconnecting boxes for underground electric mains.** Robert Hird Clark, 2, Market-street, Bradford.

25937. **A novel or improved composition to be used as a coating for metallic surfaces for the prevention of corrosion and, if desired, for electrically insulating such surfaces.** Thomas Moore Hickman, Prince's-chambers, Wolverhampton.

25950. **Coin-collecting device and system for telephone exchanges.** Harold Dudley Stroud, 65, Chancery-lane, London. (Complete specification.)

25972. **Improvements in and connected with the protection of conductors and insulation of flexible cords for electrical apparatus.** Sydney Stuart Galsworthy, 10, Cravenhill-gardens, Lancaster-gate, London. (Complete specification.)

25985. **Improvements in means for automatically winding clocks and the like with the aid of electricity.** Georg Hartmann, 18, Buckingham-street, Strand, London.

Nov. 30.

26034. **Improvements in telephonic intercommunication.** John Young, 21, Gloucester-walk, Campden-hill, Kensington, London.

26043. **Improvements in submarine telegraphy.** Isidore Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

26063. **Electric current generating and motive-power machine.** Walter Shelverton Frost, 135, High-street, Homerton, London.

26082. **Improvements in dynamo construction.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

26092. **Improvements in or relating to receiver switches for telephone instruments.** Isidore Bernard Birnbaum and Francis George Bell, 322, High Holborn, London.

26096. **Improvements in controlling systems for electric motors.** Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, March 21, 1904, being date of application in United States.) (Complete specification.)

26097. **Improvements in magnetic clutches.** Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 1, 1904, being date of application in United States.) (Complete specification.)

26098. **Improvements in electric current-controlling systems.** Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, June 4, 1904, being date of application in United States.) (Complete specification.)

26099. **Improvements in motor-controlling systems.** Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, June 10, 1904, being date of application in United States.) (Complete specification.)

Dec. 1.

26124. **Electrical release movement.** Charles Vincent, 142, Great Dover-street, London.

26157. **Improvements in and relating to electric arc lamps.** Ferdinand Nusch, 81 High Holborn, London. (Alfred Cotis, France.) (Complete specification.)

26161. **Improvements in or relating to electrical circuit breakers** William Sherman Toplis, Westinghouse-building, Norfolk-street, Strand, London.

26169. **Improvements in thermal cut-outs.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26170. **Improvements in electric switches or cut-outs.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26171. **Improvements in armature windings for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26172. **Improvements in electric switches and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26173. **Improvements in paper articles and methods of making the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26174. **Improvements in and relating to electric transformers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26175. **Improvements in electric transformers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26176. **Improvements in and relating to electric transformers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. The General Electric Company, United States.)

26179. **Improvements in and relating to percussive tools, particularly applicable to electrically-operated percussive drills.** Percy John Ogle, 1, Queen Victoria-street, London.

26194. **Improvements in dynamo-electric generators and motors.** Ludwig Torda, 40, Chancery-lane, London.

Dec. 2.

26220. **Improvements relating to troughs or conduits for underground electric mains or cables and for similar purposes.** John Wilkinson, 18, Southampton-buildings, Chancery-lane, London.

26260. **Improvements in electric arc lamps.** James Bernard Sipe, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26262. **Improved magnetic separating apparatus.** Carl Scholl, 6, Lord-street, Liverpool. (Complete specification.)

26269. **Improvements in coils for electromagnets, solenoids, and the like.** James Bernard Sipe, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26282. **Improvements in switch installations for telephone exchanges and in switches therefor.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

26283. **Improvements in electric meters.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société pour l'Exploitation de Compteurs Electriques Rittener et Cie., Switzerland.)

26285. **Improvements in rotary-field electricity meters.** Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

26288. **Improvements relating to electrical apparatus for training and elevating heavy guns.** Vickers Sons, and Maxim, Limited, Alfred David Williamson, and Cecil Leslie Sumpter, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26290. **Improvements in the control of alternating-current motors and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26291. **Improvements in and relating to vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26292. **Improvements in joints between metals and vitreous materials and method of forming the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26293. **Improvements in and relating to dynamo-electric generators.** Allgemeine-Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 3, 1903, being date of application in Germany. (Complete specification.)

26294. **Improvements in electric brakes.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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26295. Improvements in electric control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

DEC. 3.

26327. Improvements in electric switches. Thomas Henry Large, 154, St. Vincent-street, Glasgow.

26331. A guard for electric cars and such like for the saving of life. Fred Darnton, 11, Duke-street, Millfield, Sunderland.

26367. An improved system of wireless telegraphy. William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschafc für Drahtlose Telegraphie, Germany. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 22, 1904.

1903.

24220. Apparatus for lighting gas lamps by electricity. Gergacsevics.

25765. Electricity meters. Cervera.

25886. Coin operated or controlled electricity meters. D'ck.

26124. Apparatus for controlling and operating the points of electric railways and tramways. Stewart, Turner, and Dixon.

26513. Canopy trolley standard for electric tramcars driven on the overhead system. de Macedo.

27893. Controllers for electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

1904.

821. Systems of electric motor control and controlling apparatus therefor. British Thomson-Houston Company, Limited. (General Electric Company.)

1624. Device for preventing accidents from overhead trolley wires when broken. Mudie.

1968. Motor-control systems. British Thomson-Houston Company, Limited. (General Electric Company.)

2243. Trolleys for collecting electricity. Thomson.

2315. Electrical terminal attachment device. MacIver and Guy.

2397. Construction of trolley wheels or pulleys for collecting electric currents used in overhead electric traction and the like. Carnegie and Beevers.

2449. Emergency brakes for electrically-propelled vehicles, trains, and the like. British Thomson-Houston Company, Limited. (General Electric Company.)

2452. Controlling alternating-current electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

2453. Controlling alternating-current electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

2558. Device for automatically switching off the electric current in an overhead trolley wire immediately a trolley wire breaks or is broken. Payne and Poupart.

2614. Terminals for electric batteries. Prested.

14105. Means for connecting the electrodes of galvanic batteries with their leads. Wiechmann.

16479. Telephone repeaters. Kretzinger.

17528. Apparatus for automatically indicating and registering by electrical means the progress or course of several physical processes or phenomena. Siemens Bros. and Co., Limited. (Siemens und Halske Akt.-Ges.)

18628. Holder or socket for electric incandescent lamps. Stern and Greene.

22964. Gas or vapour electric apparatus. Baker. (Date applied for under International Convention, Nov. 6, 1903.)

23050. Electrical railways. Gill.

23279. Electrical resistances. Aron.

23377. Regulating dynamo-electric generators. Deutsch.

23452. Insulation of coils of electrical apparatus. Moore. (Date applied for under International Convention, Nov. 21, 1903.)

23622. Galvanic batteries. Möllmann.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Allianee Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	5/8
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	15/32 9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-5⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	–	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manut., 5 per cent. Pref., 275,001-375,000	5	–	2⅝-3¼
—— 4 per cent. Mortgage Debenture Stock	100	–	88-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅝-¾
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	69-73
Callender's Cable, Debentures	100	–	104-106
—— Ordinary	5	–	9½ 10
—— 5 per cent. Pref.	5	–	5⅛-5⅜
Crompton and Co.	5	–	14-14⅜
—— 5 per cent. Debentures	100	–	93 98
Edison and Swan United, "A" Shares, 1-89,261	5	–	¾-⅞
—— "A" Shares, 01-017,139	5	–	1-1¼
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1⅛-1¼
—— 7 per cent. Cumulative Pref.	2	–	2⅛ 2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9⅛-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10½-11
—— 4½ per cent. Preference	5	–	5⅛-5⅜
—— 4½ per cent. Debentures	100	–	110-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	19½-19⅝
—— 4 per cent. Debentures	100	–	99-103
Parker, Thos., Limited, Ordinary	10	–	10-10½
Telegraph Construction and Maintenance	12	–	38 40
—— 5 per cent. Bonds	100	–	103-105
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	12-13
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9½-10
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock, Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5⅛-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	7⅜ 8
—— Nos. 20,001-30,000	5	–	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12½-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	104-107 xd
Charing Cross and Strand, Nos. 1-70,000	5	–	8⅛-8⅜
—— 70 001-80,000	5	..	8-8⅛
—— 4½ per cent. Cum. Pref.	5	–	5⅛-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅞-5
—— 40,001-80,000	5	..	4⅞-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	103-105
Chelsea Electricity Supply	5	–	6⅛-6⅜
—— 4½ per cent. Debentures	100	–	109-111
City of London, Ordinary	10	–	10¾-11
—— 6 per cent. Cumulative Pref.	10	–	13¼-14
—— 5 per cent. Debenture Stock	100	–	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	104-106
County of London Electric Supply, Ordinary	10	–	9⅛ 9⅜
—— 6 per cent. Cum. Pref.	10	–	12-12⅛
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	101-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	6 6⅛
—— 6 per cent. Cum. Pref.	5	–	6-6⅛
—— 4½ per cent. First Mort. Deb.	100	–	106-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1⅛-2⅛
—— 5 per cent. Debenture Stock, Red	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5⅛-5
—— 4½ per cent. First Deb Stock, Red.	100	–	102-105
Havana Electricity, Limited, 1-15,000	10	–	9⅛-10⅛
Hove Electric Lighting, Limited, Ord. 1-13,000	5	–	7⅛ 8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	100-102
Kalgoorlie Electric Power and Lighting, Limited, 5 per cent. Cum. Pref., 1-150,000	1	–	9/16-11/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5		12½-13¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10⅛
London Electric, Ordinary	5	–	2-2⅛
—— 6 per cent. Pref.	5	–	5⅜ 5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	97 99
Metropolitan Ordinary	10	–	16½-16⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5 7/16-5 9/16
—— 3½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.	100	–	93-95
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	–	14½-15
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.)	100		101-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510	5	–	6⅛ 6⅜
—— 4 per cent. Debenture Stock	100	–	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2⅜-3¼
—— 4 per cent. Debenture Stock	100	–	85-87
South London, Ordinary		–	4⅛ 4⅜
South Metropolitan Electric Light and Power Co., Ord.	1	..	⅞-1
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	107 110
—— Ditto, June, 1904		..	
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	14-14½
—— 7 per cent. Pref.	5	–	8⅝-9
—— 3½ per cent. Deb.	100	–	99 101
Urban Electric Supply Co., Ordinary, 8-30,007	5	–4	15/16-5 1/16
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–4	15/16-5 1/16
Westminster, Ordinary	5	–	12¼-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6½-7
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅝-5¾
—— Ord.	5	..	7¼-7⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	–	143 146
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	106-107
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	10½-11
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98 101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606	1	..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13½-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103
—— Ord Pref.	100	..	102-105 xd
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each	40	–	102-104 p e
—— 4½ per cent. Vancouver Power Deb.	100	–	98-101
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9½-10⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10⅜-11
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	..	96-97

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Name.	Amount paid. £	Last price. £
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	3½-3¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	6⅝-6¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5⅛-5⅜
—— 5 per cent. Deb. Stock, Red.	100	106-108
—— Prov. Cert., all paid	100	103-106
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	96-99
Calcutta Tramways, Limited, 1-102,268	5	7⅛-8¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	107-109
Cape Electric Tramways, Nos. 1-480,000	1	1⅛-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4⅞-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	9½-10
—— 5 per cent. Cum. Pref.	10	11-12
—— 4 per cent. Debentures	100	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb Stock	100	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000	5	3¾-4½
—— 4 per cent. Debenture Stock	100	90-93
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	10⅜-10⅞
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	103-105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	103-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	⅜-½
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	103-105
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 54,001-74,000	5	¼-1½
Oldham, Aston, and Hyde Tramway, Ordinary	10	·12½
—— 5 per cent. Cum. Pref.	10	9⅛-9⅝
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk.	100	103-106
Potteries Electric Traction, Ordinary 20,001-40,000	10	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-8½
—— 4½ per cent. Debenture Stock	100	98-102
South Lancashire Electric Traction and Power Company		
—— £250,000 Ordinary	1	1
—— £101,152 5 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.
Electric Railways.—		
Central London, Ordinary	100	93-96
—— 4 per cent. Pref.	100	101-103
—— ,, ,, deferred	100	84-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	108-110
City and South London, Consolidated Ordinary	100	46-47
—— 4 per cent. Debenture Stock	100	104-107
—— 5 per cent. Pref. Stock '91	100	122-125
—— ,, ,, ,, '96	100	117-120
—— ,, ,, ,, '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	96⅜-97¼ xd
Waterloo and City, Ordinary	100	88-90
Telephones.—		
National Telephone, Preferred	100	107½-108½
—— Deferred Stock	100	96½-97½
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5⅜
—— 5¼ per cent. Deb. Stock, Red.	100	98-99
—— 4 per cent. Deb. Stock, Red.	100	104½-105½
—— 4 per cent. Prov. Cert.	—	67½-68½
Oriental Telephone and Electric Company	1	15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week: Ending	1904. £	1903. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1904.	1903.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per: Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	Dec. 3	1,098	1,066	+ 32	+ 5,771h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 3	174	168	+ 6	+ 494	8	8	,, 15	14,160	3,201,585	336,049	1·03	10·11	1,770	5·04
Barking Corporation	Dec. 3	56	20	+ 35	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 4	932	925	+ 26	+ 520	23·53	23½	March 31	56,073	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Corporation	,, 3	337	—	—	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 3	5,410	4,889	+ 521	+14,375	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 2	724	694	+ 30	+ 3,330	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·89
Blackpool Corporation	,, 1	258	261	— 3	+ 5,902	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 5	182	183	— 1	+ 330	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	,, 4	1,719	1,567	+ 152	+ 522	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	Nov. 30	706	734	— 28	+ 2,043	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	Dec. 3	3,607	3,314	+ 293	+26,433	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 4	720	696	+ 24	+ 3,282h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 2	4,175	4,274	— 99	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 3	933	774	+ 159	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 4	274	268	+ 6	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 3	1,816	1,700	+ 116	+ 1,653	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 3	164	157	+ 7	+ 212	—	—	Dec. 31g	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 3	6,937	7,091	— 154	— 229k	6	6	,, 31	362,471	44,933,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 4	2,837	3,187	— 290	— 2,160h	6¼	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	Nov. 30	129	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Dec. 1	384	357	+ 27	— 2 512	—	—	,, 31g	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 2	93	233	— 4	—	7·23	7·23	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 6	153	166	— 13	— 279	4½	4½	,, 31	11,255	2,871,332	280,901	0·94	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 2	87	89	— 2	— h	7	6⅔	Dec. 31g	6,234	883,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 2	3,593	3,408	+ 85	} —	47	46	,, 31g	134,648	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 2	762	610	+ 112											
Dundee City Tramways	Nov. 30	776	775	+ 1	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Dec. 3	572	529	+ 43	+ 1,465	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 3	13,641	13,142	+ 499	+20,278h	143	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 3	177	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	Nov. 30	2,187	2,158	+ 29	+ 3,901	33	30½	March 31	68,289	16,322,054	1,387,885	1·00	11·79	2,059	8·77
Huddersfield Corporation	,, 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,652,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	Dec. 3	2,066	1,804	+ 252	+10,095	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	Nov. 26	322	327	— 5	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 23	97	126	— 29	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 20	200	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Dec. 3	5,180	4,854	+ 325	+12,053	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 3	1,602	—	—	—	7½	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 26	9,275	9,582	— 307	+13,723	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	Dec. 4	1,429	1,504	— 75	— 1,964h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	Nov. 26	10,737	9,089	+ 648	—	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	Dec. 3	127	119	+ 8	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 1	79	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 3	11,094	10,565	+ 529	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 2	1,559	976	+ 582	+11,507h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 3	102	92	+ 10	+ 1,276	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corpn.	,, 3	3,481	3,341	+ 140	—	45	38½	,, 25	185,027	39,715,120	4,059,907	1·1	10·94	4,111b	—
Newport (Mon.) Corporation	Nov. 26	491	445	+ 46	+ 434	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Dec. 3	1,272	1,201	+ 71	+ 5,683	29	29	,, 31	91,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31g	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 1	384	389	— 5	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 4	4,387	4,055	+ 330	+ 3,405	34½	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 1	733	808	— 74	— 2,271	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	—	—	—	—	—	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 2	371	347	+ 24	+ 7,831	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 4	1,082	1,046	+ 35	+ 972	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	—	—	—	—	—	3¾	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 3	614	569	+ 45	—	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 1	930	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	Nov. 30	642	396	+ 246	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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DESCRIPTION OF ELECTRIC LIGHT AND POWER SCHEMES IN NEW YORK, WITH SPECIAL REFERENCE TO THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.*

BY P. S. SHEARDOWN, MEMBER

New York City, the metropolis of the United States, and the largest and wealthiest city in the Western Hemisphere, is finely situated on the islands and mainland at the mouth of the Hudson River. The population of the city in 1903 was estimated by the United States Census Bureau at 3,716,139. In point of numbers, as well as from a commercial and financial standpoint, the city is second to London alone among the great cities of the world. Although owing to the configuration of State boundaries, certain neighbouring cities, such as Jersey City, Newark, and Paterson, lie in the State of New Jersey, and cannot be reckoned as a part of the city in a political sense, they should, nevertheless, be considered in the metropolitan area, and with this addition the total population is increased to about 4,500,000. New York City is divided into five boroughs.

	Area of miles.	Population in 1900.
Manhattan borough.....	21	1,850,093
Bronx ,, ...	39	200,507
Brooklyn ,, ...	66	1,166 582
Queen's ,, ...	124	152 999
Richmond ,, ...	57	67,021
	307	3,437,202

The borough of Manhattan, which may be called New York proper, comprises the whole of the island of Manhattan. This island is a long narrow strip of land lying nearly north and south. The extreme length of the island is 13½ miles, its breadth varying from ½ to 2½ miles, the total area being 21 miles. It is, of course, this island position of New York which has made land so valuable, and building sites being so costly has brought into existence the skyscraper style of building.

I should like to explain here that except for the old portion of the city, at the extreme south end, the island is laid out quite symmetrically. A commission was appointed in 1807 to lay out the upper streets of the city, and Houston-street was taken as the starting point. It was decided to lay out streets designated by numbers instead of names running east and west, and making 20 to the mile, and to intersect these streets by numbered avenues running north and south, giving seven to the mile. A slight protuberance on the eastern side of Manhattan Island, below Fourteenth-street, was taken care of by short avenues, designated A, B, C, and D. Later on, two additional avenues were added—one to bisect the territory between Fifth and Fourth avenues, called Maddison, and one to bisect the territory between Fourth and Third avenues, called Lexington-avenue. The streets are called "East" or "West," according as they lie east or west of Fifth-avenue. It will thus be understood that a block is a square of buildings bounded on two sides by streets and on the other two sides by avenues. Fourteenth-street is usually taken as making the boundary between up-town and down-town. Down-town, or south of Fourteenth-street, is the commercial or banking and general financial portion of the city; north of Fourteenth-street we come into the shopping, hotel, and theatre quarter; and north of this again we arrive in the more purely residential part. The celebrated Broadway runs more or less diagonally across the island from south to north-west, intersecting most of the avenues and streets.

The electric power stations and systems, which can only be very briefly described in the limits of a short paper, may be divided (A) into those situated on Manhattan Island (area, 21 square miles), and (B) those situated in what may be called the outlying or suburban districts: (A) Power stations and systems on Manhattan Island, the property of (1) New York Edison Company, for the supply of current for public and private lighting, and power for stationary motors, elevators, and fans; (2) the Metropolitan Street Railway Company, for operation of street electric tramcars; (3) the Inter-Borough Rapid Transit Company's Manhattan Railway power station, for operation of overhead electric railway; (4) the Inter-Borough Rapid Transit Company, subway division station, for the operation of electric trains in the new subway. (B) Power stations situated outside Manhattan Island: (5) Edison Electric Illuminating Company, of Brooklyn; (6) Brooklyn Rapid Transit Company; (7) New York Central and Hudson River Railroad Company; (8) New York and Pennsylvania and the Long Island Railroads.

The New York Edison Company and the Waterside Generating Station.

The history of the New York Edison Company is most interesting. They started with and have always kept to a low-pressure direct-current supply network. Originally it was a two-wire, 120-volt system, but is now a three-wire system with 240 volts across the outers. In 1882 they were in possession of the celebrated Pearl-street generating station, which was considered a wonder at the time, and contained six 125-h.p. "Jumbo" generators. Compare this with the new Waterside station of the same company, which has in operation 16 generators, each rated at from 5,500 h.p. to 8,000 h.p., and we are enabled to form some conception of the enormous growth of the business in 20 years. Between these two extremes we have Duane-street station, erected in 1891, with the system of sub-stations by which the city of New York has been supplied. This station is a most interesting one. It was erected before the era of high-potential transmission, and perforce was located near the centre of gravity of the load. Real estate in the heart of the centre of the city of New York City being very expensive, it was necessary to concentrate the power in the smallest space. The form of switchboard first installed in this station, and now in use there and in the other sub-stations throughout the city, is remarkable for its space economy, and was developed by the company's technical staff. In the Vanvleck edgewise system all instruments and regulating switches are read or handled in a vertical plane on the edge of a quarter circle instead of being moved around the face. Besides this station there were numerous other steam generating stations, located in different parts of the system as close as possible to the centre of gravity of the principal portion of the network that it was intended to supply, but owing to the fact that in New York and other large cities the heaviest load in the business section occurs at a different time from the peak load in the theatre and residence section, it would evidently be a most desirable and economical arrangement to have the stations in these districts so connected that each could help the other, utilising the capacity of the generating equipment to the best advantage. This result was attained before the completion of the Waterside station by installing rotary converters and static transformers in Duane-street and the various sub-stations. A net efficiency of over 82 per cent. from direct current to direct current is obtained, and now that Waterside station is in operation the apparatus already installed in the sub-stations is used to transform from high-tension alternating to low-tension direct.

It became evident several years ago that even with this system of mutual help the time was soon coming when the full capacity of the various stations would be inadequate to supply the demands of a rapidly increasing number of consumers; and the multiplication of generating stations being undesirable, plans were drawn for a new station where practically all the current used by the company could be generated, the various stations throughout the city being retained as rotary converter sub-stations. The Waterside station, equipped with the most modern and economical plant, now generates the bulk of the current used on the system, the larger Edison stations—Duane, Twelfth, and Twenty-sixth streets—being used as distributing stations, and as supplementary generating stations during the period of heavy load in the winter months. Some of the less important stations — Vandam, Thirty-ninth, and Fifty-third streets—equipped with less economical generating apparatus, will have their generating equipment removed and will serve as distributing centres. Storage batteries located at all the important distributing centres, in addition to acting as a reserve, will also be used to eliminate the peaks from the local demand, so that the load on the Waterside station will be almost constant during the 24 hours. By utilising the more important generating plants during the months of heavy demand, the larger generating apparatus already installed is used to advantage, additional new investment being saved, which would otherwise be necessary to take care of this capacity.

We notice, then, that in new work the original system of distribution is a direct-current low-pressure one. In the old days, before the development of high-pressure transmission, the feeding of this system was direct current and at low pressure, and under these conditions the economy of having a station located close to the waterside, where rent was low, coal could be obtained cheaply, and the steam plant run condensing, had to be sacrificed because the capital involved in the outlay on copper of low-tension feeders would be a still more costly matter. With the development of the high-pressure three-phase method of distribution it is now possible to have the advantage of a low-pressure network fed economically from a distance by high-pressure currents generated in a station which can be located in a position where the greatest economy in generation can be obtained.

There is, of course, a certain amount of loss, both in capital outlay and in distribution, by using an alternating-current transmission and a direct-current system of distribution, which necessitates practically a double outlay on electric generating machinery, owing to the fact that rotary converters or motor-generators have to be employed at the sub-stations, these also requiring more expense in the way of attendance than if alternating current is used all through. This matter was carefully considered by the Edison Company, who remark in one of their interesting publications: "The arc lamp may be used upon

* Paper read before the Dublin Section of the Institution of Electrical Engineers.

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direct or alternating circuits provided the frequency is not less than 40-50 cycles, and although the New York Edison Company has found that satisfactory commercial service can be obtained from alternating-current arcs on ordinary circuits, direct-current lamps are considered, on the whole, somewhat more efficient and reliable. For general industrial use the alternating-current motor, particularly that of the induction type, has reached a stage of perfection making it in every way the peer of the direct-current motor, the absence of commutator and brushes constituting a prime element of simplicity and ready maintenance, although involving a higher first cost. Though constant-speed motors may be designed to operate with satisfaction on alternating currents, yet the direct-current motor is decidedly superior where intermittent service or variable speed is required. As a considerable part of the power used in large American cities is required for elevators and machinery running at variable speed, it becomes almost obligatory to furnish direct current to satisfy this demand. After a careful consideration, therefore, of all the local conditions, the character of the large existing stations, sub-stations, and underground system, the territory to be covered, the present and prospective business, the broadening nature of the electrical industry, and other features none the less perplexing because less indefinite in engineering outline, it was decided to build a large central station generating high-potential alternating-current transmission to sub-stations, and after passing through static transformers and rotary converters to be fed as direct current into the usual low-tension three-wire network. In deciding upon the location of such a central station, the general rule that it shall be located as nearly as possible at the centre of gravity of the system is often modified by the cost of land, availability of water supply, coaling facilities, and various local considerations. The Waterside station of the New York Edison Company is admirably situated to satisfy all these requirements."

There is one other advantage not mentioned in the above statement by the Edison Company which the direct-current network has over the alternating-current network, which is, that storage batteries can be located in the sub-stations, which enable a splendid load factor to be obtained at the generating station, and also give a large reserve of power in case of sudden darkness caused by fog, etc.

THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.

The buildings of this station are located on First-avenue, covering the block between Thirty-eighth and Thirty-ninth streets, and running to the East River, an area of 272½ft. long by 76ft. wide. The boiler-house is 276ft. long by 76ft. wide, and is separated by a massive brick wall from the main generating room, which is the same length, but 115ft. wide.

Coal-Handling Equipment.—The coal is entirely handled mechanically by means of grab, bucket, and conveyors. The coal is lifted from the hold of the colliers and distributed into the bunkers over the boilers, which have a capacity of 10,000 tons, or sufficient for two weeks' supply. To avoid the possibility of interruption in the coal supply, very large storage capacity has been provided. Labour questions at the mines or on the railroads, or storm blockades in transportation over the railroads, the water, or the city's streets are possible causes of interruption. To avoid these, at each step in its growth the company has made what seemed to be adequate provision for coal storage. Consequently, in 1903, a large tract of land known as Shadyside, on the New Jersey shore of the Hudson River, opposite the Grant Monument on Riverside Drive, Manhattan, was purchased and thoroughly equipped with coal-handling machinery. Coal may be delivered on the property by either boat or rail, and automatically placed in the storage piles. In the station, buckets or endless chains lift the coal to the bunkers on the upper floors, and it is delivered at the doors of the boilers by gravity. In this storage yard it is lifted on enormous trusses, and by gravity takes place on the pile, where it remains until needed for use.

Boilers.—There are 56 boilers of the water-tube type, each 18ft. long, with 6,500 square feet of heating surface, and rated at 650 h.p. As the engines require only 12·5lb. of steam per indicated horse-power, the boilers easily develop enough steam to meet all their requirements. As divided, there are 28 boilers on each floor, standing in two rows, in batteries of two each, facing an aisle 30ft. wide. They are designed for 225lb., and now operate at 176lb. pressure per square inch. There is a complete installation of blowers of large capacity for forced draught, and 20 of the boilers are provided with automatic stokers with the necessary auxiliary apparatus for their operation. The remainder, in which anthracite coal is used exclusively, are fired by hand.

Engines.—It was intended originally to instal 16 engines of the vertical marine type, three-crank, with one high and two low pressure cylinders. The development of the steam-turbine in the larger units has made it seem desirable to modify these plans somewhat, and 11 only are so far erected. The balance of the equipment will consist of turbines and their auxiliary apparatus. With 175lb. of steam pressure at the throttle, 27in. of vacuum, and 75 revolutions per minute, at the most economical load the engines indicate between 5,200 h.p. and 5,500 h.p. They are capable, however, of a sustained load of 8,000 h.p., and of an ultimate capacity at the maximum cut-off of five-eighths of the stroke of 10,000 h.p. The load or speed of any engine when running in multiple can be varied by the adjustment of the governor mechanism by an electric motor controlled from the operating gallery. Each engine has a surface condenser of the Worthington type with a cooling surface of 9,200ft.

Steam-Turbines.—Turbines of the Curtis type, manufactured by the General Electric Company, each having a capacity of 5,000 kw., are now in course of installation, and will be in service in time to assist this winter. The first turbine is of the two-stage type, with eight rows of revolving blades and six rows of guide blades, divided equally between the stages. The second and third turbines will be of the four-stage variety, having four sets of expanding nozzles and four revolving units, each unit containing two lines of blades, with one line of guide blades between them. In the first type the steam is partially expanded at the first set of nozzles, flows through the four revolving blades and three guide blades of the first wheel, and expansion is then finished in the nozzles between the stages. The steam then passes through the four revolving blades and three guide blades of the second stage into the exhaust chamber in the base of the turbine, and from there passes into the condenser, standing beside the turbine and of about the same height.

Generators.—Directly connected to the engines, the generators are of the revolving-field type. They are rated for continuous operation at 3,500 kw., and for short periods are capable of sustaining an overload which is limited only by the capacity of the engine. Three-phase current at 6,600 volts is generated at a frequency of 25 cycles per second. By test, the actual efficiency for one-quarter overload is 97·2 per cent.; full load, 97 per cent.; three-quarter, 96½ per cent.; and half-load, 95½ per cent. The regulation is such that if the full load be suddenly thrown off, the rise in the voltage of the generator will not exceed 8 per cent.

Field Excitation.—Each exciter set, of which there are three in the station and a fourth in course of installation, consists of a 225-h.p., 6,600-volt three-phase induction motor, directly connected to a 150-kw. direct-current four-pole generator giving a potential of 200 to 280 volts. A storage battery, occupying the vault on the Thirty-eighth-street side of the building, ensures absolutely continuity in the exciting current. The battery alone is capable of exciting the fields of 16 generators for one hour.

The Switchboard.—The controlling, indicating, and recording features of the electrical equipment of the station are confined to a series of galleries occupying the entire westerly end of the structure. The general switching arrangement in this station, which is typical of American modern high tension, is most elaborate and carefully planned out, the following conditions being carefully attended to: (*a*) that each switch shall be located in a fireproof chamber by itself so as to obviate any risk of fire; (*b*) to so separate all switches and high-tension cables leading thereto that if by chance a fire should occur on any part it will be impossible for it to incapacitate any other part of the plant; (*c*) that there shall be ample room to get at any part of the switching apparatus; (*d*) to arrange that in case of one piece of switchgear getting out of order that this shall not interfere with the operation of the unit with which it is connected; (*e*) that as far as possible there shall be a duplicate method of feeding from point to point.

It is obvious in dealing with plant of the size contained in a modern power station that this cannot be controlled in the old way, where all leads and connections are brought to one switchboard and operated by switches fixed thereto. In the station now being described, the high-tension switches are contained in separate brick or other incombustible chambers, and thus we have in the station four galleries, on each of which are situated rows of these brick chambers, each containing a three-phase oil-break switch. On the top of each chamber is located a small series motor which operates the oil switch, and is itself operated by a low-pressure current. The leads from all these small motors are carried back to a controlling board, on which are mounted close together and in a most compact space the small switches for operating the small currents at low potential which operate the main switch motors. By this means the control of a huge station can be brought to quite a small board, usually arranged in the form of a flat table.

The general lay-out of the arrangement for the control of each generator and cable is as follows: The main cables from each three-phase generator are brought first to a three-phase, oil-break, motor-operated switch, the cables being so arranged that they are kept perfectly separate from the cables of any other generator or feeder. This main oil-break switch is situated on the first gallery above the ground floor. From here the machine cables run to the fourth gallery, where they are connected into what is known as the selector oil-break switch. This is a similar type of switch to the main switch, but is

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arranged so that the machine can be thrown by it on to either the main 'bus bars or on an auxiliary set of 'bus bars. Each feeder cable on entering the station is brought first to an oil-break switch motor, operated and also equipped with a relay, which enables the switch to be used as a circuit breaker, automatically opening the circuit at any predetermined limit of current. From this it passes straight up to a second oil-break switch similar to the first, but not arranged as an automatic breaker. The object of having two switches in series is to be able to disconnect a cable even if one of the switches becomes inoperative. From the top of the second switch the leads pass through what is known as the feeder selector switch, which enables each cable to be connected to either the main or auxiliary 'bus bar. The controlling board which operates these switch motors contains small double-throw switches. Throwing the switch in one direction closes the main oil switch and in the other direction opens same, a small red lamp showing bright when the oil switch closes and a green one being lighted up when it is opened. If for any cause the oil switch does not respond when its controlling switch is operated, the lamps indicate same to the engineer of board. Not only are the oil switches operated from this controlling board, but the governors of the engines are also operated by motors, the control of which is brought to the same board, so that the engineer in charge has the operation of the whole station under his command at this control board.

The three-phase 25-cycle current at 6,600 volts generated at the Waterside station is distributed to the various rotary converter sub-stations by underground cable feeders following four distinct trunk lines of subway ducts. The size of the cables used for feeders has been selected to secure the best utilisation of a 3in. duct, the size generally used by the Subway Company, through whose ducts much of the cable is laid. To fill these conditions the standard copper section was adopted of 250,000cm. sectional area for each of the three conductors. The company is now operating about 41 miles of rubber-insulated cables and 28 miles of paper-insulated 6,600-volt cables. The company has now in operation 16 rotary converter sub-stations on Manhattan Island. In several of these sub-stations the rotary converters are operated in connection with existing steam plants; in others rotary converters only are operated. In each of the latter, as well as in several of the former, there are one or more storage batteries, of which mention will be made later.

Of the existing generating stations, only the Duane, Twelfth, and Twenty-sixth streets stations are operated as combined steam and rotary sub-stations, their existing steam plants being utilised as generating stations supplementary to the Waterside station during the period of heavy loads in the winter months. All the other stations will finally be exclusively rotary converter sub-stations.

The Sub-Distributing Stations.—The typical equipment of a rotary converter sub-station is: (1) high-tension switchboard for high-tension feeders and rotary converter machine panels; (2) air-blast static transformer; (3) low-tension alternating-current switchboard for the operating of rotary converters; (4) rotary converter I.R.T. regulators; (5) rotary converters; (6) low-tension direct-current switchboard and 'buses with instruments and synchronisers; (7) storage battery and booster set; (8) compensating for balancing loads on three-wire system; (9) low-tension feeder panels. The course of the current through one of the sub-stations is as follows: Coming into the station on the high-tension three-conductor cable feeder as three-phase, 6,600-volt, 25-cycle alternating current, it passes through the high-tension feeder panels. From the high-tension machine panels connections are made by duplex cables to the high-tension primaries of the static transformers; the secondaries are connected through alternating-current switches to an I.R.T. regulator and then to the alternating-current collector rings of the rotary converter. The direct-current terminals of the rotary converter are wired to the positive and negative switches of the machine, which can be connected to three sets of 'bus bars supplying current to the low-tension direct-current feeders. The rotary converters are all built for a normal potential of 270 volts, which can be raised or lowered 30 volts by the I.R.T. regulators, and the unbalancing of the station load between the two sides of the system is taken care of by the storage battery and a compensator.

The reason for the employment of three sets of 'bus bars is because the company have only one standard size of low-tension feeder cable, which is of an area of 1,000,000cm., as the length of these cables between the sub-stations' 'bus bars and the point at which they feed the network vary considerably. If they were all supplied at the same electrical pressure the short feeders would be overloaded, and the ones feeding to a distance would supply the network there at a low pressure. Consequently, in each sub-station there are three sets of 'bus bars, each set at a slightly higher potential than the one below, and the cables can be connected as required to either of the three sets of 'bus bars according to the load which it has to carry. The different voltages of these three sets of 'bus bars are also useful for the charging and discharging of the accumulators, the arrangement at peak load usually being that the accumulators are discharging through the lowest pressure set of bars which feed the shortest feeders. The bulk of the generating machines are connected to the middle set of 'bus bars, a few machines being connected to the higher set of 'bus bars, to which are connected the extra long feeders. On a large system like this the arrangement of having only one size of low-pressure and one set of high-pressure feeder cables illustrates well the length to which American organisation will go in order to have standardisation and simplicity wherever possible.

Static Transformers.—The static transformers are all of the air-blast type, and are in sets of three 200-kw. and three 400-kw. respectively for 500-kw. and 1,000-kw. rotary converters. They are mounted on a platform constituting the air-duct for ventilation under an air pressure of ½oz. to ¾oz. supplied by electric blowers installed at one or both ends of the platform. The primary and secondary transformers are wound for a ratio of transformation of 6,300 to 170 volts, but other ratios may be obtained by connecting to intermediate taps to compensate for drop on feeders of different lengths and to facilitate adjustment of alternating-current voltage to direct-current voltage required. In the later transformers a thermometer is mounted in a casing between transformer coils to give temperature indications.

I.R.T. Regulators.—The secondaries of the induction regulators are connected in series between the electrically-operated switches and the alternating-current collector rings of the rotary. The potential or primary windings of the regulators are connected across the secondaries. The primary windings are wound on the rotor of the regulator, which can be turned through a fixed angle in either direction by a small direct-current motor or induction motor controlled from the operating switchboard. The I.R.T. regulators of General Electric and Westinghouse make have 65 kw. capacity for 500-kw. rotaries and 130 kw. capacity for the 1,000-kw. rotaries.

Rotaries.—The rotaries are six-phase and of two sizes, 1,000 kw. and 500 kw. rated capacity. The 1,000-kw. rotaries are 270-volt direct current, 187½ revolutions per minute; the 500-kw. rotaries are either six-phase 270-volt direct-current, 375 revolutions per minute, or six-phase 300-volt direct-current, 375 revolutions per minute. The latter type are equipped with 130-kw. I.R.T. regulators, by means of which the rotary can be operated between the range of 240 to 360 volts direct current, the higher voltage being required in the up-town sub-stations owing to the length of low-tension feeders. The overload capacity of the rotaries is liberal; they are designed to carry 25 per cent. overload for three hours after carrying continuously full rated load, or 50 per cent. overload for one hour. The efficiency of the rotary converters is high. In the case of 1,000-kw. converters an efficiency of 96 per cent. and in the 500-kw. 95¾ per cent. has been obtained. The rotary converters were supplied by the General Electric Company and the Westinghouse Company.

Storage Batteries, Boosters, and Compensators.—Storage batteries are installed at nearly all the stations from which current is distributed, and they perform at least three important functions: (1) they ensure continuity of the service; (2) they smooth out the irregularities of the local demand; (3) they assist in the regulation of the system. The standard battery used contains 150 cells, 75 between the neutral and each outside wire. Each cell has a capacity of 2,000 ampere-hours at a one-hour rate, 3,000 ampere-hours at a three-hour rate, 4,000 ampere-hours at a 10-hour rate.

Low-Tension Feeders and Mains.—The feeders and mains are all underground, and are connected in a continuous network on the Edison three-wire system, 2×120 volts at the customers service. For feeders the company has adopted a lead-covered, paper-insulated, two-conductor, concentric cable, with a copper section of 1,000,000cm. for each conductor, and provided with six pressure wires. The common neutral system is used as a general neutral serving for all feeders, and connecting with a neutral main at every block.

Currents Generated.—For all the company's generating stations the maximum load on Manhattan Island during 1903 was 359,460 amperes, which at the average station pressure of 140 volts equalled 50,600 kw. It is expected that the Manhattan Island maximum of 1904 will approximate 425,000 amperes at 140 volts. The output of the generating stations on Manhattan Island during 1903 aggregated 131,000,000 kilowatt-hours. The ratio of maximum load to connected installation was 36·6 per cent., a percentage which has been decreasing from year to year with increased concentration in the generation of current and greater diversity in the purposes for which it has been employed. The average load on the Waterside station for the maximum day of 1903 (Dec. 24) was 21,535 kw., a load factor of 56 per cent. of the 24-hour capacity; the average for the month of December was 18,059 kw., 47 per cent. of the capacity.

Installations Supplied.—Current is supplied through more than 42,000 meters to installations aggregating 1,507,342 incandescent lamps, 19,386 arc lamps, 85,072 h.p. in motors, and 2,000 kw. in customers' storage batteries, heating, and cooking

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appliances and experimental apparatus. Of the arc lamps, 3,126 are supplied for the municipality. The aggregate of these installations is the equivalent of 2,955,214 lamps of 16 candles, each averaging 50 watts.

Prices.—Current is sold to the public under several schedules, the one selected in each instance being that which offers to the customer the best arrangement that can be made. The price varies only between given classes. One cannot obtain a price better than another's in the class, and to get in any class it is only necessary to comply with the conditions that control it, which are alike to all. To the smaller customers current is sold under a retail contract, in which the maximum price is 15 cents a kilowatt-hour, falling as the average use of the installation increases; thus it is 10 cents for the third and fourth hours of average use, 7½ cents for the fifth and sixth hours, and five cents a kilowatt-hour for all use in excess of six hours daily. The larger installations are supplied under wholesale contracts, which, through the medium of guarantees, ensuring a relatively large consumption of current, offer marked reductions from the prices of the retail schedule. Thus, on what is known as the wholesale "A" form, a customer guarantees a monthly use of current amounting to 2,000 kilowatt-hours, and a daily average use of the installation of two hours, for 10 months of the year, and the maximum price is reduced to 10 cents a kilowatt-hour. For all current in excess of four hours' daily average use of the installation, the price is reduced to five cents a kilowatt-hour. There is also a second wholesale form of contract, which deals with customers taking a still larger quantity of power; and there is a third form of wholesale contract, which was developed in order to get on to the supply mains, many of the huge blocks and buildings which have hitherto been supplied with current by their own private lighting plant. This schedule is for customers taking supplies of from 10,000 units per month for 12 months in the year, when the maximum charge is five cents per unit, which is reduced to three cents per unit for current in excess of 50,000 units per month per year. For these wholesale contracts the consumer has to supply space free for the installation of a high-tension sub-station by the company.

Incandescent Lamps.—Experience has shown that where customers who are not informed technically purchase incandescent lamps upon the open market their standards of lighting diminish materially, causing not only dissatisfaction to the immediate user, but a very poor opinion generally on the part of prospective users. For this reason the company requires that all retail customers shall permit it to supply incandescent lamps, including them within the price for current. The wholesale customers in the private plant class, however, have the option of purchasing incandescent lamps either from the company or elsewhere, and when this option is exercised a special reduction of one cent per kilowatt-hour is made.

Metropolitan Street Railway of New York.

As is well known, the electric tramways in the Manhattan Island, New York, are operated on the conduit system, although there are still to be seen in New York a number of short lines operated by horses, the expense of constructing the conduit not being warranted by the traffic on these lines. The company work electrically the equivalent of 200 miles of single track, and to produce the necessary power for operating the 2,000 cars on the daily schedule (over 3,000 cars are owned by the company) there are two power stations, one known as the Ninety-sixth-street and the other as Two hundred and eighteenth-street stations. The Ninety-sixth-street station contains 11 6,600-volt 3,500-kw. three-phase 25-cycle generators. These generators are driven by vertical cross-compound condensing engines. Steam is furnished to the engines by 80 boilers, nominally rated at 250 h.p. each. The output has been in times of heaviest load (which occurs about Christmas) as high as 575,000 kilowatt-hours per day. The output during the maximum hours of the day has frequently gone as high as 36,000 kw., or about the nominal load for the 11 generating units. The coal consumption at this power station is stated to be about 2·8lb. of coal per kilowatt-hour, and the total output of the station for the year ending Dec. 31 last was 149 million units. The Kingsbridge or Two hundred and eighteenth-street power station supplies current to the two northern sub-stations on Manhattan Island, to the borough of the Bronx, and to the sub-station at Mount Vernon and Yonkers. The arrangement at this station follows the same general plan as the Ninety-sixth-street power station, the generating unit being eight in number and of the same size as those just described. This station is not at present and never has been fully loaded. The three-phase current is distributed to rotary converter sub-stations located throughout the city, the general arrangements with regard to switchboard distribution and sub-station equipment being practically of the standard type as already described in the Edison station.

Electrical Equipment of the Inter-Borough Rapid Transit Company.

Manhattan Island Railway Division.—The Inter-Borough Rapid Transit Company have leased all the elevated railways now in operation in Manhattan Island and in the borough of the Bronx. The rolling-stock required is over 1,500 cars, and during the hours of heavy traffic 1,332 of these cars are in service on the road. About 85,000 passengers are carried each day, the heaviest passenger load on record being 1,063,000 passengers carried on April 4 this year. The trains were formerly operated by steam locomotives, but are now worked by electric cars on the General Electric Sprague system of multiple-unit control. The power station for operating this system is equipped with eight Allis-Chalmers engines, each of 8,000 h.p., and which are each directly connected to a 5,000-kw., three-phase, 11,000-volt, 25-cycle generator, but the alternators, and also the engines, are designed to carry an overload of 50 per cent. for two hours, and in service they are frequently loaded up to this amount for short spaces of time. The eight alternators have delivered to the line from 40,000 kw. to 47,000 kw., and, at the same time, an additional 500 kw. to 6,000 kw. was being supplied by the Kingsbridge station of the Street Railway Company. In order to meet the increased demand for power, a 5,500-kw. alternator, driven by a Parsons steam-turbine, is soon to be installed. The 11,000-volt alternating current is transmitted to seven rotary converter sub-stations, the general arrangements being similar to those already described, with the exception that the high-tension gear is designed to deal with 11,000 volts current. The General Electric form H oil switch is used throughout, and it is stated that, under most severe conditions in service, it has opened the 11,000-volt circuits without trouble of any kind.

Subway Division.—As well as operating the elevated railways of Manhattan, the Inter-Borough Company has just constructed at huge expense a subway totalling a length of about 20 miles, or equivalent to 63 miles of single track, of which a small portion at either end is elevated. On part of the route there are four tracks, so as to enable the operation of express and local services. This subway is in no way a deep-level tube, as in London, but is immediately under the surface of the road. The service is just now opened, and when thoroughly organised it is estimated that the combined express and local services will require 700 cars, and the power required when the maximum number of trains are on the line is estimated to be 52,300 kw. The power station is located on the North River, between Fifty-eighth and Fifty-ninth streets. It is designed to contain 11 5,000-kw. engine-driven alternators, which will furnish power for the subway cars, and four 2,500-kw. turbine-driven alternators for the supply of light in the subway. The station differs from all other large power stations in New York in the arrangement of the boilers, which are all on one floor, placed in two rows, with centre fire aisle. Six brick stacks will eventually be erected, although at the present time only four are built. The stacks are 15ft. inside diameter and 225ft. above the grates. The nine Allis-Chalmers engines ordered are of the same type as those in the Manhattan elevated train section, consisting of two horizontal high-pressure cylinders, each 42in. in diameter, and two vertical low-pressure cylinders, each of 86in. diameter. Each engine is rated at 7,500 i.h.p., and when operating at best efficiency the guaranteed steam consumption is 12·25lb. of dry steam per indicated horse-power. The 11,000-volt three-phase alternator is mounted on the main shaft, between the main bearings of which there are only two, as the high and low pressure connecting rod on each side are connected to the same crankpin. Fuel economisers will be installed, and most of the boilers are hand fired. The alternators are of the Westinghouse make, and rated at 5,000 kw. The armature windings differ in design from those of the Manhattan engines, the conductors being formed in U-shape coils, which are slipped through the partially closed slots from both sides of the armature; the ends of the U-shaped conductors are bent and soldered together, forming closed coils, the ends of which are connected to other similar coils. There are eight sub-stations located—four on the main line and two on each branch—at an average distance apart of 12,000ft. Foundations are provided for eight 1,500-kw. rotary converters in each station, and the transformers are air cooled by forced draught.

(To be continued.)

Brisbane.—Tenders are invited by the Deputy Postmaster-General for the supply and delivery at the Telegraph Office Yard, Thursday Island, of 100 tubular wrought-iron telegraph poles to Specification No. 11 and Schedule No. 51, and also for the supply and delivery at the cable tanks, Thursday Island, of three nauts of submarine cable to Commonwealth Specification No. 8 (Queensland, No. 22) and Schedule No. 50. Tenders by Dec. 12. They must state the time required for delivery; this time will be counted from the date of the notification of the acceptance of the tender. Specifications and forms of tender can be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, and Adelaide. Neither the lowest nor any tender will necessarily be accepted. Tenderers are required to note that Customs' duties must be included in all charges, as per clause 2 of the general conditions. All tenders sent by post must be registered.

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NOTES.

The Institution.—At last week's meeting the President stated that he thought the proceedings of the Institution should terminate, as nearly as possible, by 9.30, in justice to the staff of the Institution of Civil Engineers.

The McMillan Fund.—We are pleased to learn that, owing in a large measure to Mr. W. H. Patchell's vigorous appeal at the Institution dinner, this fund has now realised the £2,000 which the committee always hoped to attain. This generous response of the members on behalf of the late secretary's family is a matter for congratulation.

Right of Way.—The Supreme Court of the United States has decided in favour of the Pennsylvania Railroad, a case involving the right of that company to remove poles belonging to the Western Union Telegraph Company from its right of way. The court held that the Congressional Act of 1886 does not grant an "eminent domain" to telegraph companies over the private property of railroad companies.

Scientific Education.—The new science buildings connected with King's School, Grantham, which have been erected at a cost of £16,000, were opened last week by Sir Oliver Lodge, principal of the Birmingham University. Sir Oliver, in his address, said he would like to see the control of education more localised, as he considered that the Board of Education was overburdened. Scientific education had great possibilities, but to some extent was on its trial, and it rested with the boys of to-day to establish it.

Wireless Telegraphy.—In order to obtain better results, and to foster the wireless telegraphic industry in that country, the firm of Siemens and Halske in Russia is developing the Popoff system in conjunction with the Gesellschaft Drahtlose Telegraphie. It is anticipated that the experience gained with the various systems in Germany will enable the undertakers to bring the Russian system up to the modern standard. It is reported that the wireless telegraphy station at Bari (Italy) has received 400 words from Poldhu (Cornwall) in half an hour. The experiments are being continued with very satisfactory results.

What is a Workman?—This oft-asked question was submitted to the Bournemouth magistrates on Wednesday, when a journeyman butcher was charged with using a workman's ticket in contravention of the local tramway by-laws. The bench held that the defendant was not a "workman," and imposed a small penalty. The usual definition of a "workman" is one engaged in manual labour, but this interpretation is not rigidly adhered to at all places. In some cases a part of a man's duties are of a manual character, which rather complicates matters. Would not the simplest solution of the controversy about ill-remunerated clerks being charged full fare, while well-paid foremen have the benefit of the reduced rate, be to make cheap travelling the reward of early rising irrespective of occupation? This is the practice on the Central London Railway, where prince or peasant can have the advantage of the cheap rate by using the early morning trains.

Personal.—Our sincerest sympathy is with Mr. C. J. Sutherland, who, on the ground of ill-health, has just resigned his position of electrical engineer to the Worcester City Council. At the meeting of the Council last week the members were unanimous in their expressions of regret, and some enthusiastic tributes were paid to the admirable manner in which Mr. Sutherland had performed his duties. The chairman of the Electricity Committee said that he had always acted fearlessly and faithfully, and the advice he had given to the Council was of the soundest. Alderman Millington said that Mr. Sutherland was one of the best officials he had ever come into contact with. We echo the chairman's regret that the resignation should be due to such a cause, but trust that the complete abstinence from work which has been ordered by his medical adviser, and perhaps a change of climate, will result in Mr. Sutherland enjoying many years of well-earned relaxation. It is gratifying to hear that the last few days have witnessed an improvement in his health.

Another Tramway Association.—There are already in existence three associations in connection with tramways and light railways, and the general consensus of opinion seemed to be that the number should be reduced rather than enlarged. A fourth has, however, recently made its appearance, but its *raison d'être* is explained by the fact that its operations will relate solely to the affairs of the Metropolis and its environs. The Metropolitan Association of Electric Tramway Managers, as the new institution is designated, was decided upon at a meeting of tramway managers held at the Municipal and County Club. The membership area will cover the county of London, Croydon, Bexley, Erith, West Ham, East Ham, Ilford, Barking, Leyton, Walthamstow, South Middlesex, and other districts in close proximity to London where electric tramways are being developed, either by municipalities or companies. Mr. A. L. C. Fell, chief officer of the London County Council tramways, was elected chairman, and Mr. H. E. Blain, tramways manager, West Ham Corporation, hon. secretary.

The Pacific Cable Conference.—It is announced that the Pacific Cable Conference, which was to have met at the Colonial Office last month, has been postponed owing to the fact that the Canadian Postmaster-General is unable to be in England at present on account of the elections and other matters. So far the Canadian Government has not indicated a date on which the Dominion delegate will be able to come to London, but the Pacific Cable Board, as well as the delegates to the conference, are anxious for the conference to meet as soon as possible, and it is hoped that it will assemble at an early date. The delegates to the conference appointed by the contributing governments are: the Secretary of State for the Colonies, president; Sir William Mulock, Canada; Sir Sandford Fleming, New Zealand; and Lord Jersey, the Australian Commonwealth. Sir Sandford Fleming, who is in Canada, has been collecting information for presentation at the conference. Lord Massy has joined the Pacific Board as one of the representatives for Australia, in succession to Sir Horace Tozer, who has resigned his post owing to his return to Queensland.

Speed Limits.—From time to time the anomaly in regard to the speed limits for trams and motorcars respectively has been the subject of comment, and now the Tramways and Light Railways Association have made cogent representations to the Board of Trade. It is scarcely apparent why trams running on a well-defined track, and for the public convenience, should be restricted to an average of something like eight miles an hour, while owners of motorcars may in general career along at between double and treble that pace. This disparity, however, is due rather to the ultra-cautious policy which places such limits upon the speed of trams than to excessive latitude in the case of the motorist, because, as the association point out, a higher speed is now practicable for road traffic, with due regard to the public safety, than was formerly considered desirable. The association submit that the Board should, therefore, adopt a standard uniform with that of the motorcar, and sanction a general limit of 20 miles an hour, reservations being made for special cases. This is certainly a pretty big jump, and may savour somewhat of the hustling

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tactics of New York. If, however, this be considered too radical a change, tentative increases of, say, 20 per cent. in urban and something up to 50 per cent. in rural districts might be tried.

Birmingham Electric Club.—A large number of members assembled at the first meeting of this new institution on Saturday night at the Colonnade Hotel, Mr. J. J. Inniss presiding. In his inaugural address Mr. Inniss pointed to the great possibilities of the club, and said it was essential that the standard of the aspirations of the members should be raised as high as possible, having regard to the advance, educationally, which has taken place during recent years in Birmingham. As the club membership included all departments of the electrical profession, he hoped that the papers to be read at the meetings would be as practicable as possible. Like other professions, that of the electrical engineer was somewhat crowded in some of its departments, but there were satisfactory openings for good men, such as designers of machines, as at present some of the large firms had to go abroad for their chief designers. There were also great possibilities in other directions, and in support of this he reviewed the advance that has taken place during the past decade in the various branches of the electrical industry. We are happy to see that this new organisation has been launched under such favourable auspices, but we sincerely trust that it will refrain from duplicating the work of the Birmingham Section of the Institution of Electrical Engineers, and devote itself rather to the social side, in which sphere it should have a distinct future.

The Dolter Surface-Contact System.—We note that a trial has been given to the Dolter surface-contact system in Dresden, over a section of track between 300 and 400 yards long. An old accumulator car was converted for the purposes of the experiment, and it is an interesting fact that this car has a wheel base of only 1·75m., despite which no difficulty was found in mounting the electromagnets used to actuate the contact studs. There is a short break in the continuity of the current supply as the car is approaching or leaving the section, during which a 12-volt osmium lamp serves for illumination at night, being run off the accumulators installed as a reserve for energising the electromagnets. Since the trials, extending over some four months, have been satisfactory, the authorities are retaining the system, and have granted a concession for the regular service of the converted car between Blasewitz and Tolkewitz It has also been decided to adopt the Dolter system on some of the routes at present served by accumulator cars. Thus Dresden, which long boasted of three distinct systems of electric traction, has now added a fourth, the overhead trolley, conduit, accumulator, and surface-contact systems being all represented on a practical scale within its borders.

Tramway Electrical Equipment.—The *Official Circular* of the Tramways and Light Railways Association contains the model description issued by the Board of Trade for the electrical equipment of tramways or light railways on the overhead trolley system: "Power will be supplied at from 500 to 550 volts through underground feeders to hard-drawn trolley wires —— S.W.G. The feeders will be lead covered, laid in troughing, filled in solid with composition, and covered with hard-burned tiles or other suitable protection, or will be drawn into earthenware ducts. Swivel trolley heads will be used, and the trolley wire will be in general at a height of about 21ft., and at a distance horizontally of from 4ft. to 5ft. from the centre of the track. The trolley wires will be flexibly suspended from brackets fixed to tubular poles, or in some cases from span wires fastened to poles or to the walls of houses by suitable means, and in such a way as to provide for double insulation throughout between the trolley wires and earth. The bracket arms will have an average length of — ft., and will in no case exceed — ft. in length. Section switches will be provided at every half-mile, either in pillar boxes, or in boxes attached to the poles or to houses. Feeder switches will be provided in pillar boxes, and all pillar boxes will be arranged to prevent explosion of gas accumulating in them, or in ducts connected with them." The Board of Trade have also issued a plan on a scale of 6in. to one mile giving a typical diagram of the feeders, feeding points, return feeders, earth-plates, and pilot wire points.

The Electrical Engineers (R.E.).—The annual dinner of the non-commissioned officers' mess was held at Anderton's Hotel on Saturday, C.S.M. Marshall in the chair. An excellent attendance, including several officers, assembled, very few vacant chairs being noticeable. There were some half a dozen toasts, and a number of capital speeches were made. C.S.M. Marshall, in giving "The Officers," alluded to their admirable technical qualifications, which included the ability to run a dynamo and still keep the belting on! Captains Rosenthal and O'Shaughnessy replied, the latter paying a warm tribute to the N.C.O.'s as "the backbone" of the force. Q.M.S. Applebee gave "The Permanent Staff," which was responded to by the adjutant (Captain Dumble), C.S.M. Wiltshire (who is leaving the corps amid mutual regrets after completing his term of service), Sergeant Riley, and Sergeant Bufton (who expressly disclaimed the gift of oratory). The toast of "The Visitors" was responded to by Q.M.S. Logley (R.G.A.), Sergeant Sheer (of the 1st Middlesex R.E.), and Mr. Tucker. Lieutenant Shepherd proposed "The N.C.O.'s Mess," and expressed the belief that the new system of company formation would prove a great advantage, Sergeant Matthews and others responding. Finally, Sergeant Bird gave "The Press," and doubtless said some very agreeable things, but the mirth prevented all his remarks from being audible at the Press table. C.S.M. Marshall was a most genial chairman and ready spokesman, and mention should not be omitted of the several entertainers, some of whom were exceedingly humorous.

The New York Subway.—Despite the objections raised by some physicians to the hygienic conditions of the New York Underground, the service appears to have given pretty general satisfaction, and some influential members of the medical profession have voluntarily undertaken the task of rebutting the views of their professional brethren. The feature that appeals most strongly to the down-town business man and the theatre-goer is the system of express trains, in which the operating company has fully redeemed its promise of a 15 minutes' service to Harlem. These trains have hitherto been run under a four-minute headway, but now that the east side branch of the road has been opened, the expresses will be run under a two-minute headway as far as the junction at Ninety-sixth-street, and a four-minute headway upon the two branches of the road from that point to their respective termini. There are two features in particular that mark the road as constructed on the most up-to-date practice in electrical traction. One is the remarkably rapid acceleration, which amounts to 1·25 miles per second, and the other is the splendid condition of the track. The combination of 100lb. rails with a tie-plate on every tie, and broken stone ballast laid on a concrete foundation, provides a remarkably smooth track, in which both surface and alignment are all that could be asked. Another feature that contributes to comfortable riding is that the curves are "spiraled"—that is to say, the track runs from the tangent to the maximum curvature in a parabola, the change of direction being so gradual that the

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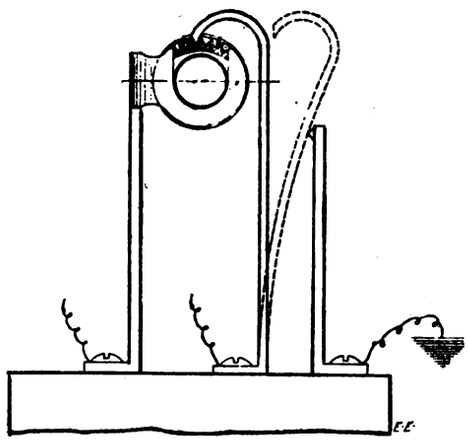
jolt which usually accompanies the entrance of a train upon a curve is entirely removed. The express train service is regarded as the great feature of the new undertaking, and it is understood that the company intend to extend this class of traffic.

New Cut-Out Design.—An addition has been made by Mr. F. B. Cook, of Chicago, to the forms of cut-outs designed to effect the self-repairing of the heat coils, of which a description appears in the *Electrical World* of New York. The arrangement of parts is shown in the accompanying diagram. The thermal device is cylindrical, the



surface being serrated. The cylindrical piece can revolve between cheeks which bear upon its ends, except when it is held fast by cement or solder inserted in these joints. One side of the circuit to be protected is carried to the holder, while the other is connected to a spring piece, which may be hooked over one of the teeth of the cylinders, as shown. Upon the passage of an excessive current the thermal device softens the current, and the pull of the spring piece rotates the cylinder and becomes released and flies back out of contact, opening the circuit. As the cylinder cools the cement hardens, leaving everything in readiness for resetting.

Railway Electrification.—The electrification of the Springs-Randfontein section of the Central South African Railways has been contemplated for some time, and we learn that the authorities have now, in consultation with Messrs. Mordey and Dawbarn, evolved a definite scheme for the accomplishment of this work. The Government, through its London agents, has entered into a provisional agreement for the conversion of the line with an English-American firm, and the details of the scheme have been communicated to the members of the Inter-Colonial Council. Messrs. Mordey and Dawbarn estimate that by electrification of the Springs-Randfontein line a saving of fully £40,000 per annum will be effected. This amount has been arrived at without allowing for increased revenue due to an improved service. Allowing for this improvement, the direct saving, it is estimated, will amount to £60,000 per annum. This increased saving is arrived at on the basis of a 20 per cent. increase in the train mileage, and a 29 per cent. reduction in the time occupied by each journey. The price mentioned is £445,000, the estimate of Messrs. Mordey and Dawbarn amounting to £430,000. It is stated that hitherto the administrators have only been deterred by the difficulty of raising the capital, but it is understood that the contracting firm are prepared to accept payment out of the profits of the line at the rate of £25,000 per half-year, commencing two years from the placing of the order, with interest at the rate of 4 per cent. on deferred payments. Lord Milner views the scheme with favour. If the results turn out as favourably as is expected, the electrification of other sections is pretty sure to follow; the railway authorities have themselves indicated as much. Although the firm with whom the provisional arrangement has been made is an English-American one, we are glad to see that British plant only is to be utilised, so that the scheme should result in many big orders for British houses.

The Nobel Awards.—It is gratifying to see that England has gained a double success in the department of scientific research, two of our most prominent physicists in Lord Rayleigh and Sir William Ramsay having gained the Nobel prizes for physics and chemistry respectively. To describe the careers of these distinguished scientists would be a superfluous undertaking, as our readers are doubtless familiar with them, but a few remarks in regard to same may be of interest. Lord Rayleigh was senior wrangler in 1865, since when, by experimental and mathematical research, he has been a constant contributor to scientific progress. He is one of the greatest living authorities on acoustics, his "Theory of Sound" being a standard work. His best known and perhaps most valuable discovery was the finding of argon in the atmosphere just a decade ago. By a most refined chemical investigation, in the later stages of which he was associated with the other Nobel prize-winner, Sir W. Ramsay, he demonstrated the existence of an inert gas, which was added to the list of elements under the name of argon. It is announced that his lordship will present the value of the Nobel prize (about £7,825) to his Alma Mater. Sir William Ramsay has been the recipient of almost every medal and honour conferred by scientific bodies. Educated at Glasgow and Tübingen, Sir William became successively principal of University College, Bristol, and professor of chemistry at University College, London. He followed up the discovery of argon first by the detection of helium in the mineral clevite, and then his skilful investigations, assisted by Dr. Travers, resulted in the detection of three new gases in our atmosphere—krypton, neon, and xénon—the experimental work leading to these results ranking with the most refined ever carried out. Of xenon, for example, there is about one part in 70,000,000 of air. Recently Sir William and Mr. Soddy have demonstrated that the ultimate residue of the disintegration of radium is helium.

Damages for Tramway Accident.—The payment of £1,000 as damages for an accident would be a pretty hard hit to a young and struggling undertaking, so it is rather fortunate that the Corporation which has been mulcted in this sum is one of the most prosperous in the kingdom. At the same time, the authorities at Liverpool are to be commiserated with upon the display of muscular energy by one of their servants which resulted in this liability being incurred. The plaintiff was an elderly medical man who was travelling on the Corporation tramways, and he entered the interior of the car with a lighted cigar. He did not attempt to smoke it, but declined to extinguish it. Thereupon the conductor ejected him from the car, with the result that he sustained a broken leg. The judge stated that he did not feel any sympathy for the plaintiff, who had acted very stupidly, but at the same time his lordship awarded him a very substantial solatium, on the ground that the conductor was not justified in employing "unnecessary violence." Precisely where the line is to be drawn it would be interesting to know. From the report the conductor does not seem to have acted with any deliberate barbarity. It chanced, however, that he was a very powerful man, while the passenger was an elderly and somewhat feeble one. If a conductor is not to be allowed to use force to remove a passenger who persists in infringing a by-law of this kind, it facilitates such breaches, especially in rural districts, where the local constable is not always available.

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If, on the other hand, the conductor uses "unnecessary violence," it is a hardship that the owners should have to bear the consequences. But this, we fear, is an inevitable case of the principal being responsible for the acts of his agents. In certain cases the captain of a ship incurs individual liability, but even there the payment usually devolves upon the owners in practice, as default would probably gain the service a bad reputation. The position of tramway owners in these matters is scarcely an enviable one, but, happily, such incidents are relatively infrequent.

The Paris Automobile Exhibition.—On Friday last the great motor exhibition at the Grand Palais in the Champs Elysées was opened by President Loubet. The exhibition is of a representative character, but there are no striking innovations. The exhibition practically marks the disappearance of the tubular frame, the unenclosed type of radiator, and the atmospheric inlet valve. Even Renault and the De Dion firm have come substantially into line in this respect. Panhard still retains the wood and flitch plate frame, and C.G.V. the square section wood-filled tube, but with these exceptions, every French maker has adopted the "chassis embouti," first introduced by the makers of the Mercédès. The conservative Panhard, however, still adheres to the atmospheric inlet valve on the 7-h.p. and 10-h.p. cars, and De Dion retains it on all models, but everywhere else the mechanically operated valve reigns supreme. Radiators are invariably enclosed, and generally cooled by one, or sometimes two fans. There is a distinct tendency to place the fan in the flywheel, and where the belt-driven fan is retained, provision is generally made by means of a spring for keeping the belt at a constant tension. Clutches are of many varieties, as heretofore, but the well-tried leather-covered cone type seems at least to be holding its own in popularity. The high-tension and low-tension systems of magnets are both increasing in favour, to the almost entire extinction of the old coil and accumulator method of ignition. In one or two cases the ignition-lever has entirely disappeared. There is a slight tendency to place less reliance on the engine governor, and in many cases the depression of the clutch pedal throttles the motor; and in all the Mors cars the governor has been abolished altogether, thus following the established Wolseley practice. The methods of lubrication and filling petrol tanks show considerable improvement. Prominent among the British exhibits is that of the Hozier Engineering Company, which includes a 10-12-h.p. two-cylinder car, fitted with an Astor engine built into a long frame. This car is an improved successor of that which the company successfully introduced last season.

Submarine Navigation.—One of the attractions in last week's programme at the Northampton Institute consisted of a demonstration of Middleton's system of submarine navigation. The salient peculiarity of this system is that the vessels are propelled, impelled, directed, controlled, and governed by fins actuated by prime movers—*i.e.*, engines or motors—in such fashion that they can move in any way in the fluid in which they are immersed. To simplify the motion of the fins, one or more screw propellers are, in addition, fitted to these vessels. This is, however, purely to simplify the mechanism impressing the proper motion on the fins. The fins are a new instrument of impulsion invented for the purpose of enabling a vessel to be navigated in tridimensional space, for the screw is only fitted for motion in two dimensions, and a submarine vessel should be capable of moving even better in a vertical plane than a horizontal one. Another great feature claimed by the inventor is greater safety as compared with the "A 1" type, the fins being arranged so as to promote buoyancy. A safety chamber or detachable department is provided in which the crew can leave the vessel as a last resort should it sink or founder. Dr. Walmsley is impressed by the importance of such vessels in the event of a naval war. With submersible cargo-carrying boats our food supplies could be transported with comparative safety The chief advantages claimed for the Middleton system are thus summed up: (1) the vessels of this system are completely navigable under water, being impelled and controlled by engine power, and can move in any direction in such medium; (2) the vessels of this system are nearly crewless, three men being sufficient in a vessel of 180 tons to navigate the vessel, load and fire its guns, and discharge its torpedos; (3) the vessels of this system carry guns which can be loaded and fired either above or beneath the surface of the sea; (4) the vessels of this system have a safety chamber or detachable compartment into which the crew can enter up to a few moments before the vessel is entirely filled with water, and by which they can escape from a sunk ship; (5) the vessels of this system can be made of any size. The experiments last Saturday did not proceed very far and had to be abandoned, possibly owing to the limited time for preparation. It will be of interest to observe the capabilities of the system under suitable conditions.

Electricity in Factories.—The Electrical Trades Section of the London Chamber of Commerce have forwarded objections to the Home Office with the object of securing a *locus standi* at the enquiry which is to be held into the regulations which that department has formulated under the Factory and Workshop Act of 1901. It is pointed out that difficulties may arise from the existence of two sets of rules, and the section submit that the Home Office regulations should be on identical lines with the proposed amended Board of Trade regulations. They further submit that the testing departments of electrical manufactories should be exempted from the scope of the regulations. Specific suggestions are made as follows:—"Clause 1: That alternative systems should be allowed in view of the advantages in certain cases of employing cables run on insulators and the adoption of other approved methods. Clause 5: That main distributing boards which are in charge of a special attendant should be exempted from the regulations with regard to the enclosing of switches. The section submit that the requirement as to the earthing of lampholders would be troublesome, and suggest as an alternative that an approved type of lampholder should be permitted. Clause 6: That as electrical 'undertakers' are already under penalties prescribed in various sections of the Board of Trade regulations—to see that their work on consumers premises is efficiently carried out—the section submits that it is unfair to put the onus of giving annual certificates as proposed, on such undertakers." These regulations are designed "in respect of the use and distribution of electricity where the normal pressure is greater than 250 volts and less than 650 between any two conductors." One of the reasons for the Home Office regulations is that the jurisdiction of the Board of Trade only extends to installations fed from public supply systems. A reasonable degree of legislation would probably not meet with any great opposition from manufacturers and contractors, as it furnishes the public with some assurance of the safety of electrical installations, but differences in the Home Office and Board of Trade codes are calculated to cause considerable inconvenience and expense. The differences may not be grave, though a few of the Home Office regulations appear to be somewhat obscure, but the aim of two public departments ought surely to be, as far as possible, uniformity of practice.

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Pollak-Virag High-Speed Telegraphy.—At the Carlton Hotel on Friday last a demonstration was given of the high-speed telegraph system invented by two Hungarian electricians, Messrs. Antal Pollak and Jozsef Virag. This apparatus uses two line wires and an earth return, and does not involve the maintenance of synchronism between the receiver and transmitter. The message is transmitted by means of a perforated paper strip, which is punched with two sets of perforations by means of a machine with a keyboard like that of a typewriter. This strip is passed over a roller made up of six electrically-insulated sections, and metal brushes pressing on the roller form electrical connection with one or other of these sections whenever a perforation comes opposite them. The currents thus allowed to pass vary in intensity, and those from one group of three sections go to one telephone at the receiving end while those from the other group of three go to a second telephone. To the diaphragms of these two telephones, which are placed close together, a mirror is connected, and is so suspended that it is free to move both horizontally and vertically, in unison with the movements of the diaphragms. The perforations which energise one telephone are arranged to represent the vertical motion necessary in writing a character or figure, while the other set of perforations similarly represents the horizontal component. Hence the two telephones together reproduce these components, and the result is that under their combined influence the mirror moves in such a way that its motion marks out the complete characters. These motions are imperceptible directly, but if a pencil of light be allowed to fall on the mirror, the movement of the reflected ray, of course, increases in amplitude as the surface upon which it is received is removed further and further from the mirror, so that the characters described by it may be obtained of indefinite size. At the point where the size is as required, the reflected ray is made to impinge on a photographically sensitive strip of paper, and so gives a permanent record of its movements. The inventors realised that if the apparatus was to be of practical utility means must be found for the rapid development and fixing of the photographic image thus produced, and they were successful in devising an automatic machine which effects development in five or six seconds and fixing in six or seven seconds, the paper being then delivered almost completely dry, with only a slight dampness on the gelatine surface. It is stated that strips containing 10,000 or 12,000 words are successfully handled in this way. The speed of the telegraph as a whole is limited by the speed at which the perforations can be made—about 300 letters a second. Several perforating machines can, however, be used to feed the transmitter, and it is said that as many as 50,000 words an hour can be received, though the number, of course, varies with the length and nature of the line in use. In some experiments made by the Hungarian postal department between Budapest and Pozsony, a distance of about 136 miles, with two copper telephone wires of 3mm. diameter, the transmission of 45,000 words an hour was found possible; while in another case, between Berlin and Königsberg, the maximum was about 40,000 words over a distance of 440 miles with wires 4½mm. in diameter. Experimental telegrams were successfully transmitted at the Carlton Hotel over an artificial line equal to 250 miles. The British Post Office is reported to be carrying out some trials with this apparatus.

Northampton Institute.—The prize distribution and conversazione at this foundation took place on Friday and Saturday last, Mr. L. B. Sebastian, chairman of governors, presiding. There was a large and distinguished attendance, including Mr. Alexander Siemens, Mr. J. Gavey, Mr. W. H. Patchell, and members of the governing body of the City of London College, Birkbeck College, the Central Governing Body, the London County Council, the City Companies, and Finsbury Borough Council, while the prizes and certificates were presented by Lord Reay. The principal, Dr. R. Mullineux Walmsley, had an eminently satisfactory report to present to his audience on the expansion of the institute's work, especially on the technical side. The students in the electrical engineering section (evening classes) number 500, the telegraphists and telephonists, under arrangement with the Post Office, are almost as numerous, and there are 300 students in the department of mechanical engineering. The day classes are also progressing admirably. The increase would have been larger had it not been found necessary to stop the enrolments in certain classes in the electrical engineering department, and it may be remarked that this feature has been very much accentuated during the current session, when within the first week several important classes were completely filled, and later applicants had to be refused admission. This shows the great need for the further extension of the accommodation of the institute if its usefulness is not to be seriously curtailed. Not only is it impossible to accept all the students offering for the present classes, but also the further development and improvement of the teaching in these classes, as found advisable by experience, is arrested. The work of the institute, it is gratifying to see, has met with largely increased recognition from the Board of Education. In the technological examination the number of passes from this institute during the past season has been greater than that of any similar institute in the Metropolis, and these successes were accompanied by a fair number of medals and prizes open to competition all over the country. Amongst these may be mentioned the first prize in the honours grade in telephony, and the first prize in the ordinary grade in electric light and power, in telegraphy and telephony, and in watch and clock making. Dr. Walmsley was very hopeful of last year's London Education Act, and attributed a large measure of the success gained during the past season to the generous support of the Technical Education Board of the London County Council. The newly-constituted department of technical optics has been overcrowded, and Dr. Walmsley thought there was reason for hope that Clerkenwell would recover its position as the centre of that industry, especially as the Company of Opticians and Spectacle Makers and the local traders were lending liberal aid. The social side of the institute has also been very successful. In conclusion, Dr. Walmsley thought it might be safely asserted that the institute is doing well the work for which it was established, and that it has shown that it is prepared to make good use of any additional ways and means and of any further opportunities which may be placed within its reach. Lord Reay, before presenting the numerous prizes and certificates, congratulated Dr. Walmsley and Dr. Drysdale upon the progress that had been made. He emphasised the need of technical instruction being the paramount consideration in such institutions, and entirely approved of the lines on which the Northampton Institute had been developed. Several other speeches followed, Mr. Piggott, L.C.C., imparting the felicitous information that the Board of Education has reformed. It now took a real interest in its functions, and on a recent occasion, as on the evening under notice, he saw a representative of the Board on the platform—an unprecedented incident. Mr. Alexander Siemens proposed a vote of thanks to Lord Reay, which was accorded unanimously. A conversazione took place the same evening, and was continued on the following night, when a number of attractive features were provided.

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MESSRS. EVERETT, EDGCUMBE, AND CO.'S LONDON WORKS AND SOME OF THEIR SPECIALITIES.

It is not so much our intention to describe here Messrs. Everett, Edgcumbe, and Co.'s works at Great Saffron-hill, Holborn-circus, E.C., as to bring to the notice of our readers some of the electrical instruments which have contributed so largely towards making the firm's reputation. Indeed, a detailed description of the former would scarcely be justified, since the scene of Messrs. Everett, Edgcumbe, and Co.'s activity is to be transferred to Hendon, where they are about to establish new works on a scale more commensurate with their requirements. The plans for these works were in course of preparation at the time of our visit to Great Saffron-hill some few weeks ago. It is no new discovery that the heart of London affords too little expansion room for an increasing manufacturing business, and that the firm in question have been able to remain in it so long is due no doubt to the relatively small space which suffices for the manufacture of electrical instruments on a large scale. However, there is a limit to the capacity of any works, and this limit has been approached in the present case, thus making it necessary to seek a suitable site elsewhere. By moving into the country, Messrs. Everett, Edgcumbe, and Co. will not only obtain more room wherein to expand, but also be able to reduce the cost of producing their goods, and so strengthen themselves against the growing competition which is felt even in this special branch of the electrical industry.

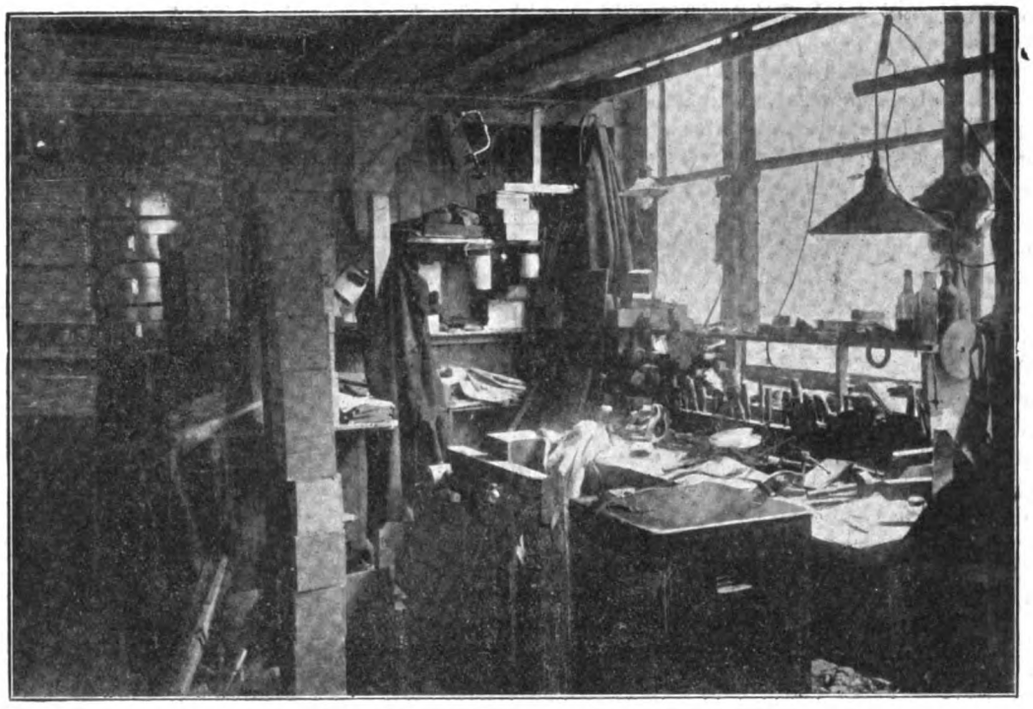

FIG. 1.—Corner of Cabinet-Making Department—Everett, Edgcumbe, and Co.'s Works.

Having regard to the facts stated, it follows that the accompanying interior views of the firm's present works are destined to become historical at no distant date. Upon entering the works, we pass through the showroom and main shop to the cabinet-making department (a corner of which is shown in Fig. 1), for it is here where the manufacture of the firm's portable wood-cased instruments may be said to commence, and these instruments, as distin-

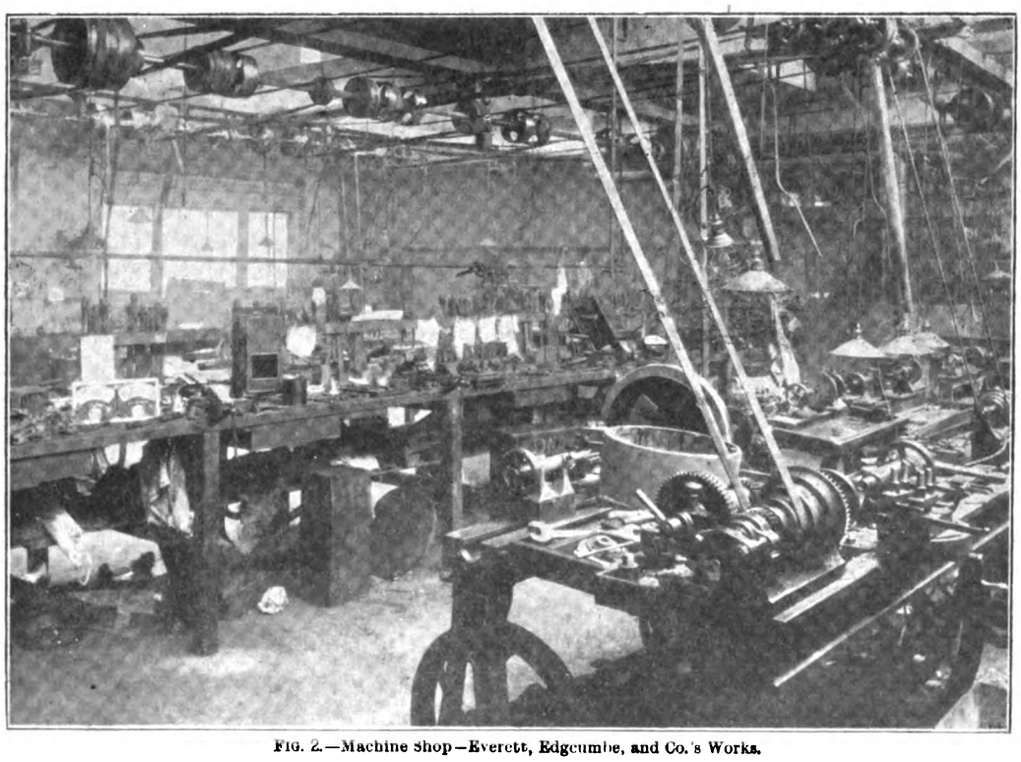

FIG. 2.—Machine Shop—Everett, Edgcumbe, and Co.'s Works.

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guished from those in metal cases for switchboard use, represent no inconsiderable portion of the total output. Users of these instruments know the excellence of their exterior finish, and we shall see presently that an equal amount of care is taken with the concealed parts, which is really more essential. Opposite the cabinet-making

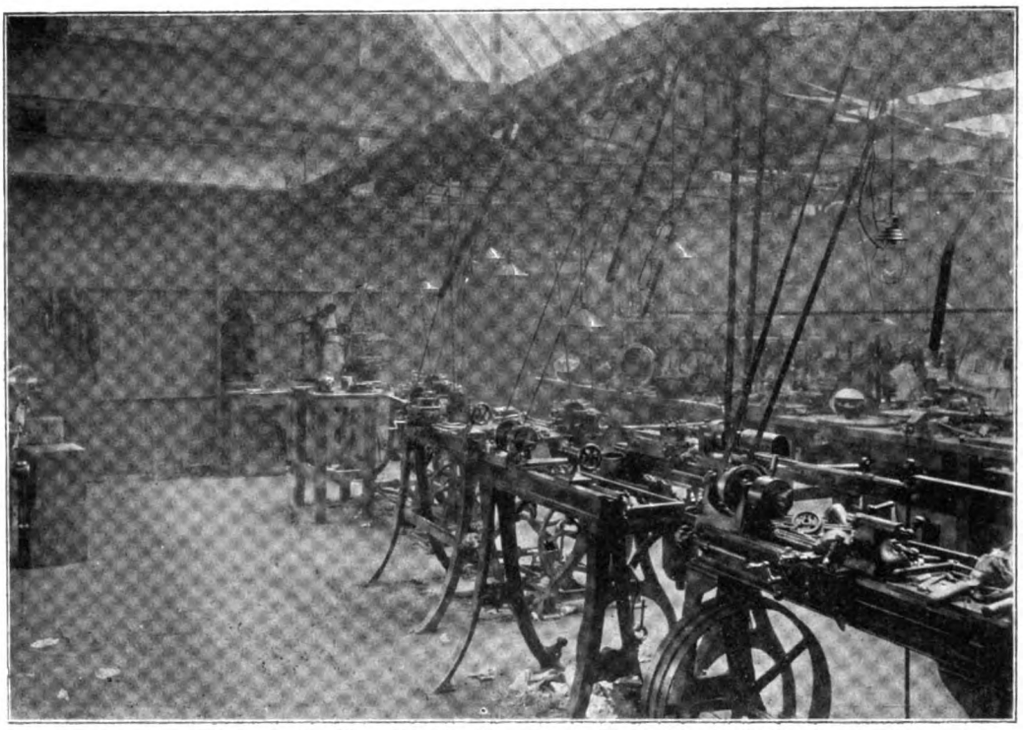

FIG. 3.—Another View of Machine Shop—Everett, Edgcumbe, and Co.'s Works

department is the store for raw material. Here we see iron, copper, and brass in rod, tube, and sheet form; metal cases, rough castings, and an endless variety of components in a crude state, besides finished parts of minor importance, such as screws of ordinary standard sizes. It is not possible to take a photograph, the space being too crowded, so

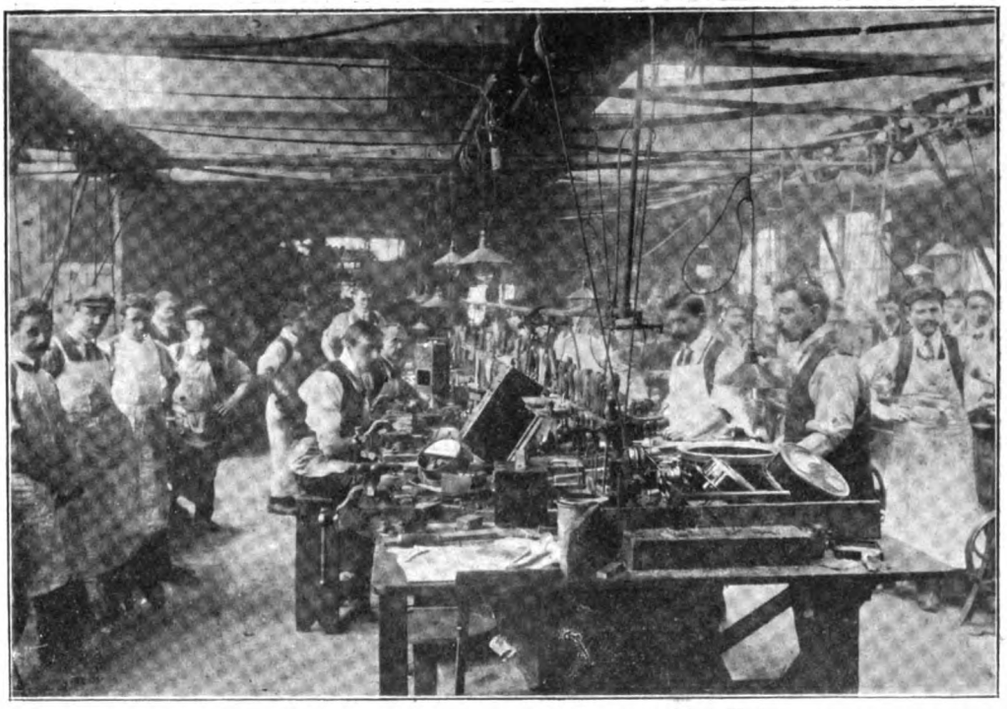

FIG. 4.—Workmen at Benches—Everett, Edgcumbe, and Co.'s Works.

we turn our attention to the machine shop (Figs. 2, 3, and 4), where an array of small machine tools and workbenches meets our view. The machine tools are engaged in turning out standard parts; they are of the semi-automatic type. Here are machines making parts for insulation testing sets, synchronisers, etc, and there capstan lathes fashioning ebonite bushes for insulated terminals, and so on. Jig and circular saws for cutting fibre, wood, and other materials, disc emery wheels, stamping machines, drills, etc., also, we note, find employment in this shop. Our attention is called at one point to a pile of external resistances for voltmeters, and at another to some neat little oil-coooled transformers destined for use in conjunction with power-factor indicators, all made on the spot. We linger awhile to watch the process of lacquering carried on in the department partitioned off for that purpose, casually examine an interesting machine designed by Mr. Everett for printing recorder charts, glance round the racks in the tool store, and then return through the machine shop and packing department to a stairway leading to the first floor (Figs. 5 and 6), on which the parts from the machine tools and benches are ultimately assembled, and the finished instruments calibrated. Here we are shown the racks containing stocks of components all ready for assembling. The machine shop below is organised to replenish these stocks as the demand

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may require. In this way a sudden run on any particular instrument can be met without a large stock of the finished article being kept. Close to these racks girls are busily occupied in winding coils of the several descriptions used, including small resistances. Great care is taken, we notice, in assembling the different parts of an instrument, as also with the subsequent calibration. From the set of readings taken for each instrument a curve is plotted from which a scale is drawn direct by means of an ingenious machine designed especially for the purpose. In other words, a special scale is drawn for each instrument. The standard instruments used for checking the readings are themselves systematically compared with other standards, so as to eliminate the possibility of error. Continuous-current, single and three phase generating plant for testing purposes, charging accumulators, etc., is installed on the same floor. Neither this nor the stocks of finished instruments are, however, shown in the accompanying illustrations.

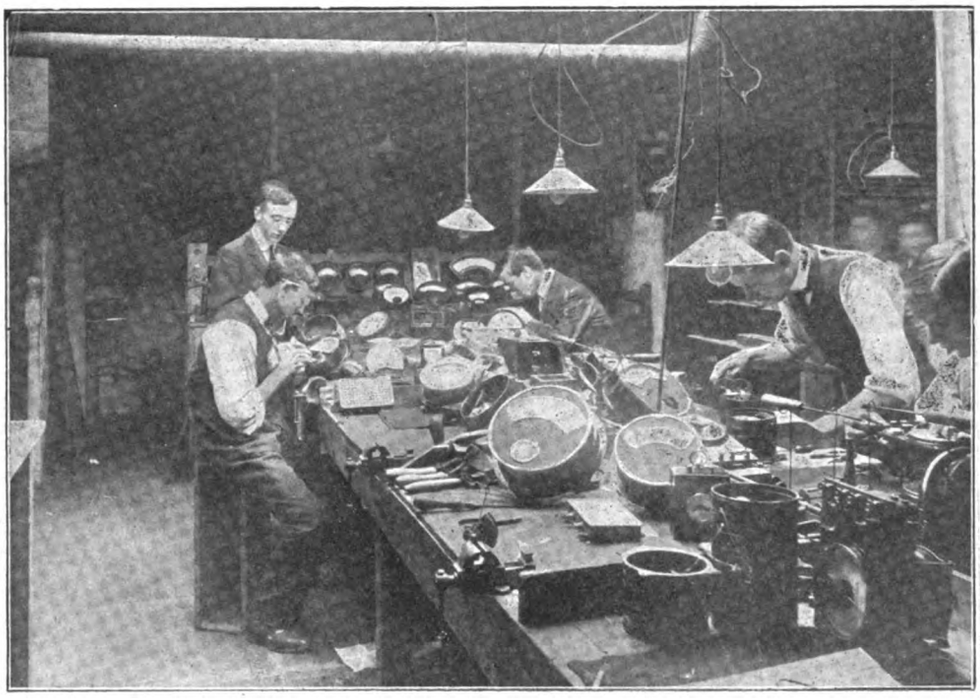

FIG. 5.—Putting Instruments together—Everett, Edgcumbe, and Co.'s Works.

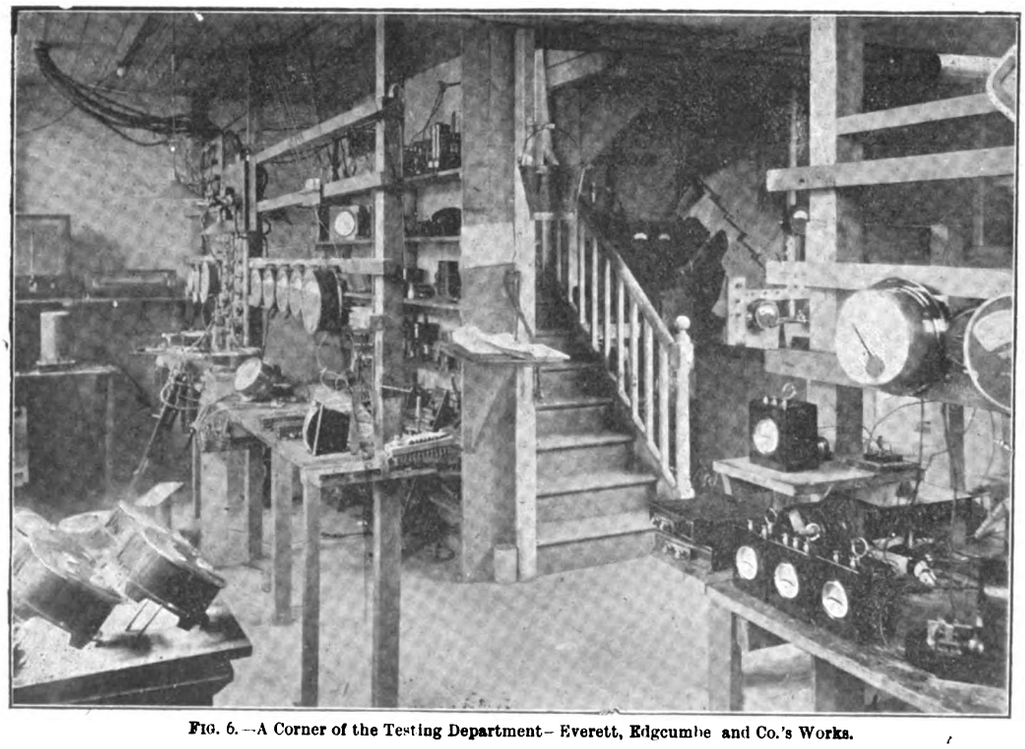

FIG. 6.—A Corner of the Testing Department—Everett, Edgcumbe and Co.'s Works.

Having thus briefly dealt with Messrs. Everett, Edgcumbe, and Co.'s works, we may now proceed to describe some of the more largely used instruments of their design and manufacture. The accompanying illustration (Fig. 7) shows their rotary synchroniser, which is meeting with considerable favour from central-station engineers. This instrument serves to indicate (1) whether the incoming machine is running too fast or too slow; (2) by how much it is out of step; (3) the precise moment for switching in. It is based upon the fact that if the rotor and stator of a rotary-field asynchronous motor be supplied from two sources of alternating current of nearly the same frequency, and be so connected that both fields rotate in the same direction, the rotor will revolve at such a speed as will enable the fields to revolve "in step." In the actual instrument the rotor and stator are each provided with a two-phase winding. In the case of a two-phase system, suppose the rotor to be connected to the terminals of the generator

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to be paralleled, and the stator to the 'bus bars. Then, if the frequencies be the same, the fields will revolve at the same speed, and there will be no tendency for the rotor to move. If, however, the frequencies are different, then the rotor will revolve in one direction or the other according to which of the two sources has the higher frequency, the speed being such that one revolution of the rotor corresponds to two complete cycles. The rotor axle carries a pointer which revolves in front of a dial, and is so set that when the frequencies are equal it stands vertical. In practice, in order to simplify the connections and to make the instrument applicable to single-phase systems, the

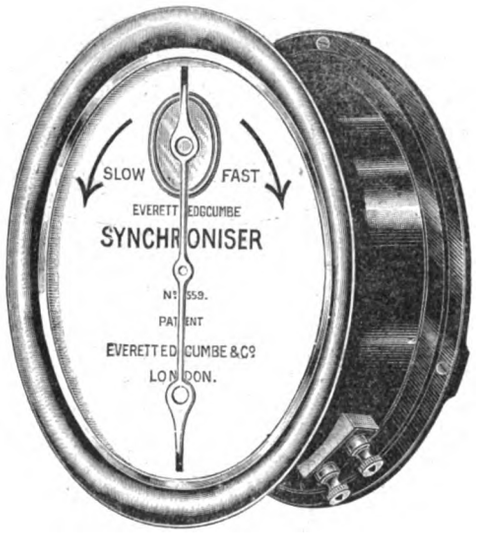

FIG. 7.—The Everett-Edgcumbe Rotary Synchroniser.

necessary two-phase currents are produced by means of choking coils in two of the circuits and non-inductive resistances (lamps) in the other two.

The accompanying diagram (Fig. 8) shows the method of connecting the synchroniser in circuit. A single-phase circuit is shown for convenience. In the case of a two or three phase circuit the synchronising operation is carried out on one phase only, so that only two transformers in all are required instead of four or six, as is the case with most other synchronising devices, and as the current taken is small (from $\frac{1}{2}$ to $\frac{3}{4}$ of an ampere) the ordinary synchronising or voltmeter transformers can be employed for this purpose. An important feature of the apparatus is the ingenious method by which the direction of rotation of the pointer is made visible at a distance from the switchboard—for example, at the engine. This is done by means of a

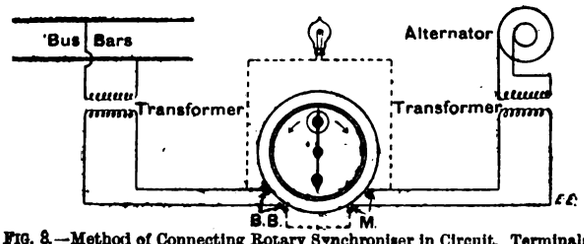

FIG. 8.—Method of Connecting Rotary Synchroniser in Circuit. Terminals marked B B connected to 'Bus Bars. Terminals marked M connected to Alternator.

movable vane, which obscures either a red or a green lamp, seen through an opening in the dial (see Fig. 7), according to whether the hand is revolving to the right or to the left. Thus the engine-driver can see at a glance whether his machine is running too fast or too slow. Further, on the top of the instrument can be mounted an ordinary synchronising lamp, from which he can see by how much his machine is out of step. In several large stations an addition has been made, consisting of an auxiliary contact attached to the red and green shutter, by means of which coloured lamps or other signals can be actuated at a distance from the synchroniser. The instrument is usually constructed for 100 volts, and is provided with a dial some 12in. in diameter. The current is led into the rotor by means of special rod brushes, and the rotor itself runs in ball bearings, and the whole is so simple that there is no likelihood of anything getting out of order.

The design of wattmeters has also been specialised by Messrs. Everett, Edgcumbe, and Co., who make these instruments in two forms, respectively for switchboard and portable use. Both are constructed on the dynamometer principle, in which a fixed current coil acts on a small pivoted coil connected in series with a large non-inductive resistance, and carrying a current proportional to the voltage. The switchboard pattern is shown in Fig. 9 herewith. The errors to be chiefly guarded against in wattmeters are: (1) self-induction in the moving coil, which causes the current to lag behind the voltage; (2) capacity in the moving-coil circuit, causing the current in it to lead; (3) eddy currents in neighbouring metal parts—as, for example, the conductors themselves or their supports,

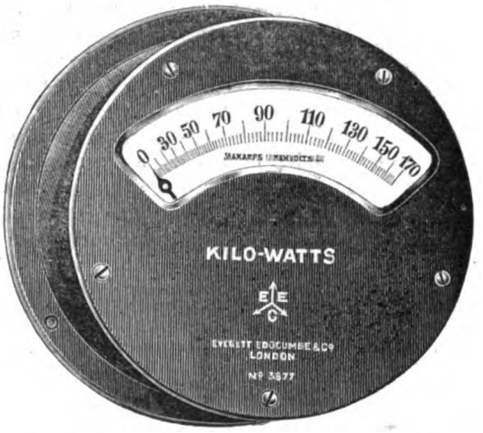

FIG. 9.—The Everett-Edgcumbe Switchboard Pattern Wattmeter.

All these errors have been most carefully avoided in the instruments in question. The series resistance of the moving coil is not only wound non-inductively, but is also wound in sections, whereby the capacity, which is often a serious item, is rendered quite negligible. The series resistance forms a very large proportion of the total resistance of the moving circuit, so that the self-induction of the moving coil is quite swamped, as is also its temperature coefficient. In order to reduce eddy currents to a minimum the current coils are most carefully laminated, and metal parts are dispensed with as much as possible, metal having a very high specific resistance being employed where such cannot be avoided. At the same time, the construction is thoroughly mechanical, and a rigid frame of German silver

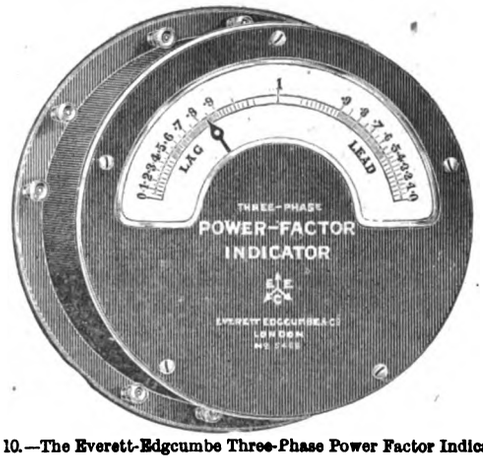

FIG. 10.—The Everett-Edgcumbe Three-Phase Power Factor Indicator.

is used to hold the parts securely in place. Special care is taken with the design of the current and voltage transformers, iron of the best possible quality being used. The magnetic circuit is as short and as perfect as possible, and in the case of the current transformers, the ohmic resistance of the secondary circuit (including transformer and winding) is reduced to a minimum, while the self-induction is considerable. This has the result not only of ensuring that the current in the secondary is strictly proportional to the current in the primary irrespective of changes of frequency, but also that the phase relation between them remains the same at all loads. The instruments are fitted with the Everett-Edgcumbe "air-damping" device so as to render

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them practically dead-beat, and the scales are extremely evenly divided. The switchboard pattern, which measures about 10in. over the base, has scales 6½in. long, and the case is constructed throughout of insulating material, so as, in the first place, to avoid eddy currents, and, in the second place, to make it quite safe for use on high-tension circuits. It is the practice now to use wattmeters in connection with series transformers, so that the high tension is not led into the instrument itself.

Our next illustration (Fig. 10) shows one of the firm's power-factor indicators for three-phase circuits. As ordinarily constructed, power-factor indicators are of two types: (1) instruments which show merely the wattless component of the power, and (2) instruments showing the actual power factor or angle of lag between amperes and volts. Those manufactured by Messrs. Everett, Edgcumbe, and Co. belong to the second class. They have the advantage of being independent not only of the voltage of supply, but also of the frequency and wave-form. This is a unique feature, as the usual construction, in which a phase difference is produced by means of an inductive and a non-inductive resistance, is, of course, only accurate at one particular frequency and wave-form. In the case of a balanced three-phase load, the instrument consists of a fixed coil inserted in one of the lines, and three volt coils fixed at an angle of 120deg. to each other, and carried by a spindle, which also bears an indicating pointer. Each of

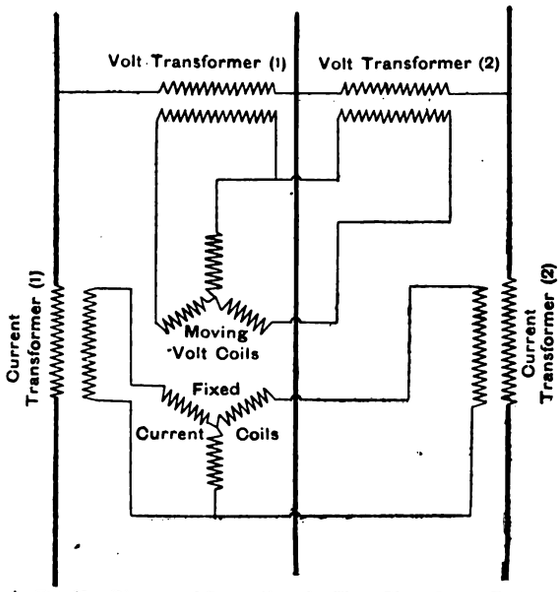

FIG. 11.—Diagram of Connections for Three-Phase Power Factor Indicator on Unbalanced Load.

the three moving coils has one end connected through a series resistance to one of the three conductors. The three remaining ends are joined together, and form the neutral point. A rotating field is thus produced, and the system will set itself in such a position that at the moment the current in the fixed coil reaches its maximum value, the field due to the moving system lies along its axis. In the case of an unbalanced system three fixed coils are employed, set at an angle of 120deg. to each other, and one being inserted in each line. The moving system then takes up a position corresponding to the average power factor of the whole system, and if a short-circuiting plug is inserted in each of the circuits, it is possible to obtain either the average power factor of the system or the power factor of each phase separately. The internal construction of these instruments is on the same lines as that of the wattmeters previously described, and the same remarks as to metal, etc., apply. It should be noticed that both the controlling and deflecting forces are electrical, so that when no current is flowing the pointer will not take up any definite position. The current coils are so proportioned that there is ample power even at one-tenth of the full load. The dial is non-metallic, and the case is constructed of insulating material.

The connections for a three-phase unbalanced load are shown in Fig. 11. The arrangement is such that two voltage transformers and two current transformers alone are required. This is preferable, owing to the fact that the necessary transformers are, as a rule, available in connection with the integrating wattmeters, which now usually find a place on the switchboard. When the load can be regarded as balanced—as, for example, in the case of a motor—only one coil is necessary, but even in this case it is preferable, when possible, to use three coils. A special feature of this arrangement consists in the connection of the third current coil in series with the other two, whereby only two current transformers are necessary. Seeing that the current in the third line must be equal at each instant to the resultant of the currents in the other two, it is

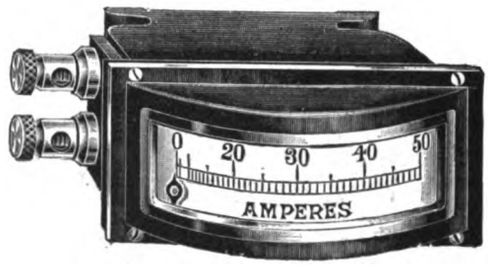

FIG. 12.—The Everett-Edgcumbe Small Edgewise Ammeter.

unnecessary to connect this third line to the instrument. In place of the two single-phase volt transformers, one three-phase transformer can, of course, be employed, and in the case of low-tension systems the volt transformers are replaced by a star resistance. The instruments are usually fitted in 8in. round cases (see Fig. 10), but can also be supplied in portable form. They are equally adapted, it may be added, for two or three phase circuits.

Reference may also be made to the firm's "Universal" moving-iron ammeters and voltmeters. These instruments have been designed with the object of providing alternating-current ammeters and voltmeters which remain practically unaffected by changes of frequency or wave-form. So well, it is claimed, has this result been attained that it is found incidentally that the instruments, when calibrated with alternating current at, say, 50 cycles, have an error of less than 1 per cent. when tested with direct current, with, of course, a proportionately small error for changes of frequency and wave-form. In order to render the effect of the latter negligible, the induction in the iron is kept extremely low, so that the force acting on the moving iron is at any instant practically proportional to the square of the current and not directly proportional to the current, as is the case when high inductions approaching the saturation point are employed. The effect of frequency is negligible not only in the case of the ammeters, but also in that of the voltmeters. This is secured by means of the special shape of coil used, which is of a flat form, so that the self-induction is extremely small, while the force acting can be made comparatively large. The series resistance of the voltmeters is wound on open frames fixed at the back of

FIG. 13.—The Everett-Edgcumbe Direct-Reading Ohmeter.

the case, and the wire itself is protected by a coating of waterproof varnish. To render these instruments dead beat for use with variable loads, a special air-dashpot has been devised, which, owing to the fact that the piston does not touch the cylinder at any point, introduces no friction or sluggishness, and is a great improvement on the oil dashpot on the one hand, and magnetic damping

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on the other, which in the case of moving-iron instruments is practically useless owing to its effect on the readings with direct current and to the magnets becoming rapidly demagnetised when used with alternating currents. For use on high-tension circuits these instruments are supplied to work off current and voltage transformers. The former are specially designed to introduce no error through frequency changes, and are similar to those employed with the Everett-Edgcumbe wattmeters. In the case of the voltmeter transformers, the insulation receives special care.

If asked why ammeters and voltmeters should almost invariably be fitted into round cases, it would probably be difficult to find a satisfactory answer. It is certainly not because they thereby occupy less space or are more convenient to read. A refreshing departure has been made by Messrs. Everett, Edgcumbe, and Co. in their small edgewise instruments, one form of which we illustrate in Fig. 12. In this instrument a scale 4½in. long is obtained—that is to say, of the same length as the ordinary round instruments 7in. or 8in. in diameter, whereas the actual space occupied is only 6¾in. by 3⅛in. The actual saving in space is really considerably greater than these figures would seem to indicate, due to the fact that the convenient shape of these instruments enormously simplifies the setting out of the board, as they can be fitted in between the switches, etc., or can be placed horizontally along the top of the board.

These meters are supplied in two distinct forms, respectively for mounting on the surface of the switchboard or for letting into it. Each type can be supplied either with horizontal or vertical scale, as preferred.

This article would not be complete without some reference, however brief, to the firm's direct-reading resistances and insulation indicator. These instruments work on the Wheatstone bridge principle, but are so arranged as to be absolutely direct reading. This is obtained by means of a special high-resistance slide-wire arrangement fixed to a central axle carrying a milled head, which in turn is provided with a pointer moving over a scale so graduated as to read direct in ohms or megohms, as the case may be. The standard resistances are connected to a change-over switch, three being provided in the case of the insulation sets and five in the case of the resistance sets. The former sets have a range of reading from 10,000 ohms to 50 megohms, and the latter from one-tenth of an ohm to 11,000 ohms. The galvanometer, which is also fixed in the same case, is an important feature of these sets, in that, in the first place, there are no pivots, and, in the second, no careful levelling is necessary. This galvanometer is of the D'Arsonval type, and consists of a small round coil swinging in a circular air-gap. The coil carries a pointer, which is seen through a small opening at the top of the case. The zero of the galvanometer can be adjusted, should this be necessary, by turning a brass milled head. In the centre of the ebonite milled head is a small galvanometer key, which can be depressed with the same hand as that which moves the milled head. It may be added here that the over-all size of this new departure in Wheatstone bridges is 9¼in. by 6½in. by 6½in.

The outward appearance of one of these instruments is shown in the last of the illustrations herewith (Fig. 13). For use with the same a compact form of magneto-generator giving 100, 200, or 500 volts, as preferred, is supplied when insulation measurements are to be made. The whole is arranged so that one operator can easily work both the ohmmeter and the generator, with the further advantage that the two instruments can be placed as near together as may be convenient, owing to the fact that they are quite unaffected by stray magnetic fields.

The generators are provided with special commutators having eight parts, and so sub-divided that, in the first place, the insulation for high voltages is easy, and, in the second place, the turns on the armature are all connected in series instead of in parallel, which, for a small machine, is a considerable advantage. The armature runs in ball bearings, and is so easy to turn that it can be readily worked with one hand. Carbon brushes are also fitted to prevent sparking and wear of the commutator. Capacity has no effect on the actual accuracy of the readings; it merely shows itself by a vibration of the galvanometer pointer when the generator is turned slowly, the position of balance being unchanged. This, of course, assumes that the generator is turned approximately evenly, or the rushes of current will make the balance difficult to obtain.

In the foregoing we have purposely confined our attention to such only of Messrs. Everett, Edgcumbe, and Co.'s specialities as more directly concern station engineers. We have, in conclusion, to thank Messrs. Everett, Edgcumbe, and Co. for the assistance they have given us with the preparation of this article.

THE ELECTRIFICATION OF THE METROPOLITAN RAILWAY.

In England no function from a christening to a funeral is reckoned complete unless there is a meal attached. This was exemplified on Tuesday last, when the inauguration of the electric service on the Metropolitan Railway was the occasion of a lunch, at which representatives from all the leading railways in the kingdom were present. It is too much to expect, however, that one lunch will act as the christening of the electric service and the funeral of the steam traffic on the Inner Circle. The function of Tuesday must, therefore, be considered solely as a christening one. The doom of the steam locomotive on the Underground is certain, but the exact date of the funeral has yet to be fixed. This public rejoicing when the change has been completed will, perhaps, render a second function unnecessary. Among those present were the following gentlemen: Sir Charles McLaren (chairman of the Metropolitan Railway), Colonel J. J. Mellor, Lieut.-Colonel Clifford Probyn, Mr. Jabez Light and Sir William Birt, directors of that line; Colonel William Terry, director of the Harrow and Uxbridge Railway; Major L. H. Isaacs, of the Metropolitan District Railway; Mr. G. J. Churchward, of the Great Western Railway; Mr. V. W. Hill, of the South-Eastern and Chatham Railways; Mr. G. C. Cunningham, of the Central London Railway; Mr. T. C. Jenkin, of the City and South London Railway; Mr. Sam Fay, of the Great Central Railway; Mr. J. F. S. Gooday, of the Great Eastern Railway; Mr. W. J. Grinling, of the Great Northern Railway; Mr. J. A. F. Aspinall, of the Lancashire and Yorkshire Railway; Mr. W. Forbes, of the London, Brighton, and South Coast Railway; Sir Frederick Harrison, of the London and North-Western Railway; Sir Charles Owens, of the London and South-Western Railway; Mr. A. L. Stride, of the London, Tilbury, and Southend Railway; Mr. Wilson Worsdell, of the North-Eastern Railway; Mr. F. J. Dunn, of the North London Railway; Mr. James R. Chapman, of the Underground Electric Railways Company of London; Mr. H. Smart, of the Railway Clearing House; Sir Wolfe Barry, Sir Frederick Dixon-Hartland, Sir Ralph Littler, Prof. A. B. W. Kennedy, and Prof. S. P. Thompson. Mr. A. C. Ellis, the general manager, Mr. T. Parker, the consulting electrical engineer, and the other chief officers of the Metropolitan Company were also present.

Sir CHARLES MCLAREN, the chairman of the company, presided at the lunch, and explained that the transition from the steam service to the electric trains would be gradual. He gave us to understand that it will be commenced on the Baker-street-to-Uxbridge line by the gradual interpolation of more and more electric trains into the steam service. He hoped that by Jan. 1 the whole of this service would be electric, and then the advantages from the improved acceleration and higher mean speeds will begin to be realised. He assured those present that they were working night and day to complete their arrangements for the electrification of the Inner Circle. In this the Metropolitan District Railway was also concerned, but he saw no reason to doubt that the two companies would be ready much at the same time. While the Metropolitan Railway draw their supply of electricity from Neasden, the District will get the necessary energy from their large works at Chelsea, but arrangements had been made for the interchange of current if necessary. Sir Charles McLaren emphasised the care the company have taken

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to secure public comfort and absolute safety. It will be news to some who are not acquainted with the early history of the Metropolitan line that the tunnels were made to take the broad-gauge trains of the Great Western Railway Company. It followed from this that the space in the tunnels is ample, and hence when once the steam-engines have been removed and the tunnels cleaned and whitewashed the atmospheric conditions will be revolutionised by the electric service. Instead of the atmosphere in the tunnels being, as we should term it, the worst in any railway in London, it will become much purer than that in any tube line, owing to the ample space between the trains and the tunnel. It was also explained that every care had been taken to make both the trains themselves and also the stations fireproof, so as to avoid any risk of fire being caused electrically. In conclusion, Sir Charles McLaren expressed the hope that with the increased facilities and lower fares the increase of traffic would be such as to recoup the company not only for the cost of electrification, but would also return larger profits on the original stock.

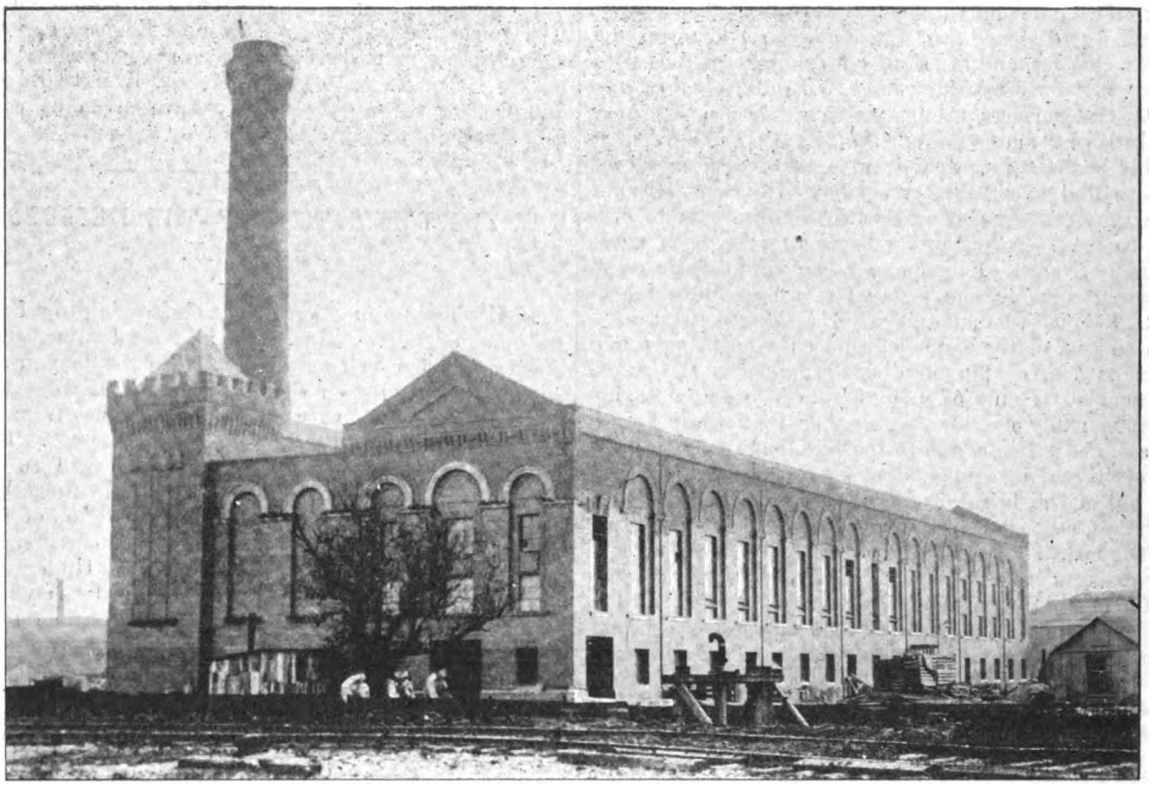

FIG. 1.—The Neasden Power House of the Metropolitan Railway Company.

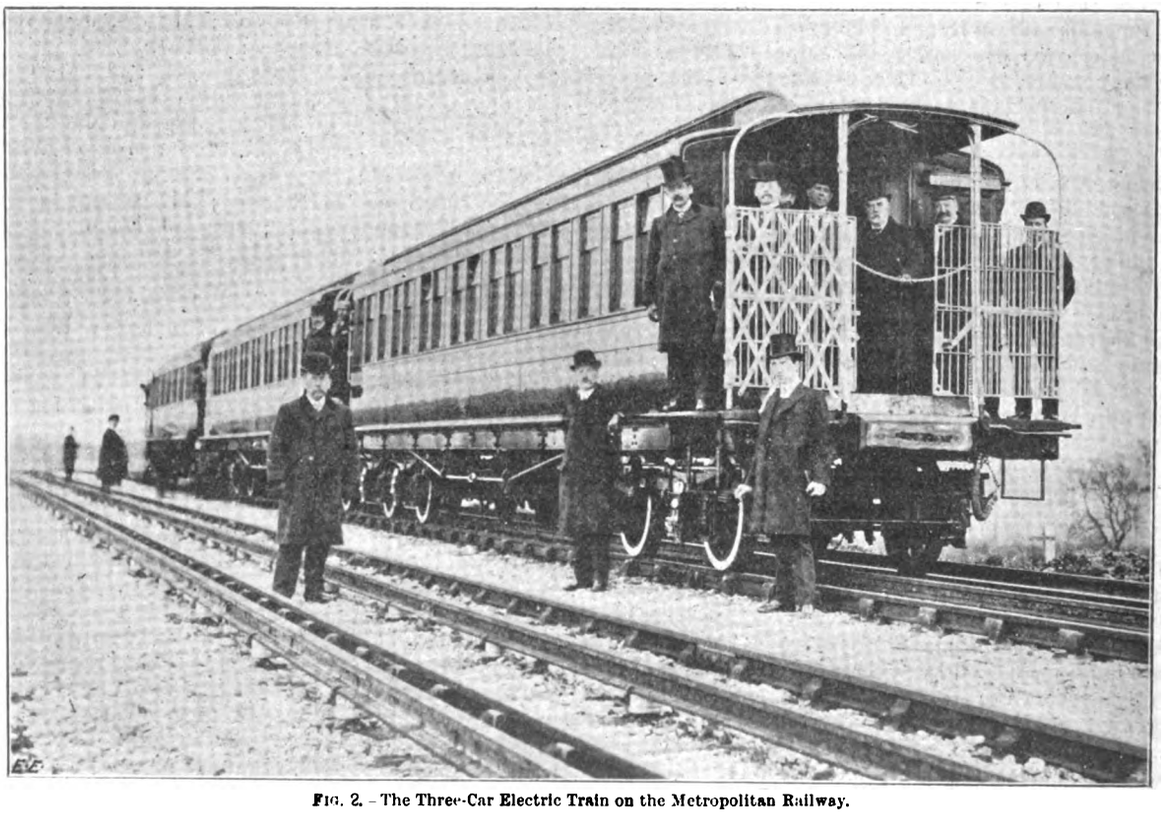

FIG. 2.—The Three-Car Electric Train on the Metropolitan Railway.

After the few remarks of the chairman there was no more speechmaking, and the company proceeded from the Great Central Hotel to Baker-street, where a six-car electric train was in waiting. In this there was ample accommodation for all present. A non-stop run was then made to

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Uxbridge, the time taken on the journey being about 35 minutes. There was, of course, on this occasion no attempt made to get maximum speed, as the train had to e run without interference with the ordinary traffic. After a short stop at Uxbridge, the return journey was made in much the same time, with only one slight stop outside Baker-street. For this return journey we secured a good point of observation in the guard's van. Standing by the door into the driver's compartment, we were able to watch with interest the ease with which the heavy train was controlled on the Westinghouse electro-pneumatic system. The controller handle seemed absurdly small for the large horse-power it had the command of, but the slight mechanical effort needed leaves the driver more free to observe the signals, etc. The sparking of the collecting shoes on the third and fourth rails seemed to impress a certain number of those present, but this was entirely due to the oil, rust, and dirt which have accumulated on these rails since they were put down nearly a year ago. On the Uxbridge portion of the line, where the experimental trains had been run more frequently, the sparking at the shoes was inappreciable. A regular service train into and out of Baker-street will soon clean these conductor rails and entirely prevent the flashing in question. The comfort

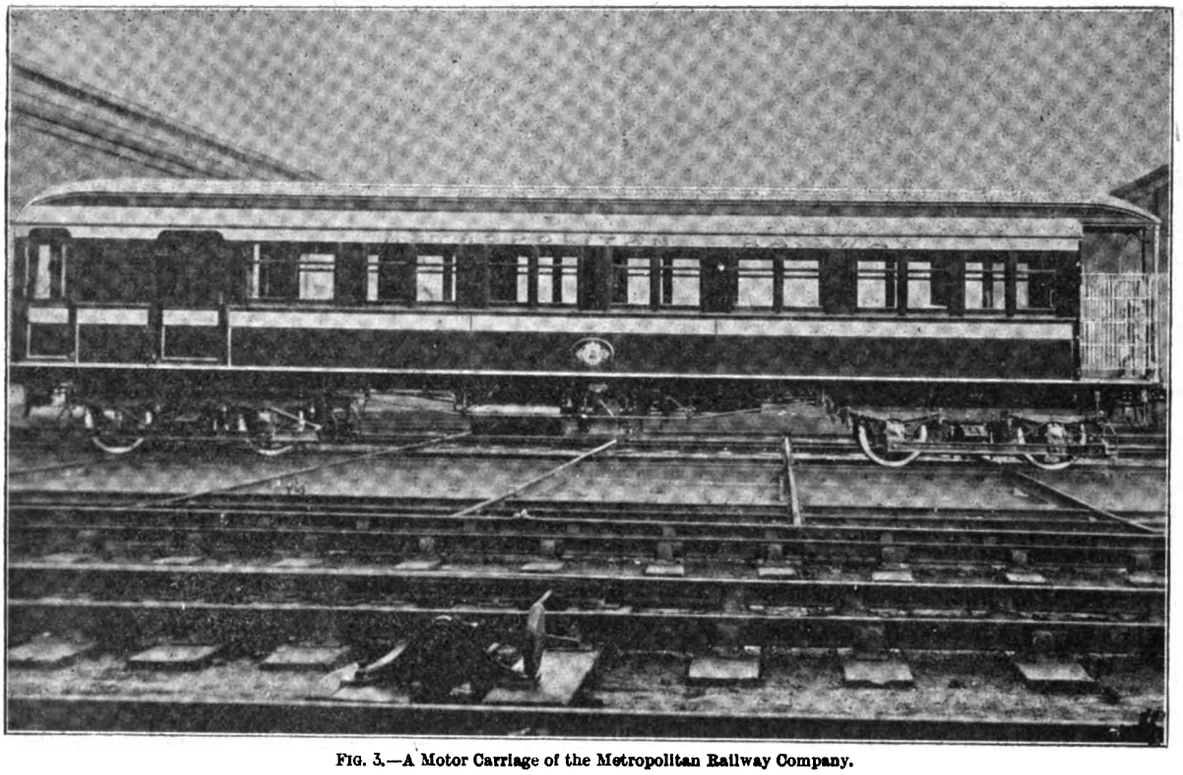

FIG. 3.—A Motor Carriage of the Metropolitan Railway Company.

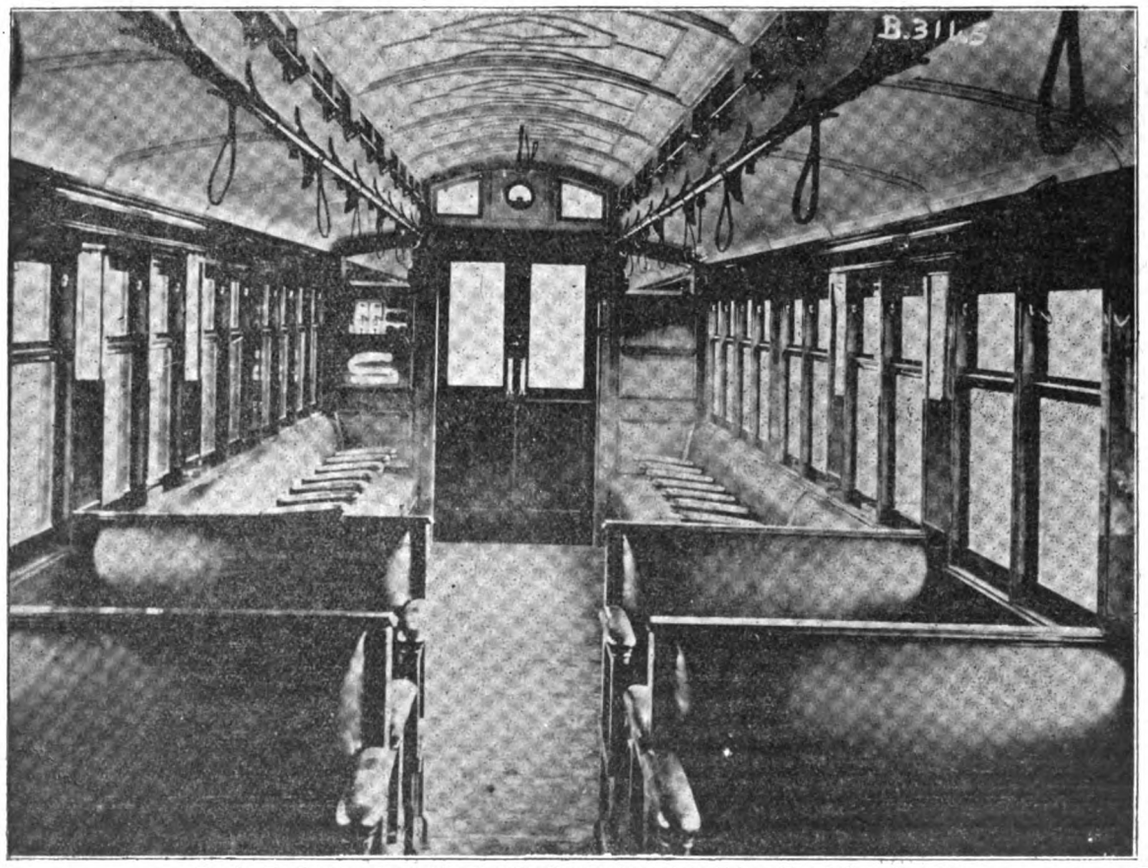

FIG. 4.—The Interior of one of the New Corridor Carriages of the Metropolitan Railway Company.

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of the carriages, and especially the airiness of the same, was commented on by those present, and the electric heating was a feature by means unwelcome on Tuesday. There is no doubt that with the intermixed system of electric and steam trains there will be a rush for the increased comforts of the former, and these improved carriages will be even more highly appreciated when they replace the rolling-stock now used on the Inner Circle.

With respect to the electrical features of the new equipments, there is very much more to be said than can be put in a single issue of any technical journal. We propose, therefore, to give at the present time an outline sketch which will show the lines on which the Metropolitan Company are working under the advice of their consulting electrical engineer, Mr. Thomas Parker. It will be remembered that the company endeavoured in the first instance to use the high-tension system of three-phase traction working on the Ganz system. The historic arbitration before the Right Hon. Alfred Lyttleton, K.C., brought out the good points of the proposed system, but it was rejected on the ground that it had not been sufficiently tried on a large scale. The company, in consequence, have adopted direct-current motors on their trains, but there are many features which mark a distinct advance on previous practice.

The generating works are situated at Neasden, adjoining the stores and repair department of the line. The site is an excellent one, as water is abundant. The supply is obtained from two artesian wells and stored in a cooling reservoir. The area covered by the building is some 3,570 square yards, the building being 318ft. long and 100ft. wide. The works are designed to contain four three-phase turbo-alternators, of which two are erected and at work. The output of each machine is 3,500 kw. Steam for these steam-turbines is obtained from batteries of Babcock-Wilcox boilers, which are fed by a type of mechanical stoker new to this country. This is the Roney stoker, in which a steep inclined grate is used, down which the fuel gradually falls owing to a rocking motion in the stepped firebars. The coal-handling plant, with its automatic weighing machine to each boiler and the ash-conveying plant, is of the latest design. Each of the boilers in question is capable of evaporating 20,000lb. of water per hour at 180lb. pressure, and of superheating the steam to 520deg. F. The steam leaving the turbines is condensed by barometrical ejector condensers, the steam coming into direct contact with the cold circulating water forced up to the top of the condensers by centrifugal pumps. The condensed steam and circulating water is then forced up to the top cooling towers, and, by falling down over a series of wooden strips, it is cooled down to about 80deg. F. The water passes from the bottom of these cooling towers out into the large reservoir, where it is cooled still further by the exposure of a large surface to the air.

The alternators generate three-phase current at 11,000 volts, and this is then transmitted to the various sub-stations at different parts of the system. There is for the control of these machines and of the distributing feeders no switchboard in the usual sense of the word. The operator has instead before him a comparatively small table on which the circuits are represented in the form of a diagram. The small switches actually inserted in position in this diagram control by electro-pneumatic relays the large switches which are placed in fireproof chambers near by. The movements of these larger switches again operate small instruments on this diagram before the operator, and hence show him exactly which connections are made at any one time. The result is that with the measuring instruments before and the diagram of connections he has much better control of the large system than he could possibly have with any arrangement of switchboards in which the switches are operated mechanically and some distance apart. We had the opportunity of witnessing a parallel running trial on Monday last, which clearly showed the advantages of the small master-board described above.

There are eight sub-stations on the Metropolitan Company's system which receive the high-tension supply at 11,000 volts from Neasden. One of these sub-stations, however, is situated within the generating station itself, so that there are only seven sub-station buildings out on the line. These are situated as follows, commencing from the Uxbridge end of the system. At Ruislip the sub-station is equipped with three rotary converters, each capable of supplying 800 kw. as direct current to the line. In the Harrow sub-station there are four rotaries of the same size, and at Neasden three. The next sub-station coming towards London is at Finchley-road, where there are four 800-kw. rotaries. The largest sub-station is at Baker-street, and here after considerable trouble space has been found for the instalment of four 1,200-kw. rotaries, with their complement of static transformers, high-tension oil switches, etc. Seeing that with a full schedule there will be about 42 trains per hour coming into and out of Baker-street, the need for this heavy equipment will be appreciated. On the Inner Circle itself there is only one sub-station on the westward portion of the line from Baker-street, and this is situated in Bouverie-street, not far from Praed-street Station. This sub-station contains three rotaries of 800 kw. capacity each, as do also the two sub-stations to the eastward at Charlton-street, near King's Cross, and at Moorgate-street respectively. All these sub-stations on the Inner Circle have been so designed that at any time an 800-kw. rotary can be replaced by one of 1,200 kw. capacity.

Of the equipment of the track we do not propose to say much at the present time, except that the company have adopted an insulated return, and are not using the running rails at all for this purpose. Quite apart from the electrical advantages of this course, the separate return is much less likely to give rise to short-circuits than are the running rails when used for this purpose. The new trains are entirely composed of corridor cars, and they will have a motorcar at each end. The new stock has been built at Birmingham and Manchester by the Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited, under the immediate direction of the railway company's carriage and wagon superintendent.

The cars, which are of two classes, are 52½ft. long, and arranged with both transverse and longitudinal seats. The ends of the cars are provided with sliding doors, and patent swing gates lead on to the car platforms. The superior class non-smoking cars are upholstered in art green moquette; the smoking cars being similar in all respects save the upholstery, which is of green leather. All the second-class cars have buffalo hide covered seats, and they otherwise differ from the superior class cars only in that the decorative work is less elaborate. Electrical heaters are fitted to every car. In the construction every provision has been made to ensure the fullest protection against fire, sheet-steel panels, asbestos slate, and other non-flammable materials having been introduced wherever possible and necessary. Each car is mounted on two English manufactured pressed-steel four-wheel bogie trucks. In the case of the motorcars, each of the four axles is driven by a separate iron-clad motor of 150 h.p. normal capacity.

On the complete train of six coaches there must be eight motors of this size, and with the weight carried on the driving axles there will be no difficulty in obtaining high acceleration. It is in the design of the controllers that the special interest lies, and we hope at an early date to give an illustrated description of the same. The master controllers are placed at either end of each motorcar so that there is no difficulty in quickly making up long or short trains. These master controllers operate on a 12-volt circuit the pneumatic switchgear under each motor coach. There are on the master controllers only five notches for forward running and five for backward running. There is, however, in the pneumatic controller under the car an automatic accelerating device which comes into action on the fourth notch of the master controller. The object of this device, which is successfully attained, is to secure uniform acceleration independent of movement of the driving lever, and without an undue draught of current from the third rail. The electrically-controlled pneumatic relays which effect this seem at first sight to be complicated, are a simple development of the pneumatic mechanism of the Westinghouse brakes, which have stood the test of time, and proved absolutely reliable. With the pneumatic switchgear operated with 80lb. per square inch on the compressed air there is ample force to operate the switches with certainty. Another feature of this turret type of controller with the switches arranged in a ring on

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the under side is that a single blow-out coil can be used, and this can be made much more powerful than if an individual blow-out magnet had to be provided for each switch.

The organisation of this conversion from steam to electric working has been in the hands of Mr. A. C. Ellis, the general manager of the company, with the assistance of Mr. Thomas Parker, the consulting electrical engineer, and Mr. C. Jones, who has been appointed chief electrical engineer. Mr. E. P. Seaton, the company's engineer, has had the direction of the line works; and Mr. A. Ingram, the carriage and wagon superintendent, has supervised the construction of the rolling-stock.

We give herewith a few illustrations of this rolling-stock and also of the generating station. In an early issue we hope to publish interesting details of the plant, drawing special attention to those points in which striking advancement on older practice has been made.

(To be continued.)

KILMARNOCK ELECTRIC LIGHT AND POWER SCHEME.

The busy little town of Kilmarnock, in Ayrshire, with its population of 48,000, was *en fête* on Saturday last on the occasion of the inauguration of its Corporation electric light and power installation. This last and most ambitious of Kilmarnock's municipal enterprises is the result of discussion and negotiation which have gone on since 1898. At that time the growing popularity of electrical energy was brought home to the Kilmarnock people by a private company expressing the desire to take possession of the burgh for electrical purposes. There and then the Town Council engaged Mr. Wm. Arnot, consulting engineer, Glasgow, to look into the matter and report. The result of Mr. Arnot's favourable report was the appointment of an electricity committee, who visited various towns in Scotland to get further information. Opposition to the municipal ownership of the proposed undertaking still persisting among a number of the citizens, Mr. Bryson, of Leith, was next appointed as engineer to the Corporation. This, however, still did not better matters, as the drafting of a scheme and an estimate of the total cost by Mr. Bryson resulted in a majority being against proceeding further with the scheme. So matters remained for over a year, when Dr. Kennedy was invited to report on a scheme of electric light and tramways. Dr. Kennedy was optimistic as to the introduction of electric light, but expressed himself doubtful as to the advisability of going on with the tramway proposals. In the meantime public opinion seems to have ripened under the continued attempts of a private company to annex the burgh, and the result was that the Town Council decided to proceed with the double scheme. A tramway order was obtained, and the whole matter was put into the capable hands of Messrs. Kennedy and Jenkin to carry through. The commission appointed to promote the Bill gave the Town Council three years to carry out the work, and it is gratifying to record that the execution of the entire scheme has occupied only about a year.

The generating station, equipped for both lighting and traction, is situated on the north bank of the River Irvine at Riccarton, a suburb of the town. The front elevation of the buildings is of red sandstone and white pressed brick. The ground floor is set apart for offices. The chief engineer's office, the mains department offices, and the stores are on the first floor. The engine-room is 71ft. 6in. long by 37ft. 6in. wide, and contains four 200-h.p. Belliss engines coupled to dynamos of Messrs. Dick Kerr's make. The jet condensing plant is by Messrs. Mirrlees, Watson, and Co., of Glasgow, and is situated at the west end of the engine-room, where there is room left for a further generating set. The switchboard is placed on a gallery about 3ft. above the engine-room floor level, and has been built by Messrs. Cox-Walkers, of Darlington. The board is a combined one for lighting and traction, and is very compact. The dynamo rheostats are placed immediately under the gallery, and the regulating switches are worked by means of hand-wheels on the switchboard gallery. The arrangement adopted enables them to be placed very close together, thus giving the switchboard attendant complete control without the necessity of moving about. The whole of the switchboard connections, including the shunt leads, are of solid-drawn copper rods, supported on porcelain insulators, practically no cable being used. The battery-room is on the north side of the engine-room, and contains 254 cells of Tudor type, the capacity of the battery being 360 ampere-hours. Only a very few regulating cells are supplied, the booster being kept in circuit practically all the time. The boiler-house contains three Lancashire hand-fed boilers, 28ft. × 8ft. × 160lb. pressure, and are of Messrs. Yates and Thom's make, and there is accommodation for two further boilers. The coal supply is brought in by carts, which are tipped over into bunkers opposite the boilers, but it is hoped that an arrangement will be entered into with the G. and S. W. Railway Company for a railway siding, and negotiations are now in progress towards this end. The boilers are fed by means of two "Weir" direct-acting pumps, which draw water either from the town mains or from the condenser discharge, and can pump either direct to the boilers or through the Green's economiser, which is composed of 192 tubes. A small motor-driven sump pump has been erected in the pump-room alongside the boilers to deal with the drains in times of floods, as the foundations of the station are below flood-level. The pipework has been supplied by Messrs. Aiton and Co., of London, and is covered with Haacke's fossil meal composition, put on level with the flanges, which are themselves covered with planished steel plates. The workshop is situated on the east side of the engine-room, and is suitable for either car or machinery repairs. The car sheds hold 12 cars, 11 of which are now ready. The cars are the work of Messrs. Hurst, Nelson, and Co., Limited, of Motherwell, with the exception of the wheels supplied by Messrs. Hadfield, of Sheffield. The motors and general electrical apparatus for the equipment of the cars have been supplied by Messrs. Witting, Eborall, and Co., London.

The cars seat 52 persons each, and have the ordinary type of staircase, with an extended canopy top. They are painted olive green and cream. One noteworthy feature of the cars is a movable step, which, instead of folding back on itself as is usual, is hung on levers. By this means the step can be swung to one side and upwards by a catch and handle on the platform. When in the raised position, the step is about 16½in. above ground level, and can still be used as a step by the motor-man if he requires to get off his car. The buildings have been constructed and fitted up throughout by local contractors with the exception of the lighting, which is by Messrs. Cox-Walkers. Mr. C. Stanley Peach, of London, and Mr. C. Fairweather, jun., of Kilmarnock, have been the joint architects.

The tramway route consists of a half-mile of double line and 3¾ miles of single line. The track work has been done by Messrs. Dick-Kerr, under Mr. J. E. Tarling's supervision, and the rails are of the 90lb. girder type with the "Dicker" joint, and were rolled by the North-Eastern Steelworks, Middlesbrough. The track is bonded with solid-ended bonds, except at the points and crossings, where drift pin points have been put in. Passing places are arranged about every third of a mile, and the line where single has been laid to one side, as far as possible, to allow for doubling later on if required. The overhead equipment has been supplied and erected by Messrs. R. W. Blackwell and Co. The bracket arm method of carrying the overhead conductors has been adopted for those parts of the route which run through outlying districts, while in the centre of the town the wires have been secured to rosettes. The poles are entirely free from anything like decoration, and have no cast-iron bases. Bronze straight line hangers and pull-offs have been adopted throughout, and the gauge of wire used is No. 00 S.W.G. The cables have been supplied and laid by Messrs. Callender's Cable and Construction Company; their insulation is of impregnated jute, they are lead covered, and laid in wood troughs filled with bitumen and covered with hard brick tiles. Messrs. Callender have also supplied

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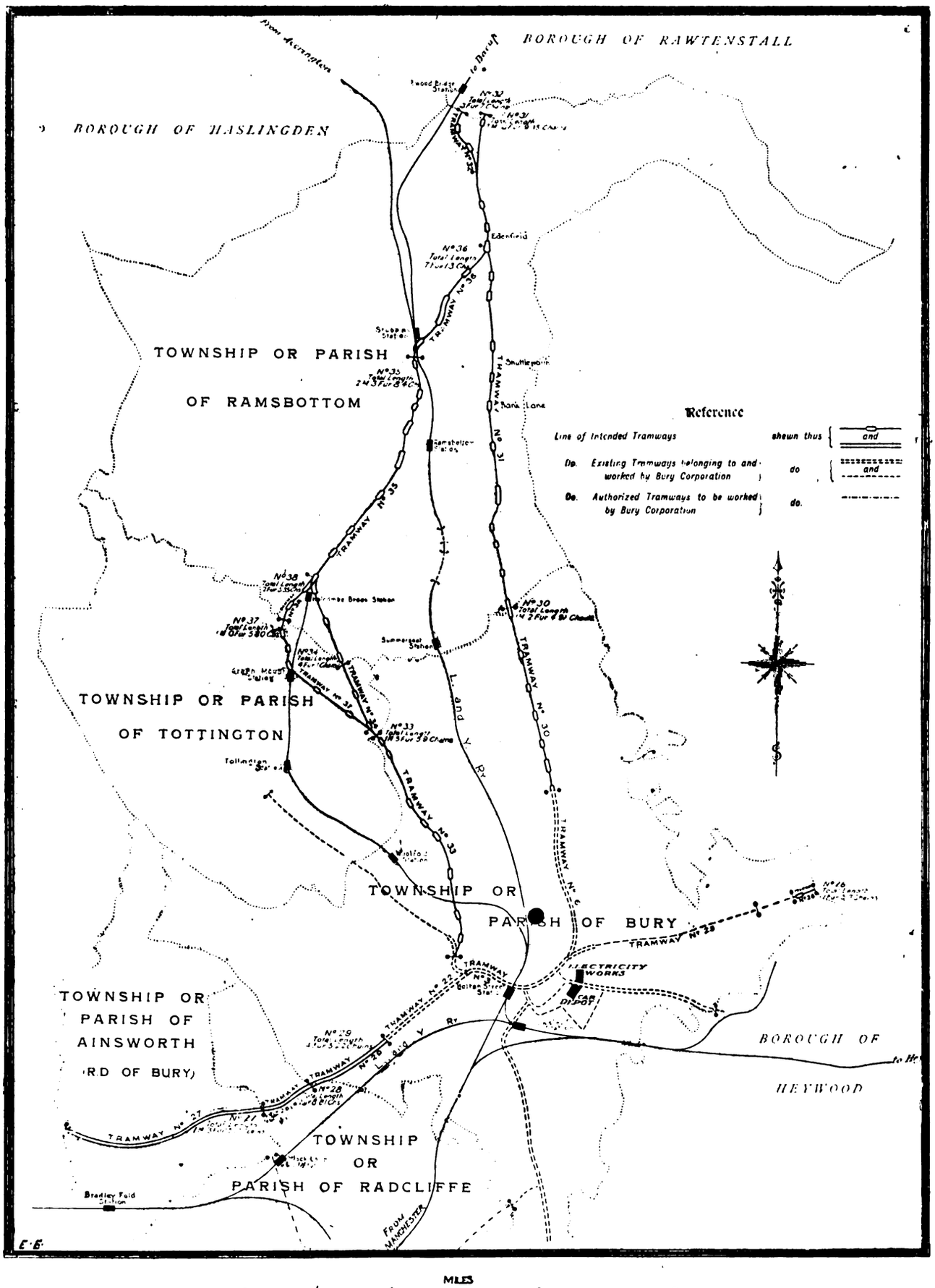
the section pillars and the signalling pillars, each of the latter containing a telephone.

The main thoroughfares of the town are lit with 50 10-ampere open type arc lamps of Messrs. Oliver and Co.'s make, and two incandescent lamps in brackets have been placed on each pillar to light the streets after midnight, when the arc lamps are switched out.

The supply for lighting purposes was started on 5th ult., and the applications to date number 56, equivalent to 5,400 8-c.p. lamps. The method of charging will be 5d. per unit for the first 1,000 units, 4½d. per unit for the next 1,000 units, 4d. per unit for the next 1,000 units, 3½d. per unit for the next 1,000 units, and 3d. per unit for all units above 4,000 per term. For heating and power the prices are 2½d. per



Map of New Tramways proposed to be constructed under the Bury Corporation Bill of 1905.

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unit for the first 1,000 units per term, with a reduction of ¼d. per unit for each successive 1,000 units up to 4,000, special terms being given to users taking more than 4,000 units.

The total cost of the lighting portion of the scheme is expected to be £37,000, while the cost of tramways will probably reach £42,000, which figures were stated by Dr. Kennedy, at the public luncheon, to be about £3,200 under the estimated cost. About £150 per week will be required to make the tramways completely self-supporting.

Mr. A. H. Burbridge, who was resident engineer for Messrs. Kennedy and Jenkin, the consulting engineers, has been appointed chief engineer and manager of the entire concern. Mr. Burbridge is a man of large experience, though only 30 years of age, and is a native of Somersetshire, having been educated at Windsor and Bristol Engineering College. He served his time, for four years, with Hawthorne, Leslie, and Co., of Newcastle-on-Tyne, and was in that firm's drawing office for three years. In 1900 and 1901 he had charge of the erection of the Motherwell electricity works. In 1904 he went to Kirkcaldy to take full charge of the electrical undertaking of that town.

The ceremony of starting the first car was carried out by Lord Howard de Walden. Before declaring the tramways system open and starting the gaily-decorated car which he occupied with a number of other prominent citizens, his lordship was presented with a silver-mounted motorman's controller with which to perform his office. Mr. Nelson, of Hurst, Nelson, and Co., made the presentation.

After the opening run over the track in six of the cars, the councillors and their friends adjourned to the George Hotel, Kilmarnock, where luncheon was served, Provost Hood, of Kilmarnock, being in the chair. Presentations were made by the chief contractors to Lord Howard de Walden, Provost Hood, and Bailie Wilson, the last-named being convener of the Electric Committee and a most enthusiastic and energetic worker for the scheme which has now been brought to such a successful consummation.

BURY CORPORATION TRAMWAYS.

Another important link in the chain of electric tramways is contemplated by the Corporation of Bury in a Bill deposited this session. The Corporation are seeking powers to connect their existing tramway system with the Bolton tramways; also to provide tramways in the urban districts of Tottington and Ramsbottom, connecting Greenmount, Holcombe Brook, Ramsbottom, Stubbins, Edenfield, and Shuttleworth with Bury. This latter tramway extends to the boundary of the borough of Rawtenstall. The diagram on opposite page will more fully explain the routes. The length of track is 20 miles. It might be added that the Bury Corporation have a system comprising 18 miles of track in full operation. The Corporation are also working a section of about half a mile in Whitefield belonging to Salford Corporation, so that Bury is in direct tram connection with Manchester and Salford. They will also work the Radcliffe tramways, consisting of 6½ miles of track, as soon as the construction is completed, and which is expected during the next few months. Radcliffe will then also be in communication with Manchester and Salford. Mr. Arthur W. Bradley, the borough engineer, is engineer for the present scheme, and he was engineer for and constructed the tramways now in operation.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on Dec. 8 the following were the candidates balloted for:

Member.—A. Clough, Newhaven, 14, Mersey-avenue, Aigburth, Liverpool.

Associate Members.—B. H. Lamb, care of Messrs. Thos. Cook and Son, Calcutta; C. R. Palairet, 100, Baron's Court-road, West Kensington; J. N. Stephens, 1, Devonshire-road, Palmer's Green, N.; W. H. Williams, 35A, Pembroke-square, Kensington.

Student.—A. J. Langhorne, Claverhouse, Upper Sydenham, S.E.

FORTHCOMING EVENTS.

FRIDAY, DEC. 16.

Institution of Mechanical Engineers. — At 8 p.m., "Heat Treatment Experiments with Chrome-Vanadium Steel," by Captain H. R. Sankey and Mr. J. Kent-Smith. Messrs. Seaton and Jude's paper on "Impact Tests on the Wrought Steels of Commerce," which was read at the last meeting, will be further discussed jointly with the above paper.

North-East Coast Institution of Engineers and Shipbuilders.—General meeting.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., "The Working of Batteries under Reversible-Booster Control," by Mr. E. D. S. Shelmerdine.

Institution of Civil Engineers.—At 8 p.m., students' meeting, "Folkestone Harbour: Cylinder-Sinking at the Root of the Old Pier," by Mr. R. H. L. Pennell.

Tramways and Light Railways Association.—Visit to power houses of the Great Northern and City and the City and South London Railways. Meet at Moorgate-street Station at 2 p.m.

SATURDAY, DEC. 17.

Glasgow Technical College.—Anniversary dinner.

MONDAY, DEC. 19.

Faraday Society.—At 8 p.m., "The Electric Furnace: Its Origin, Transformation, and Applications (Part II.)," by Mr. A. Minet; "Electrolytic Analysis of Cobalt and Nickel," by Mr. F. Mollwo Perkin and Mr. W. C. Prebble; "The Electrolytic Preparation of Tin Paste," by Mr. F. Gelstharp; and "Note on the Electrolytic Recovery of Tin," by Mr. F. Gelstharp.

TUESDAY, DEC. 20.

Institution of Civil Engineers.—At 8 p.m., resumed discussion on Messrs. Wood-Hill and Pain's paper, "On the Construction of a Concrete Railway Viaduct."

Institution of Engineers and Shipbuilders in Scotland.—At 8 p.m., general meeting at Glasgow.

WEDNESDAY, DEC. 21.

Royal Meteorological Society.—At 7.30 p.m., discussion on Mr. F. J. Brodie's paper, "Decrease of Fog in London during Recent Years," and the following paper will be read: "The Study of the Minor Fluctuations of Atmospheric Pressure," by Dr. W. N. Shaw and Mr. W. H. Dines.

Jan. 13.—A lecture, entitled "Theory of Electricity and Magnetism," will be delivered by Mr. J. Swinburne to the students of the Institution of Civil Engineers.

Jan. 27.—The following papers will be read at the Physical Society: "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows; "Action of Radium on the Electric Spark," by Dr. Willows and Mr. J. Peck; "The Slow Stretch in India-rubber, Glass, and Metal Wires when subjected to a Constant Pull," by Mr. J. Phillips; "Determination of Young's Modulus for Glass," by Mr. C. A. Bell; and "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

PERSONAL.

Mr. John Henry Fooks Bale was on Wednesday appointed electrical engineer to the Battersea Borough Council at a commencing salary of £400. Mr. Bale has been resident electrical engineer, Mersey Railway, for the British Westinghouse Company since 1902. On emanating from the City of London College, Finsbury, and Owen's College, Manchester, he became a mechanical pupil at the Haslam Engine Works, Derby, 1887-1890, and subsequently an electrical pupil at Messrs. Immisch and Co.'s, London, 1890-1893. Mr. Bale was construction engineer and resident engineer and manager to the Brush Electrical Engineering Company, Limited, Loughborough, and Lynton Electric Light and Power Company, Limited, from 1893 to 1899, and chief assistant electrical engineer to the Manchester Corporation from 1899 to 1902. There were 108 applications. There were also 131 applications for the appointment of a shift engineer at a salary of £104 per annum, and Mr. J. Galbraith-Westlake, of Peterborough, has been appointed.

The Kirkcaldy Town Council have increased the salary of Mr. O. F. Francis, burgh electrical engineer, from £250 to £300 per annum.

Mr. J. E. Teasdel, deputy electrical engineer under the Cardiff Corporation, has been the recipient of a gold watch and chain, case of cutlery, and a cigar-case from the employés of the electric light and tramways department on the occasion of his leaving Cardiff to take up the post of chief engineer and manager of the electric light and tramways of Pontypridd Urban District Council.

New Publications.—"Elements of the Differential and Integral Calculus," by W. A. Granville. (New York: Ginn and Co.; London: F. J. Mathieson. 10s. 6d.).—"Petrol Motors and Motorcars," by T. H. White. (London: Longmans, Green, and Co. 4s. 6d.).—"The Electrical Transmission of Energy," by A. V. Abbott. (London: Crosby Lockwood and Son. 30s.).

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TO CORRESPONDENTS.

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"SHOWING A FACE."

This is an American expression, as explained by Sir W. White at the jubilee dinner of the Society of Engineers on Wednesday last. Purely professional topics may be extremely pressing and interesting, but an occasional aside or burst hurts no man; on the contrary, frequently does good. The Society of Engineers is not an electrical society, although its *Transactions* contain a good many papers on electrical subjects, yet it deserves a good word here because of its general work and because of its age. Third in age among the engineering societies — the Institution of Civil Engineers and the Institution of Mechanical Engineers being older—it has for fifty years quietly and unostentatiously done good work. It was happily put by the president (Mr. D. B. Butler) that the society's influence for good was especially great among younger men. In the two older institutions the numbers were larger, the critics of the widest experience, so that young men felt diffident in expressing opinions. The Society of Engineers thus forms a training ground where young men can move freely, express their views, and more readily gain a hearing. The beginner often has something good to say, but finds a difficulty in saying it and ease of expression and the logical putting of the argument, which come, like most things, by constant practice. Fifty years ago the Society of Engineers was founded at Putney, and called the Putney Club, and in 1857 the club became the society, and the meetings henceforth were held in London. Sir W. White, in an exceedingly interesting speech, pointed out that an older society, called the Society of Engineers, was founded in 1771, and was still in existence, but under another name — "The Smeaton Society"—in honour of Smeaton, the builder of Eddystone Lighthouse. At the close of the year 1855 the Society of Engineers numbered twenty-five members, in 1857 these had increased to fifty-four, while in this—the jubilee year—the roll numbers over five hundred. We think young men should consider well the claims and the advantages of the society, and support it in still greater numbers. Among the advantages — and by no means the least — is the "showing a face"—that is, meeting fellow professionals, hearing criticism, exchanging opinions, and, above all, establishing friendly intercourse with the members of the profession who are growing up and doing business all round. The young men of to-day—learners, it may be—are the workers of to-morrow, the men who will be called upon to engineer the world. Fifty years ago a large part of the world's surface was a *terra incognito*. Intercommunication was a difficulty, the interchange of letters and messages with the Antipodes a question of months. Now we are linked by cables, the ocean is traversed by ships of a size and speed then undreamt of. Monetary proceedings of huge magnitude are transacted by means of a cablegram, and on every hand progress has been so rapid that the gain to the world is incalculable. Progress is surely not at an end. It may even proceed at a greater rate in the near future than it has done in the immediate past. We talk about an electrical era. Why, electrical engineering is a thing of the past quarter of a century, and what it will be at the end of another quarter of a century no man knows. Will horses be then kept in museums; will steam under the conditions now known be a thing of the past; shall we have yoked the ether and able to hold the reins? We know not; but one thing we do know. It is that the possibilities in the hands of the younger men are enormous—unprecedented in the history of the world. It is they who must carry on the work of progress. They dare where the older, and in a way more experienced, would

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never venture. They, with youth and energy backed by knowledge and ability, are those who will work among great things, and to qualify for that work must "show a face" everywhere and on all occasions. Would that words could act as a trumpet-call, and waken up the young men. England behind? Rubbish! We may be sleepy, but all that is necessary to place us in the forefront of nations is for the younger men to put in their energy, and let it be, when necessary, qualified by the experience of their elders.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PROPOSED BENEVOLENT FUND.

SIR,—It having been pointed out in many quarters that the electrical industry, although very wide-reaching and giving employment and occupation to many thousands of individuals in all grades of life, has in connection with it no means of supporting any of those unfortunate members of it who fall into temporary or permanent need, an influential committee of gentlemen actively connected with various branches of electrical work has been constituted to organise a benevolent fund for the industry.

This committee has authorised me to announce to you that insufficient time has elapsed to prepare a full scheme of operation, but that as we are approaching the Christmas season, when doubtless many connected both directly and indirectly with the industry are giving gifts in kind and cash, to ask you to make a preliminary notice in your esteemed journal so that they may earmark or retain some important percentage of these gifts for the fund.

As soon as a sufficient sum is available, this fund will eventually be used for the purpose of providing pensions and donations for deserving cases in the electrical industry, voted for by the subscribers.

Further details will shortly be announced, but in the interval the organisation is being rapidly proceeded with.—Yours, etc. JUSTUS ECK.

[We publish the above, as requested by Mr. Justus Eck, but unless the effort is being made in connection with the benevolent fund of the Institution of Electrical Engineers we should not be inclined to give it our support. We have felt for a long time that the benevolent fund of the Institution is not receiving the support it deserves, and that it really should have the consideration of the Council before the scheme for providing a separate building for the Institution's work. In the severe competition nowadays the early pioneers of the electrical industry are apt to fall behind in the race, and it is only right that the profession as a whole should assist in cases of this kind. The benevolent fund of the Institution of Civil Engineers does a splendid work in this way, and it is free from one point which is unavoidable in Mr. Justus Eck's proposal—*i.e.*, if the deserving cases are to be voted on by the subscribers, the assistance can only be given after extended publicity. In the case of the Civil Engineers' Benevolent Fund only two, we believe, of the committee actually know the names of those receiving assistance. If this is so, there is more chance of help being given where most deserved than is possible when there is publicity both of the application and of the award. We do not know how far Mr. Eck proposes to deal with workmen connected with the industry, but these, we think, have a benevolent fund in their trade society.—ED. *E. E.*]

RUNNING POWERS—COMPULSORY OR OTHERWISE.

The following interesting letters on the above subject have been received since we published our last issue dealing fully with the matter. The experience of the writers lends great weight to their opinions.

Rotherham, Dec. 13, 1904.

Dear Sir,—It is a difficult matter, indeed, to express an opinion as to the desirability of intercommunication between tramway systems, and particularly with regard to the commercial possibilities of compulsory interchange of traffic and the best method of dividing the receipts and working expenses from the through-going traffic. I am, however, of opinion that it is wise where authorities can enter into agreements to have intercommunication, it is desirable in the interests of towns separated by very short distances, and in some cases where there is no actual distinction except what is recognised by the various rating authorities.

We are on the point of arranging with Sheffield to run through from Rotherham, and *vice versâ*. Unquestionably it will be a gain to both towns. It will facilitate travelling and induce greater numbers to use the trams, although the period of waiting at our terminus is comparatively short, yet, short as it is, those who are in the habit of using the trams are constantly grumbling because of the necessity of changing from one car to another. The method of dividing the receipts will have to be regulated according to the traffic in each particular town. For instance, in some towns it might be found that the traffic in each town will be about equal, and I am of opinion that the easier way of dealing with the receipts is to let each authority take the receipts in its own area, giving the conductors tickets belonging to both authorities. The working expenses can be dealt with in almost the same way—*i.e.*, each undertaking bearing its own expenses in its own area, unless, of course, the distance in one area is greater than the other, and in that case the agreement would have to be made on the basis of so much per car mile run.

D. L. WINTER,
Chairman of the Rotherham Tramway Committee.

Rotherham, Dec. 8, 1904.

Dear Sir,—I am in receipt of yours of the 29th ult. *re* the question of intercommunication between tramway systems. The Newcastle case, as you pointed out, has been more in evidence of late, and I am pleased to see that this is being amicably settled. I am certainly of the opinion that where intercommunication between tramway systems is practicable, it is most desirable and in the interest of the public that a mutual arrangement for interchange of traffic should be come to. As to terms, I think that this is a question that could be settled with very little difficulty by the authorities interested.

With regard to the latter part of your letter *re* the carrying of parcels and goods, this is no new thing, having been done for some years on several systems, and to my knowledge adds very considerably to the revenue, and I am sure it is worthy of most careful consideration by all tramways committees.

I regret that I have not had time to go further into the matter, but trust these few remarks will be of service to you.—Yours faithfully, W. GRANT,
General Manager, Rotherham Tramways.

Liscard, Cheshire, Dec. 8, 1904.

Dear Sir,—Replying to your enquiry, which I regret has not had earlier attention, the question of running powers over electric tramways is one that is bound to be much in evidence in the future, and personally I am in favour of providing the amplest facilities for intercommunication between neighbouring communities, so that where a mutual working arrangement cannot be entered into between two or more undertakings, and it can be shown there is a public demand for tramway accommodation, I think that running powers should be conceded, subject to the payment to the owning authority of an adequate amount for wear and tear, and an equitable proportion of the earnings on its track.—Yours faithfully, R. R. GREENE,
General Manager, Wallasey Council Tramways.

Bournemouth.—A memorial has been sent to the Corporation for an extension from Westbourne to Sandbanks.

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BRADFORD'S BURNOUT.

Thursday, Dec. 8, will be remembered by those connected with (or connected to) the Bradford electricity supply for some considerable time as a day of disaster and vexation, possibly with the usual Athanasian accompaniment.

The shadow of the trouble had been hanging over the heads of those responsible for some little time previously, as the recent report of Mr. Blackman's to the Electricity Committee foreboded. This report stated that the sheathing of some of the cables had been eaten away, and that a considerable amount was known to be on the point of breaking down. That this was a correct estimate may be judged by the fact that a short-circuit occurred upon the negative side of the system in the morning at six o'clock, developing into a heavy short across the outers 10 minutes later, and upon investigation the fault was located to the feeder laid across the iron bridge in School-street. The feeder was disconnected at both ends, but a heavy fault still remained. The pavement upon the railway bridge was opened up, when it was found that the arcing had burnt a hole in the iron plates forming the bottom of the bridge. The cable was cut upon each side of this, and tested bad in both directions.

At 8.30 a.m. the pavement opposite the Midland Station, about a quarter-mile distant from the bridge, was displaced by an explosion, and the ground was immediately opened up to expose the cables, which at this point are laid in two parallel brick and stone culverts, which contain the cables supplying current to the four most important feeding points in the centre of the town. While this work was proceeding, violent explosions occurred, and the pavement was displaced at other points in the immediate vicinity. The explosions became so serious that at 10 o'clock the works were shut down in order that the faulty cables might be cut clear.

There are at each feeding point three pavement boxes arranged side by side, and the links in all except the centre boxes were removed at the four feeding points and at the works, but the explosions continued after the current was cut off with increasing violence, so that it was not considered advisable to commence running again until the ground had been opened up and the culverts ventilated in places by the removal of the cover stones, which are 6in. thick, and consequently heavy to handle.

Observation at this time showed that nearly all the 15 cables in the two culverts were burnt asunder. The works were started up again at mid-day, when smoke commenced to re-issue from the ground, the mains being at the time fed by 1,800 kw. of plant across the outers, and 320 kw. of steam balancers on each side. The ground was accordingly opened up below the bottom of the culverts, and short lengths of armoured cable, which, by the way, no one upon the job knew were located there, pulled out in a very heated condition. It was difficult at the moment to account for the cable being alive, as the whole of the cables had, so far as could be ascertained, been disconnected at both ends upon the positive and negative poles. The bottom of the culvert, which also consisted of stone slabs 6in. thick, was removed for some yards, and arcs exposed, which were, however, kept down by re-covering them with earth. The works and feeding-point boxes were visited to confirm that all the links in the outside boxes and at the works had been removed. This proving to be the case, and as the arcing continued with unabated vigour in close proximity to a large gas-main, the works were shut down a second time at 2.30, as the feeders remaining were not in any event nearly adequate to carry the evening load. It was subsequently found that pieces were fused out of the gas-main which was not cut off, and it is therefore probable that the damage would have assumed very serious proportions had the arcing continued.

The whole of the cables upon each side of the fault were now cut, and every available man was set trimming back the ends, as it was necessary to test the cables to ascertain which were useable, as they had been very considerably heated carrying the heavy currents to the faults, and the terminal points of the individual cables in each direction were unknown, owing to the cables having been mixed in the culvert.

While this work was proceeding new cable was got on to the job and pulled in to bridge the gap, which was 160 yards in length. Several of the cables in different parts of the town were found to have dead earths upon them, which so reduced the capacity of the mains between the fault and the feeding points that the current could not be reinstated until such time at night as the load fell to the capacity of the available mains. The supply of practically the whole of the town was reinstated at midnight, but while the main fault was being dealt with another developed in quite another part of the town, and this was taken in hand and the supply recommenced here soon after six next morning. During the night the faults upon the more important of the defective cables were located, and the following day additional temporary cables were got in to augment those bridging the gap caused by the destroyed cables.

The cables that were the cause of the mishap, and those burnt out thereby, were laid between 8½ and 16 years ago, and were burnt through at many places at old-fashioned, cast-iron, straight-through joint-boxes, fitted with rubber glands, the cables having lead sheaths and hygroscopic insulation. The Bradford system of mains has until the last few months consisted wholly of single-core cables, and there are no fuses upon these.

The mystery of the live cables beneath the culverts was cleared up in tracing the cables out, and found to be caused by a set of three single-pole disconnecting boxes being arranged with the negative between the positive and neutral instead of the neutral box being in the centre, as in all other parts of the town.

The trouble is attributed to stray currents upon the cable sheaths causing a fault at the point where a cable entered a rubber gland joint-box, and thus raising the potential of the lead sheaths (these not being electrically connected across the boxes), and the moral is obvious.

Considerable inconvenience was caused by the complete shut down of the thousand odd motors in the town. Candles were quickly at famine prices, and finally became unobtainable. A committee meeting at the town hall was illumined by candles stuck in whisky bottles, which, strange to say, were found on the premises. When at midnight the current was put on from the works, the unusual spectacle of business establishments fully lit up and with shafting at work was to be seen. This was due to switches having been left on, and a number of policemen were detailed to drag unfortunate shopkeepers from their beds in the suburbs to come down and switch off.

THE MEASUREMENT OF VACUUM.*

BY C. TURNBULL.

The invention of the steam-turbine has given us an electric generator taking up little space even for enormous outputs. We are also able to obtain single boilers which will give us as much as 40,000lb. of water in an hour in an economical manner, although taking up small floor space. But while many of the problems of other days are being solved, the greater problem still confronts us—namely, that the price for electrical energy has gone down to limits that were almost undreamt of, and it is likely to go down still further. We must therefore look to the saving of at present neglected losses to pay our way in the future. Given large and efficient engines and boilers in the station, one of the chief problems will be to move very large quantities of coal, oxygen, and condensing water in the most economical manner. Indeed, I have no doubt that we will soon see the same attention given to instruments showing the composition and temperature of flue gases, the amount and temperature of condensing water, and to the actual vacuum at the engine exhaust, with a view to the regulation of the results in a proper manner, that is now given to the switchboard instruments.

* Paper read before the Newcastle Section of the Institution of Electrical Engineers.

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To-night I would particularly direct your attention to the measurement of vacuum. While this is becoming one of the most important things in the whole station, its measurement at present is obtained in a most unsatisfactory and indirect manner. The vacuum gauge in common use measures the difference between the condenser pressure and the atmospheric pressure. It is, therefore, necessary to read the barometer as well as the vacuum gauge to get at the true result. Thus with a vacuum gauge at 25in. and the barometer at 30in., the actual pressure of the condenser

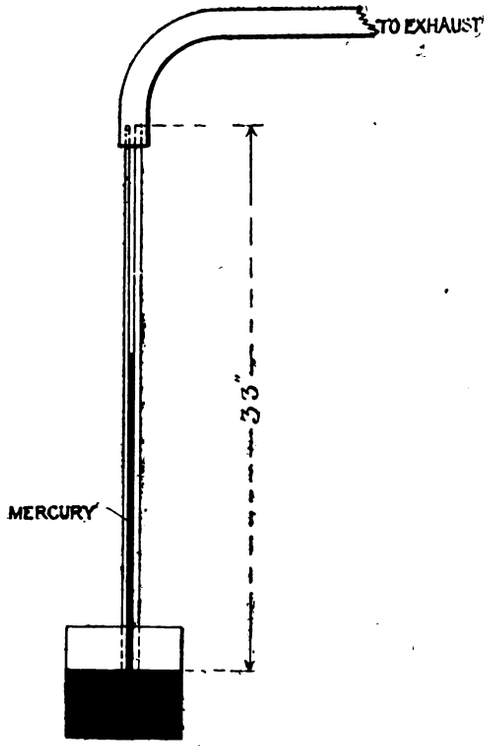

FIG. 1.

is 5in., and this 5in. is the only quantity that really concerns us. (The term "percentage of vacuum" which is sometimes used is quite wrong.) Unfortunately, this fact seems to have been covered up a good deal. A high barometer helps to make a high reading on the vacuum gauge, and people sometimes seem to like it accordingly, yet the increased atmospheric pressure probably decreases the actual vacuum. The lower the barometer is, the better will be the actual vacuum, although the vacuum gauge will

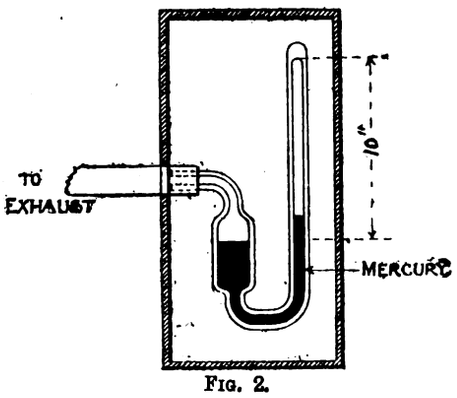

FIG. 2.

show a worse result. What we require, then, is an instrument which will fulfil the following requirements: (1) it must show the actual pressure in the condenser quite independently of the pressure of the atmosphere; (2) it must be quite accurate in its readings, and not liable to go wrong.

The first requirement would be met by an ordinary Bourdon gauge with an *exhausted tube* (or a similar arrangement to that used in the aneroid barometer), but with the *case* of the instrument connected to the condenser. This will measure the actual pressure at the exhaust, quite independently of the pressure of the atmosphere. Another and perhaps better way is to make use of the ordinary mercury barometer, only it must be connected up properly. As ordinarily used (Fig. 1) the mercury column balances the difference between the condenser pressure and that of the atmosphere. If we connect up as in Fig. 2, the mercury column will show simply the actual pressure in the condenser, and quite accurately. When the mercury rises 4in. in the tube, it means just that there is a pressure in the condenser which has an effect upon the back of the piston of a reciprocating engine as if the piston were lifting a layer of mercury 4in. deep. I think that this concrete idea helps us to understand the reality of the stuff left in a 26in. vacuum, and how it is that good work may be got out of this stuff if it is allowed to flow into a still lower pressure. For most purposes with the Fig. 2 instrument, a 10in. tube is quite long enough, for this will show a vacuum as low as 20in. The instrument can therefore be made in a neat and cheap form. The idea is not new, of course, but so far as I know it has not come into common use. Whether or no it would be better to speak of a 29in. vacuum as being a 1in. back pressure, time alone will show.

Position of Gauge.—It is to be noted that the reading of any vacuum gauge is materially altered by its position. If it be placed low down, then water will collect in the tube leading to it, and the weight of the column of water will affect the reading. Probably this fact often accounts for the difference of reading between the gauge on the engine exhaust pipe and the gauge on the condenser, as much as the drop of pressure between the two due to loss in the connecting pipes.

Seeing the enormous importance of good vacuum with large turbines, I have thought that the subject would prove worthy of your interest to-night

THE USE OF IRON IN ALTERNATE-CURRENT INSTRUMENTS.*

BY W. E. SUMPNER, D.SC., MEMBER.

(Concluded from page 853.)

APPENDIX.

Note I.—The Action of a Rotating Magnetic Field on a Coil conveying an Alternating Current, and free to rotate about the same axis as the field.

Assume the axis of rotation perpendicular to the plane of the paper and represented by O in Fig. 10. Let the rotating field be of constant strength, F, and of uniform angular velocity, p. Let its position be O F_0 initially, and be O F at time t, where $\theta = pt$ is the angle $F\hat{O}F_0$. Let the plane of the coil be represented by O C inclined at angle

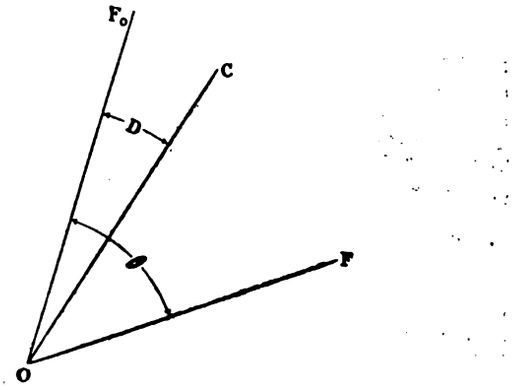

FIG. 10.

D to O F_0. Suppose the current in the coil follows the sine law, and that its value at any moment is

$$A_0 \sin (pt - \phi)$$

where ϕ is the phase angle to be measured, then the torque tending to move the coil is at every instant proportional to

$$A_0 F \sin (pt - \phi) \cos (pt - D).$$

The mean value of this will be zero when

$$D = \phi,$$

* Inaugural address of the Chairman, delivered before the Birmingham Local Section of the Institution of Electrical Engineers.

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or the angular deflection, D, of a pointer attached to the coil will directly measure the phase angle ϕ whatever the frequency of the current. If ϕ is greater than D the coil will move so as to increase D, and *vice versâ*, the turning moment reversing sign with $D - \phi$. It will be readily seen that the turning moment is greatest when D and ϕ differ by 90deg., and that there is an unstable position of equilibrium when these quantities differ by 180deg.

The rotating field will tend to induce a current in the coil as in an induction motor, and there will in consequence be a tendency for it to rotate with the field. This can be made quite negligible by the use of resistances in series with the coil. The more inductive these resistances are the less will be the effect. If the current in the coil is produced, as it would be in practice, by a current transformer, a tendency of this kind would have no effect on the current through the coil, but only on the voltage absorbed by the primary.

If the current does not follow the sine law there will be no direct proportionality between the deflection, D, and the effective angle of lag of the current. If, however, the rotating field be uniform in strength and angular velocity, D will depend upon and be a measure of the time elapsing between the instant at which the field is directed along OF_0, and the instant at which the current passes through its zero value, but D must be measured from some zero position not necessarily coinciding with OF_0. The calibration of the instrument as a power-factor indicator will to a slight extent be dependent on the wave-form of the current, for if F is constant in magnitude and angular velocity, while the current, A, through the coil has some special wave-form, the torque on the coil is proportional to

$$A \cos (pt - D),$$

and its average value will vanish for a particular relative position of the waves representing the current A and the sine function $\cos (pt - D)$, supposing these waves plotted to a time base. If the wave-form of A remains constant, but its phase (as represented by the instant of reversal) varies, the displacement of the wave A will be proportional to the time representing the phase, while the displacement of the wave $\cos (pt - D)$ will be proportional to D, hence for different phases of A the equilibrium value of D will be a direct measure of this time or phase.

If F is neither uniform in angular velocity nor constant in magnitude, the effect becomes more complicated. The torque is then measured by the average value of

$$A F \cos (\theta - D),$$

where $$F = F_0 + f, \text{ and } \theta = pt + \delta.$$

F_0 is the average strength of the rotating field, and p the average value of its angular velocity. A, f, and δ are alternating periodic functions of the time. D is then no longer proportional to the time representing the phase of A, but is still solely determined by this time for given wave-forms of A, f, and δ.

Note II.—Wattmeter Errors.

If owing to self-induction in the pressure coil the current in it lags by an angle θ behind the voltage causing it, the wattmeter will read

$$V A \cos \theta \cos (\phi - \theta), \text{ instead of } V A \cos \phi,$$

where $\cos \phi$ is the power factor of the load, and ϕ is positive for lagging currents and negative for leading ones. The factor $\cos \theta$ can be considered unity for the small angles of θ at all likely to occur. Even if θ is 1deg, $\cos \theta = 0{\cdot}99985$. This factor is, moreover, independent of the phase of the load, and is, therefore, allowed for in the calibration of the instrument. Its variation with frequency is utterly negligible.

We can regard the small angle θ as a small decrement of ϕ, so that if the true watts, W, are given by

$$W = V A \cos \phi,$$

we have for the error δW,

$$\delta W = -\theta \frac{d W}{d \phi} = \theta V A \sin \phi,$$

or,
$$\frac{\delta W}{W} = \theta \tan \phi, \text{ and } \frac{\delta W}{V A} = \theta \sin \phi.$$

In these equations, of course, θ must be in radians (1deg. = 0 01745), so that $\theta \tan \phi$ represents the error in reading as compared with the true power in watts, while $\theta \sin \phi$ is the ratio the error in reading bears to the volt-amperes. These errors are worked out in Table I. for an angle of 1deg. For small angles the errors are proportional to θ. Whether these errors produce an appreciable effect on the instrument reading depends very much on the meaning in watts of the full deflection of the instrument. If this denotes V A numerically, the error as a reading may not be easily detected for lower power factors, but if it denotes V A $\cos \phi$, or W, the error may be large.

The error increases with the phase difference ϕ between volts and amperes. In the measurement of power on three-phase mains by the two-wattmeter method, there is always a phase difference of 30deg. or more between the currents in the two coils of one of the instruments, and it seems natural to expect appreciable errors in the masurement when the mains carry lagging currents. But on examination it will be found that the error is not greater than would be the case on single-phase mains carrying currents of the same power factor. For if the instruments are alike, the effect of a small lag θ in the pressure coils is the same as slightly diminishing ϕ. The two wattmeters read respectively

$$W_1 = A V \cos (30 + \overline{\phi - \theta})$$

and
$$W_2 = A V \cos (30 - \overline{\phi - \theta}),$$

where V is the voltage between the mains, and A is the line current, assuming balanced loads.

So that the watts read are given by

$$W_1 + W_2 = 2 A V \cos 30 \cos (\phi - \theta),$$

and the true watts, W, are obtained from this by putting $\theta = 0$. Hence as before, regarding θ as a small decrement of ϕ, we have, if δW is the error in the measurement,

$$\frac{\delta W}{W} = \theta \tan \phi.$$

Note III.—On Wattmeters having Iron-Cored Electromagnets.

Suppose an instrument such as is illustrated in Figs. 6 to 8 have its electromagnet excited by a coil of n_1 turns and resistance r, by means of a current A_m produced by voltage V_1. Let N be the total flux through the coil, the induction density in every part of the air-gap being assumed proportional to N. We have

$$V_1 = r A_m + n_1 \frac{d N}{dt} \quad . \quad . \quad . \quad . \quad (1)$$

Let the load current, A, be passed through the primary of an air-core transformer, the secondary of which is connected, through a considerable non-inductive resistance, R, with the moving coil of the instrument. Assume the current, c, produced in the secondary winding is insufficient to alter the magnetic effect of A. We then have

$$c = \frac{k}{R} \frac{d A}{dt} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where k is some constant. The torque exerted on the moving coil for any given deflection will be proportional to

$$\int_0^T c N \, dt,$$

where T is the periodic time. This quantity is proportional to

$$\int_0^T N \frac{d A}{dt} dt.$$

But since N and A are periodic functions having the same period, T, this integral is easily shown to be the same numerically as

$$\int_0^T A \frac{d N}{dt} dt.$$

whence by (1) it is proportional to

$$\int_0^T A (V_1 - r A_m) \, dt.$$

Assuming that the vector representing the copper drop,

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$r A_m$, is negligible in comparison with that representing V_1, it will be seen that the deflection of the instrument is a measure of

$$\int_o^T A V_1 \, dt,$$

or of the watts, if V_1 is the voltage across the mains. This result will be true whatever the wave-form or frequency, whatever the nature of the iron forming the core of the electromagnet, and whatever the phase difference between V_1 and A, provided the copper drop is negligible, and the transformer current, c, varies as the rate of change of A.

Suppose the self induced magnetic voltage is denoted by V_m, where

$$V_m = n_1 \frac{dN}{dt}, \text{ and } V_1 = r A_m + V_m,$$

the deflection of the instrument measures the mean value of the product $V_m A$ in all cases. Suppose the coil of the electromagnet, instead of being shunted directly to the mains, forms the load of the secondary of an instrument transformer, the primary of which is shunted across the mains at voltage V. The average product of V A then represents the watts to be measured, while the reading of the instrument is a measure of the mean value of $V_m A$.

If Fig. 11 represents the vector diagram of the voltages and currents considered, and if θ_1 and θ_2 represent respectively the phase differences between V_1 and V, and between V_1 and V_m, the error in the wattmeter mainly depends

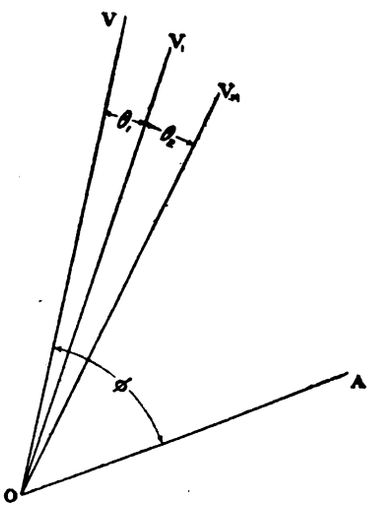

FIG. 11.

upon the values of these phase differences, θ_1 and θ_2. For the ratio of the lengths of the vectors V_m and V is independent of ϕ, the phase of the load current A in reference to V, and varies only inappreciably with frequency, or for different values of V. If θ is the excess of the angle separating V from A, over the angle separating V_m from A, the error of the wattmeter follows the same law as that given in Note II., and we have for small values of θ,

$$\frac{\delta W}{W} = \theta \tan \phi.$$

The value of θ must be well within 1deg if the wattmeter is to work satisfactorily on circuits of different power factor. θ is the resultant phase error due to (1) the phase difference between V_1 and V_m; (2) the phase difference between the primary and secondary voltage of a pressure transformer if used with the magnetising coil; and (3) any difference between a right angle and the actual phase difference of the currents c and A.

It is to be noted that the inductive effect of the alternating field does not tend to turn the moving coil. The field flux, N_1, enclosed by the latter varies with the position of the coil, but, for a given position, is always proportional to the total flux, N, produced by the alternating electromagnet. The induced E.M.F. is proportional to the rate of change of N, so that with non-inductive resistances in series with the coil the current produced by this E.M.F. is proportional to, and in phase with, the rate of change of N. The field in which the coil is placed is measured by N, so that the torque on the coil due to this induced current is proportional to

$$N \frac{d \cdot N}{dt},$$

the average value of which is zero for all periodic functions.

If it can be shown that the angle between V_1 and V_m introduced by the copper drop in the magnetising coil is no larger than the phase differences caused by the use of current and voltage transformers with wattmeters, it necessarily follows that the use of iron-cored electromagnets in wattmeters need introduce no greater error into the measurement of power than such transformers actually do in practice, while the greater sensitiveness and range of an instrument constructed in this way are obvious advantages.

TRADE NOTICES AND NOVELTIES.

Electrical Instruments.

During the last two years Messrs. Crompton and Co., Limited, have been engaged in working out a system of manufacturing electrical instruments of the moving-coil type for direct currents in such a way that they can be easily verified and adjusted by the user. The practical results of this labour are set forth in a pamphlet recently published by the firm. In this pamphlet the details of the construction adopted are clearly described and illustrated. Every indicating instrument is, we are told, either a milliampere-meter reading to 15 milliamperes, or a milli-voltmeter reading to 75 milli-volts. The large currents or pressures they are used to indicate are not required for their calibration, for which a Leclanché dry cell or a small accumulator is sufficient. The method of testing them, and of making any small corrections that may be found necessary, is explained on pp. 9 and 10 of the pamphlet, a copy of which any reader interested could not do better than obtain.

"Bifluid" Tachometers.

A new type of speed indicator is described in a list recently issued by Messrs. W. E. Moulsdale and Co., 24 Chapel-street, Liverpool. The "Bifluid" tachometer, as it is called, is a patented instrument for measuring speed of rotation or of progressive motion by utilising the difference of effect exercised by centrifugal force on two fluids of widely different specific gravity, enclosed in a tube and specially-constructed reservoir. The instrument may be mounted direct upon any vertical revolving part, or driven by pulley and belt from any rotating part of the machine. It has no springs, levers, or pendulums, but acts like a thermometer or a barometer, indicating on a scale by the height of the fluid in the tube the speed of the motor or machine at any instant. The scale may be graduated to show miles per hour, feet per second, revolutions per minute, knots per hour, or any other desired combination.

Fourteen-Day Recording Instruments.

We note that Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, are making recording voltmeters and ammeters which will run for a fortnight without rewinding or reinking. In other words, two of the chief difficulties peculiar to the design of this class of apparatus—that of driving a continuous band of paper and keeping up a supply of ink for a lengthened period without constant attention—have been successfully overcome in these instruments; the former by the use of a serrated driving wheel acting on the centre of the paper band, and the latter by a special form of pen capable of carrying a large supply of ink, and moving across the paper in a straight line instead of describing an arc of a circle. The paper roll is rewound on a spool after it has passed beneath the pen. The electrical movement consists of two solenoids, into which are drawn soft-iron cores attached to a beam on the spindle of the pen lever. The pull is exerted against a phosphor-bronze spring, and owing to the special form of solenoids and construction of other parts, a practically equal scale is produced, while hysteresis is reduced to a negligible quantity. The movement of the cores within the solenoids gives a strong damping effect, so much so that the system is more dead-beat than a moving-coil movement under similar conditions. For recording ammeters of 40 amperes and upwards a moving-coil system is, however, used in place of this solenoid movement, and outside shunts with lengths of flexible connectors are supplied. These recording ammeters and voltmeters are made in two types, respectively for mounting on switchboards and portable use. The portable type voltmeters have the resistances self-contained up to 300 volts; above that voltage separate resistance boxes are added.

Catalogues, etc.

DICK-KERR PLANT.—From Messrs. Dick, Kerr, and Co., Limited, of Abchurch-yard, Cannon-street, London, E.C., Preston, and Kilmarnock, come two publications—one a revised edition of their direct-current generator book and the second a volume describing alternating current machinery of the firm's manufacture. Either is well worthy of a place on any electrical engineer's bookshelf. In fact, we have never seen better productions of their kind, the illustrations being especially fine. The first-mentioned describes the various parts and the process of manufacture of a Preston standard-type continuous-current generator, while the principal features of Dick-Kerr three-phase generators and sub-station plant are set forth in book No. 2. The construction of these latter machines is based on the very latest developments in the design of polyphase plant. Some useful line drawings are given, in addition to a number

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of splendid half-tone illustrations, and the descriptive matter is lucid in style. If the demand for these books bears a fair proportion to their merits, no doubt the current editions will soon be O.P. We must, indeed, congratulate Messrs. Dick, Kerr and Co., Limited, upon the general excellence of their latest publications.

FEED-WATER HEATERS, ETC.—Erith's Engineering Company, 70, Gracechurch-street, London, have sent us a copy of their catalogue, No. 153, dealing with "Cochrane" feed-water heaters and purifiers, of which they are the sole makers. These heaters are supplied for capacities ranging from 150 to 30,000 gallons per hour, and plants representing a very large total output have already been installed. In the same catalogue is described the firm's automatic hot process purifier. This is a water heater and softener combined, used for the chemical treatment of hard water. The purification is accomplished partly by the mechanical action of the heat of the exhaust steam, which drives off the liberated gases through a vent to the atmosphere, and partly by the use of a single inexpensive chemical reagent—viz., ordinary soda ash.

"EDISWAN" FITTINGS.—In issuing a second edition, the Edison and Swan United Electric Light Company, Limited, 36 and 37, Queen-street, Cheapside, E.C., have taken the opportunity to revise and enlarge their catalogue (Section II.) of ship, factory, and colliery fittings, etc. They are now listing a large size colliery fitting, with cast-iron painted reflector and well glass, to take up to five 32-c.p. lamps. We note, further, that a large assortment of all-porcelain fittings, cheap factory fittings, and street lamp fittings have been added; also two pages of traction fittings for the interiors of tramcars.

"HOLMES-PAGE" SWITCHES.—The advantages of "Holmes-Page" patent quick-break chopper-type switches are described in one of the catalogues recently issued by Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, the makers. Several useful types are illustrated, among them being single, double, and triple pole switches in cast-iron boxes, designed to meet the requirements of the various fire offices, electricity supply companies, and municipal authorities. These switches, it may be added, are of particularly neat appearance.

EXCESS INDICATORS AND AUTOMATIC LIFT CONTROLLERS.—From Messrs. Monté Callow and Co., 6, Ludgate-broadway, E.C., we have recently received two leaflets, one of which describes excess indicators (Atkinson's patent). These indicators have been designed, we are told, to meet the requirements for an instrument to record the fact of an excess current having passed through electrical apparatus, such as motors, transformers, etc., for more than a short period of time. They work on the well-known principle of the Atkinson demand indicator, and are made in four types. The second leaflet deals with automatic reversing starters, suitable for lifts working on direct, alternating, or polyphase currents. In these starters the resistance cannot be cut out of circuit when the motor is so overloaded that it is unable to start.

WEST HAM CORPORATION TRAMWAYS.

Herewith we give abstracts of the revenue account and balance-sheet of the West Ham Corporation tramways for the half-year ended Sept. 30, 1904. The capital expenditure to that date amounted to £196,538.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Electric cars—traffic expenses	8,809	0	7
General expenses, salaries of staff, etc.	2,032	14	7
Repairs and maintenance of permanent way	1,422	5	5
Power expenses—purchase of current	3,324	1	0
Proportion of cost of temporary buildings	1,000	0	0
Repairs and maintenance of horse cars	762	8	1
Total amount of working expenses	17,350	9	8
Balance carried to net revenue account	13,397	11	6
	£30,748	1	2

Cr. Income.	£	s.	d.
Traffic revenue—electric cars	27,259	15	9
Advertising rights on cars	488	5	5
Traffic and sundry revenue from horse cars	3,000	0	0
	£30,748	1	2

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
West Ham Corporation stock	289,604	0	0
Sinking fund	2,162	19	7
Sundry creditors	831	1	5
Reserve or renewals fund	3,016	7	9
	£295,614	8	9

Cr. Assets	£	s.	d.
Cost of existing works, etc.	196,538	5	3
Expenses of issue and discount of Corporation stock	41,350	11	10
Cash and investments—consolidated loans fund	2,162	19	7
Cash in bankers' hands	49,935	15	3
Stores on hand	413	6	8
Temporary buildings	3,244	15	1
North Metropolitan Tramways Company	1,769	6	0
Sundry debtors	199	9	1
	£295,614	8	9

NOTES ON PERMANENT WAY FOR TRAMWAYS.*

BY A. N. CONNETT, M.I.C.E. (MEMBER OF COUNCIL).

(Concluded from page 845.)

Theoretically, the flange pressure to overcome centre or side-plate friction on bogie trucks only takes place on entering and leaving the curve, assuming that this is not compounded. The trucks not being absolutely rigid, there is some "give" in them, and, consequently, flange pressure from this cause will exist all through the curve, though, of course, to a much greater degree at the two ends. To sum up, one cannot assume a minimum rail and flange wear with bogie trucks, especially of the side-bearing maximum traction type. Previous to the introduction of the standard types, most of the curve rails had vertical sides to the lip or guard. Consequently the wear of the lip and flange was very rapid until the angle of wear (12deg. to 16deg.) was reached. Unfortunately, there was then very little lip left, and renewals were consequently unnecessarily rapid. With the standard type of curve rails much better results will be obtained. Perhaps, in the near future, curve rails will be rolled of a more suitable material—say nickel steel.

Construction.—It has already been said that the concrete type of construction will in all probability remain standard in this country. There is nothing to show but that, all things considered, it is the most suitable. Public opinion in this country demands a better appearance of the street surface than elsewhere, and this means that the tracks must be laid and maintained in such a manner as to give the least obstruction to vehicular traffic. The best way to accomplish this is to lay both paving setts and rails on an unyielding foundation. Notwithstanding that the best cement is that which is slow setting, progressing slowly and uniformly to its maximum strength, tramway conditions are such that quick-setting cement is essential. If the work could be protected from traffic for a long period, slow-setting cement might be used with advantage, but this is generally an impossible condition. The proportions to make a good concrete are often specified in a misleading way. For instance, 6 to 1 concrete is mentioned in a schedule, and described in the specifications as 4 parts broken stone, 2 parts of sand and 1 cement. Such a mixture is in reality nearer a 4 to 1 than a 6 to 1. Ballast, or pit gravel, if suitable, is often allowed to be substituted for the mixture of sand and broken stone. In this case a mixture of 6 of gravel to 1 of cement is considered for all practical purposes the equivalent of the mixture of 4 of stone to 2 of sand. A little consideration will show that this cannot be the case. A suggested variation in the specification is that the sand and stone shall be mixed in specified proportions, and that the concrete shall consist of a mixture of so much of the aggregate to 1 of the cement. If, for example, 6 to 1 concrete is intended, this could be specified 6 of the aggregate to 1 of cement, the aggregate to be composed of 4 parts of stone to 2 of sand. There are two ways of setting the rails on the concrete, each of which has its partisans. In one case the concrete is laid to within, say, an inch of the proper surface for the base of the rail, and the rails are then laid on the concrete and surfaced by blocks or wedges. The space between the base of the rail and the top of the concrete is packed in with fine concrete. The principal disadvantage of this method is that the surfacing of the rails to the required levels may diminish the packing space to such an extent that only a very thin skin of fine concrete can be placed between the base of the rail and the foundation, properly speaking. The vibratory action of the rails due to the car traffic may crack, pulverise, or otherwise injure this thin layer of concrete or mortar. The other way is to block up the rails to the required levels first, and then place the concrete in one operation. To do this the concrete needs to be made rather wet, so that it will have the characteristics of a quaking mass. The concrete should also be carried up beyond the base of the rails on each side, and worked well under the rails, and then all smoothed off with the shovel before it is set. If the work is properly done, this method should give the better result. Great care should be exercised that the foundation on which the concrete rests

* Paper read before the Tramways and Light Railways Association.

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is sufficient to properly carry the cars and regular street vehicular traffic. If the foundation is insufficient there will be settlements of the concrete, and consequent damage to the work. It is a trying problem to the engineer to know just what to do in case the subsoil looks at all treacherous. Additional depths of concrete will answer in some cases where the settlements are not uniform, but in small pockets. The concrete in this case will act as a bridge or an arch to carry the load over the weak spots. In case uniform settlement is to be expected a sleeper construction would be the safest. This would be on the principle that there will be a settlement, and that the cheapest means of resurfacing the track one or more times until all the settlements have taken place will be to lift the rails and sleepers and repack under the latter. In this case, of course, concrete between the sleepers for paving foundations would be inadvisable. Broken stone ballast would be the best for temporary purposes until all settlement had taken place, and then finally the whole could be permanently concreted. If a concrete foundation is required at first, it might be practical to use ferro-concrete under and beyond the track for the purpose of increasing the bearing surface of the track without using a prohibitive depth of concrete. Fortunately, such cases are comparatively rare, and when they are met there must be some extraordinary means taken to prevent settlement and consequent damage to the work, or, on the other hand, to recognise that this will occur, and design the road bed so that the repairs can be made later at a minimum cost.

A very interesting variation from the usual type of construction is that adopted by Mr. A. E. White, M.I.C.E, at Hull. This is undoubtedly familiar to all, so no extended description of it need be made. The construction is essentially a concrete one, but there is interposed between the rail and the concrete a creosoted Baltic redwood sleeper 4in. deep and 7in. wide. A similar construction was used in the Third-avenue conduit construction in New York, a continuous wooden stringer being placed between the rails and the yoke seats. The purpose of this wood liner is to provide some elasticity to the running rail, and, consequently, a more noiseless and perhaps easier riding track. Such a track must in no way be confounded with what is known generally as the sleeper construction, so widely used in America. The longitudinal sleeper in Hull is merely a cushion between the rail and the concrete foundation. The rail used in Hull has novel features. The groove is in the centre, with two narrow treads on each side. The wheel, of course, has two treads and a central flange. The advantage of such a rail is that there is uniform wear each side of the groove. The joints are bevelled to an angle of 45deg. This type of rail can in the very nature of things have little general use, for the reason pointed out by Mr. White—viz., that it cannot be connected up for intercommunication with systems on which the ordinary rail is used. If what has previously been stated on the subject of rail joints is true, the good results shown in Hull with these joints should be due to other causes. Mr. White writes "that comparatively little trouble has been experienced with the rail joints, and the rhythmic hammering of the car wheel as it passes over the joint is not heard on the Hull system in the same way as in most other systems which have been in operation for any length of time with ordinary joints. The two routes first constructed have now been running for over five years, and, until during the last few months, the rail joints have had practically no attention. We are now, however, having them all tried over with a straight edge, and all joints which are in any way loose, or show a depression of more than $\frac{1}{16}$in. on a 5ft. stretch with the straight edge, are being opened out, packed where required, and tightened up." Mr. White further points out that, making due allowance for extraordinary expenses connected with the maintenance of the permanent way, there is left a sum of £700 for ordinary maintenance. This for a car mileage of 2,500,000 makes an expense of ·067d. per car mile, which is only about one-quarter of that usually found on tramlines that have been running for this period, which is certainly very satisfactory. Personally, I believe that this result is in a great measure due to the care which must have been exercised originally in the construction of the lines, and that the special features of the construction, if contributory to the good result, are only so in a minor degree.

There is a very marked tendency in permanent-way construction now to anchor firmly the rails to the concrete bed. The object of this is to prevent the working of the rails under the rolling action of the cars. The principal disadvantage in the vertical motion of the rails is to produce a joint between the abutting paving and the rails. Whether anchoring will prevent this, and, if so, what form of anchors should be used, and the reqnisite spacing, will have to be determined by experience. There is one thing that is quite evident—viz, that the amount of movement is slight, and that any anchor which allows the slightest play between it and the rail, or between it and the concrete, will not be efficient.

Paving.—The author remarks that this must be governed largely by local conditions. From the point of view of maintenance, there can be no question but that granite sett paving is the proper one for tramway tracks, but considerations of another nature have often more force than the permanent-way upkeep of tramlines. Consequently, wood paving has been largely used, especially in streets where the paving from the kerb to the rails is wood. This is quite natural, and the tramway engineer must, in many instances, accept the inevitable, and pave his lines with wood. Outside the question of wear and early renewal of such paving, there is always the danger that the blocks will expand to such an extent that the gauge of the track is endangered. With a 7in. rail and 4in. depth of block there is little, if any, danger of this occurring; the concrete and floating coming up 3in. from the base of the rail surrounds it, so that it is held tightly against any lateral movement. The effect of expansion in this case is that the wood arches from rail to rail. It is quite common to hear a dull, hollow sound when a vehicle passes over such a pavement. With deeper blocks, or shallower rails, or the combination of both, there is danger of the rails moving or tilting. In this case dependence can be placed on the anchors, if such form part of the construction, to prevent the movement of the rails. The tie-rods should be especially strong, placed as high as possible and spaced closely together. My own experience has been that with soft wood thoroughly creosoted there is little or no danger of disturbance to the track from expansion of the wood blocks. With hard wood blocks, which naturally are untreated, this danger exists, and very great precautions must consequently be taken. Tarred macadam has been used to some extent for lines in sparsely settled districts where the roads are but little used. Such pavement must be put down when the weather conditions are suitable. There is but little use in specifying tarred macadam for winter work and expecting good results from it.

In conclusion, the author remarks that there are many other special features of permanent-way construction, but these are too extensive for discussion in a single paper.

DESCRIPTION OF ELECTRIC LIGHT AND POWER SCHEMES IN NEW YORK, WITH SPECIAL REFERENCE TO THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.*

BY P. S. SHEARDOWN, MEMBER

(Concluded from page 868.)

POWER STATIONS ERECTED OR IN COURSE OF CONSTRUCTION IN NEW YORK OUTSIDE MANHATTAN ISLAND.

The Edison Illuminating Company of Brooklyn.—The population of Brooklyn as given by the Board of Health estimates for 1903 is 1,313,000 as against 1,929,000 for Manhattan, but Brooklyn covers an area of 77·62 square miles as against 21·95 square miles in Manhattan. To this constituency the Edison Illuminating Company of Brooklyn supplies electrical energy for lighting and power. The first annual report, dated Jan. 1, 1890, shows that there was an equivalent of 6,600 16-c.p. lamps connected to the mains. To-day there is an equivalent of upwards of 800,000 lamps, and the load has grown so rapidly that the 30,000 h.p. in high-class engines at the company's two

* Paper read before the Dublin Section of the Institution of Electrical Engineers.

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stations will be insufficient to carry it, and two more machines have been ordered and are now in course of construction—one a 5,000-h.p. cross-compound Westinghouse and the other a 10,000-h.p. turbine (the first Parsons turbine to be made in this country by the Allis-Chalmers Company). The company operates two systems, most of the lighting being done from a three-wire direct-current system at 230 volts across the outers, current being supplied to it from rotary converter sub-stations which are supplied with a three-phase 6,600-volt current from the main generating stations. The company also operates a two-phase alternating, 60-cycle overhead system for suburban or sparsely-settled sections. The alternating-current circuits are changed over to direct as rapidly as is warranted by business returns. The exceptional feature of the Brooklyn Company's business is the extent and proportions of its summer load, the peak of which last year was higher on July 4 than on the heaviest day in the previous December. The reason for this is that the Brooklyn Edison Company is fortunate in that it includes within its sphere of operation a district known as Coney Island, which is the greatest summer resort in America, and during the summer is the playground and theatre of amusement to a population within the metropolitan district exceeding four millions. The Coney Island load of the Edison Company begins about May 15 and lasts through until Oct. 1. Most of the lamps in use in Coney Island are of 8 c.p., and this summer their number was upwards of 300,000. One place of amusement in Coney Island, known as Dreamland, alone requires from the Edison Company 45,000 amperes. A decorative tower in the centre of this fête ground alone contains 42,000 lamps.

Power Stations of the Brooklyn Rapid Transit Company.—The Brooklyn Rapid Transit Company operates both the elevated and surface cars in the borough of Brooklyn. If space permitted, many facts of interest could be given of these extremely complex transportation systems. Suffice it to say that Brooklyn acts in part as a dormitory for Manhattan, and includes within its limits the chief summer resorts of New York City, of which the most important is Coney Island. The company own and operate 529 miles of track, of which 461 are surface and 68 elevated. Over these tracks are operated 1,600 surface and 652 elevated cars. Every day 330,000 people are carried across Brooklyn Bridge alone, 290 cars per hour crossing the bridge on the surface lines alone during the rush hours, and 264 elevated cars every hour. As many as 375,000 people have visited Coney Island on one day, there being seven surface and five elevated lines running to West Brighton or Coney Island proper. Power for operating the cars is generated partly as direct current and partly as three-phase alternating at 6,600 volts. The largest power station is of 32,000 h.p. capacity, and the smallest just a little station operating a cable power-house with 225 h.p. capacity. The Kent-avenue station is a direct-current station of 16,000 h.p. capacity. The Southern power station contains six units, each of 1,000 h.p. The Atlantic-avenue power station is a belt-driven station, containing two 800-kw. Walker generators and seven 400-kw. generators. The Thirty-ninth-street station has engines aggregating over 5,000 h.p., and there are two 400-kw. generators located in the Brooklyn Bridge station. To provide for the future growth of the system, a new station known as the Williamsburgh power station has been commenced. The plans provide for an ultimate installation of 66,000 kw. in turbo-generators, or a capacity one-third greater than the combined plants now in use.

Electrification Scheme of the New York and Hudson River Railroad Company.—This railroad company has under construction an electrification scheme of great extent. It embraces the operation of all its ordinary heavy traffic by electric locomotives through a large area north of New York proper, which it approaches through a four-track tunnel, which is now operated by steam locomotives, the gases of the tunnels causing serious inconvenience to the passengers. But this is only one portion of a work of huge magnitude, as they propose putting the whole of their termini yard and station below the street level. The scheme will involve the electrification of nearly 300 miles of single track carrying the most important passenger and mail traffic in the country, and will necessitate the hauling of trains nearly a quarter of a mile in length and weighing as high as 871 tons at speeds exceeding 60 miles per hour, the number of trains handled daily in the Great Central yard being from 500 to 700.

Two central power stations are to be erected and designed for an ultimate capacity of 30,000 kw. After an exhaustive examination of the relative merits of reciprocating engine-driven alternators and turbo-generators, the commission has recommended the use of the latter, and a contract has been entered into for eight 7,500-h.p. turbo-generators, with an ultimate installation of 12. The turbines are of the Curtis type. The system of electrical distribution will be 11,000 volts three-phase alternating, transformed in rotary converter sub-stations to direct current at 600 volts. The locomotive decided on has many interesting features, having a new type of gearless direct-current bipolar motor.

Electrification of the New York Terminus of the Pennsylvania and Long Island Railroads.—The barrier presented by the great rivers surrounding Manhattan Island (as well as the topography of the city and the high value of its real estate) have been a stupendous obstacle to the running into Manhattan Island itself of many of the large railway companies, and much as this end was desired by both the companies themselves and the general public, many of the large railway companies have till now had their termini stations on the Brooklyn or New Jersey sides of New York; the traffic from New York City to these termini being carried by means of ferries. Prior to the successful development of electric traction for heavy railway service, the bridging of the river appeared to be the only satisfactory solution of the problem, but the physical and financial barriers have been so great that this scheme has never been carried out, but now that the electric locomotive has proved itself so successful in hauling heavy trains, both the Pennsylvania and the Long Island Railway Companies have started subways under the rivers into New York. The entire traffic is to be worked through these subways to the termini stations in New York by electric locomotives. To operate these two systems, two power stations are to be erected. The New Jersey power station will have an ultimate capacity of eight 5,500-kw. units, the Long Island power station an ultimate capacity of 12 5,500-kw. units. In addition to the above, both power stations will be equipped with separate lighting units to take care of the important requirement of reliable lighting of the tunnel lines and termini buildings. For the initial equipment to operate the Atlantic division of the Long Island Railroad, the Long Island power house has been commenced, and is expected to be in operation by the spring of 1905.

PHYSICAL SOCIETY.

At the meeting of the above society, held on the 9th inst. at the Central Technical College, a paper on "**A High-Frequency Alternator**" was read by **Mr. W. Duddell.** The author described and showed in action a high-frequency alternator which he had constructed in 1900 for some experiments on the resistance of the electric arc, and with which frequencies up to 120,000 ⌒ per second had been obtained. The alternator consists of an inductor, built up out of ferrotype plate, having V-shaped notches cut in its edge so as to have flat-topped teeth. Surrounding the inductor is a laminated ring having two inwardly projecting poles, the clearance between these and the teeth of the inductor, which formed the air-gap, being less than 0·1mm. The ring is wound so that a direct current flowing round the winding tends to produce lines of force from one pole to the other through the inductor. The number of lines of force varies from a maximum when the teeth of the inductor are opposite the poles to a minimum when the poles are in front of the spaces. This variation in the total number of lines of force produces alternating E.M.F.'s in any winding either on the pole-pieces or on the ring itself; the movement of the inductor through the distance between two consecutive teeth producing one complete period. One winding on the ring could serve to carry both the direct field current which magnetises the ring and the alternating current produced. In practice, owing to the great importance of any self-induction in the alternate-current circuit, it was found advisable at high frequencies to use separate windings for the two currents. At the highest frequencies the best results were obtained with coils having a few turns of wire fixed right on the tips of the poles. The alternator is driven by means of a figure-of-8 belt drive from two phosphor-bronze discs. Each of these discs is belted to a double-grooved pulley fixed on the shaft of a direct-current driving motor. With this method of drive the inductor was run for several months at speeds between 30,000 and 40,000 revolutions per minute, and the spindle of the inductor alone could be easily run at 60,000 revolutions per minute. Using inductors having 30, 60, 90, and 204 teeth, the author obtains small alternating currents having frequencies from a few hundred periods per second up to 120,000 ⌒ per second. An illustration will perhaps convey some idea of how high a frequency of 120,000 ⌒ per second really is. In plotting curves for ordinary frequencies of 50 to 100 ⌒ per second, a scale often adopted is 10in. for 100 ⌒. If it were attempted to plot a curve up to 120,000 ⌒ per second to this scale, the curve paper would require to be 120,000in., or nearly *one fifth of a mile long*. Many difficulties were encountered with the centrifugal forces on the driving belt, and the author finally obtained the best results with a spliced cotton cord. Working drawings of the alternator characteristic curves and its wave-form are given in the paper. During the construction of the alternator bicycle wheels were used to drive it, and curves are given showing the very large power taken to drive these wheels, owing to air friction. A table is given of all the high-frequency alternators which have come to the author's knowledge, and he would be glad to receive any missing data or data of other machines to include in the table before it is finally printed.

Dr. J. A. Fleming said he had felt surprised on hearing about Mr. Duddell's alternator that he had been able to reach any such frequency as 120,000 ⌒ per second. It spoke highly of the excellent mechanical means employed. On the other hand, as far as its use in wireless telegraphy was concerned, it was no use to speak of a machine even if it gave this frequency, corresponding to a wave 1½ miles in length, if the output of the machine were only a few watts. If it were 150 h.p., it might be different. The difficulty with most high-

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frequency alternators was the magnetic leakage. Dr. Fleming then described some of the devices adopted by Tesla for obviating this defect. Many of the high-frequency alternators made had their power overestimated. Hitherto the frequency reached had been only about 10,000 ⁓ per second. A machine of this last frequency would be no particular assistance in wireless telegraphy. Such machines were, however, very useful for research and demonstration purposes.

Prof. W. E. Ayrton gave an **"Exhibition of Experiments to show the Retardation of the Signalling Current on 3,500 Miles of the Pacific Cable between Vancouver and Fanning Island."** The experiments were performed upon a cable electrically equivalent to the portion of the Pacific Cable between Vancouver and Fanning Island, the product of the capacity (in microfarads) and the resistance (in ohms) being nine millions. Three dead-beat galvanometers were employed to indicate the current at the beginning, in the middle, and at the end of the cable. It was shown that upon applying an E.M.F. at one end of the cable the current at that end was enormously greater than its steady value, and that one-fifth of a second elapsed before any indications of current were shown at the far end of the cable. By that time the current at the sending end was 3·7 times its steady value, and after two-fifths of a second it had fallen to 2·3 times its steady value. In about five seconds the current became steady.

The electrical laboratories of the college were open to the inspection of Fellows, a special feature being an exhibition of Ayrton-Mather galvanometers (showing the evolution of the present commercial instruments from the earliest types, constructed in the college), universal shunts, and electrostatic instruments.

LEGAL INTELLIGENCE.

UNDERGROUND ELECTRIC RAILWAYS OF LONDON v. THE COMMISSIONERS OF INLAND REVENUE.

The case of the Underground Electric Railways Company of London, Limited, *v.* the Commissioners of Inland Revenue came before the Court of Appeal, composed of the Master of the Rolls and Lords Justices Stirling and Mathew, on the appeal of the Commissioners from a judgment of Mr. Justice Channell in the King's Bench Division.

This was a special case, raising a question as to the amount of stamp duty payable by the company under the agreement by which it acquired control of the Brompton and Piccadilly-circus Railway, the Charing Cross, Euston, and Hampstead Railway, the Great Northern and Strand Railway, and the Baker-street and Waterloo Railway.

From the special case it appeared that by an agreement dated June 25, 1902, with the Metropolitan District Electric Traction Company, Limited, the Underground Electric Railways Company, which had a capital of £5,000,000, agreed to purchase the whole of its undertakings. On July 8, 1902, an instrument was presented on behalf of the new company for the purpose of being stamped, and the Commissioners, in assessing the duty payable, computed the consideration for the property agreed to be sold at £1,947,683. 18s. 5d., which, after making certain deductions, was put at £1,527,357. 17s. 11d. The question was whether the Commissioners were right in including therein £780,000 under Clause 3 of the agreement, which provided for the payment to the Traction Company of a certain share of the profits as part payment of the purchase money, after provision had been made for the general body of shareholders. The Commissioners held that the sum contingently payable out of the profits was "part of the consideration for the sale," and that so far as such sum was capable of ascertainment at the date of the agreement, it was liable to *ad valorem* conveyance duty. The company, on the other hand, submitted such sum as incapable of assignment, by reason of the remoteness of the contingency upon which the payment must be made. Mr. Justice Channell gave judgment for the Underground Electric Railways Company, with costs. Hence the present appeal of the Commissioners.

At the conclusion of the arguments of counsel, their **Lordships** upheld the contention of the Commissioners, reversed the decision of Mr. Justice Channell, and entered judgment for the Crown. The appeal was according allowed, with costs.

Mr. Roskill applied for a stay of execution, with a view to his clients considering whether they would appeal to the House of Lords.

Their **Lordships** granted a stay for a month.

DEWSBURY PAINTER'S ELECTRIC SHOCK.

An action came before Mr. Justice Darling last week at the Leeds Assizes, in which Parker Harrop, journeyman painter, claimed damages from Mr. N. Ramsden, painter, Dewsbury, for personal injuries alleged to have been due to negligence on the part of the defendant.

Plaintiff, while in defendant's employ, was painting the posts of the tramway company. The defendant's instructions were that when the men were painting standards in the centre of the road they must get down from the ladders if a tram was passing, but it did not matter when painting the ordinary standards. When the accident happened, plaintiff was not supplied with gloves. He was on a ladder about 20ft. from the ground, and a boy was holding the ladder at the foot. He was holding on to the ladder with his right hand and was reaching over with his left hand, bolding the brush in his left hand, when he received a violent electric shock. How, he did not know; but the experts seemed to think it probable that he touched the trolley wires. The result of the shock was that he was drawn off the ladder and up to the arm. He managed to tear himself loose, and fell to the ground. He was taken to Dewsbury Infirmary, and remained there 14 weeks. Both arms were badly fractured, his back was hurt, and his hands were burnt. He had been deaf ever since, and was now unable to follow his trade as a painter. He had not worked since the accident. Plaintiff contended that there ought to have been indiarubber gloves and a derrick.

The **Defendant** stated that he was unaware of any danger so long as the live wire was not touched, and he warned his men every morning to be careful not to touch the wires. No one suggested to him before the accident that he should provide rubber gloves. Immediately he was told of them he provided his men with them.

His Lordship, in summing up, mentioned that in the hearing it had come out that the defendant was insured, but he warned the jury to guard against giving heavy damages on that account, if they should decide to give damages at all. He put the following four questions to the jury.

Did the injury occur by reason of want of proper care on the part of plaintiff himself?—Yes.

Did the defendant neglect to supply the plaintiff with appliances proper to be used in doing the work in which he was employed?—Yes.

Did the defendant know it was dangerous even for a careful workman to do the work without gloves?—No.

Was it negligent of the defendant not to have made himself aware that it was dangerous to do the work without wearing gloves?—Yes.

The jury added "£75 damages."

Subsequently, his **Lordship** alluded to a point of law to which the jury's answers had given rise. These answers amounted to a verdict for the defendant, but as the amount of damages named was very moderate he hoped the matter would be settled.

WEST HARTLEPOOL TRAMWAYS.

At West Hartlepool Police Court the General Electric Company, Limited, were summoned under the tramways order by the West Hartlepool Corporation for not keeping the tramway in Clarence-road in a proper state of repair.

For the Corporation it was stated that the company had entirely failed to recognise their obligation to keep the track in a proper state of repair. The condition of the track was such that in some places the rails were below the setts.

For the defence it was stated that negotiations were proceeding with regard to the tenure of the tramways, and that as soon as terms had been arrived at, the company intended to reconstruct the line.

The Bench found the case proved, and imposed a fine of £5 for the first offence and £1 a day for seven subsequent days.

Another summons charged the company with failure to keep the wooden setts in Grange-road in good condition, the result being that in wet weather the road became slippery.

This charge was dismissed.

A third charge referred to the use of three cars which were not free from noise produced by the clatter of machinery.

A fine of £5 and costs was imposed, and another charge was withdrawn on payment of costs.

TRAMWAY ACCIDENT.

Godfrey Pearson sued the Bradford Corporation for damages for personal injuries received in a tramcar accident between Bradford and Wyke.

The plaintiff was travelling to Wyke on a tramcar belonging to the Bradford Corporation. After passing Odsal Top the road takes a long, steady descent to Low Moor. The car reached a considerable speed, and came into collision with a wagon coming in the opposite direction and loaded with looms. The side of the car was partially torn off, the glass was broken, and the plaintiff, who was seated with his back to the damaged side, received severe injuries. He was confined to his bed for a month, and so great was the shock to his system that he was kept from business three months. The Corporation's defence was that the driver of the wagon swerved into the car and caused the accident, and that the driver of the tramcar was not to blame.

The jury awarded £350 damages.

COMPANIES' MEETINGS AND REPORTS

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The directors' report for the year ending Sept. 30, to be presented at the forty-first ordinary general meeting of the shareholders on the 20th inst., states that, after provision for doubtful debts, there is a net profit of £11,343. 19s. 3d. Adding £66,930. 7s. 10d. brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £65,774. 7s. 1d. The directors recommend the distribution of a dividend of 5s. a share, free of income tax, amounting to £12,500, making, with the interim dividend paid in June, a total payment of 5 per cent. for the year, and leaving £53,274. 7s. 1d. to be carried forward. The general business of the Company shows an increase when compared with last year, but, unfortunately, the sales have been made on a rapidly rising market for raw material, and the selling prices of manufactured goods have not proportionately increased. Moreover, the revenue for the year has been charged with amounts expended on the development of a new business which has not yet reached a remunerative stage. These two causes account for the serious falling off in revenue, but the directors think that the revenue for the current year will not be injuriously affected to a like extent. The "Dacia" and "Buccaneer" have been employed in cable-repairing work during the year, and these two vessels are at present under charter. The works at Silvertown and Persan have been maintained in their usual state of efficiency, and extensions continue to be made. In April last the Board made an issue of £100,000 second debentures.

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POWER-GAS CORPORATION.

The following is an abstract from the managing director's report, which was presented and approved at a meeting last week: "Electricity can be produced cheaper by Mond gas-driven generators than in any other way; but engineers of central electric stations in this country have not yet made up their minds as to the feasibility of running large gas-engines in parallel for the production of alternating current, although many such installations can be seen running in parallel abroad, particularly in Germany. We hope that the North-Western Electricity and Power-Gas Company will now soon place itself on a working basis, and proceed with the erection of its first central electric station, which is to be driven by power-gas and large gas-engines, and will thereby furnish us with an object lesson, the importance of which to the development of our business cannot be over-estimated."

LANCASHIRE POWER CONSTRUCTION.

The report for the period ended Sept. 30 last, to be presented at the meeting on the 16th inst., states that there remains £90,000 still to be called up on A shares and £116,000 of B to be issued. The directors anticipate that the further calls on the A shares will require to be made and the B shares to be issued (to the contractors under their respective agreements) during the next few months. Satisfactory progress has been made with the construction of the power station at Radcliffe and the directors expect to have these works ready for supplying power early in the coming year. Negotiations are proceeding with a number of the local authorities for giving a supply in their respective districts, and an agreement has already been entered into with Swinton and Pendlebury.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

An extraordinary meeting of the South Wales Electrical Power Distribution Company was held last week, when a resolution was passed authorising the directors to create £50,000 additional debenture stock, bearing interest at the rate of 5 per cent. per annum (being the third instalment of £50,000, part of the £250,000 which the Company is empowered to borrow under Section 26 of the said Act), and to issue the same as the directors think fit.

NEW COMPANIES REGISTERED.

Donne and Willans, Limited. — Capital, £5,000. Object: to acquire and carry on the business of manufacturers, etc., of motorcars and cycles carried on by M. Donne at 27, St. John's-square, Clerkenwell, E.C., and that of engineers, machinists, electricians, metal workers, etc.

Supplies, Limited —Capital, £5,000. Object: to carry on the business of electricians, mechanical engineers, producers and suppliers of electricity, motive power, and light, etc. Registered office: 12, St. John's-lane, Liverpool.

W. W. Bamford, Limited.—Capital, £2,000. Object: to carry on the business of electrical, mechanical, consulting, and practical engineers, manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other apparatus, etc. Registered office: Deepwater Pier, Northfleet, Kent.

Brynamman and District Electric Supply Company, Limited.—Capital, £2,000. Object: to carry on the business of suppliers of electricity in all its branches, electrical and mechanical engineers, etc. Registered office: Brynamman, Carmarthenshire.

Cheshire Light Railways, Limited.—Capital, £1,500. Objects: to obtain from the Light Railway Commissioners, or other authority, any orders authorising the construction of light railways in Cheshire, or elsewhere in the United Kingdom or abroad, and to carry on the business of light railway proprietors, manufacturers of and dealers in railway and tramway carriages, motorcars, etc.

Lindsey Light Railway Syndicate.—Capital, £1,000. Objects: to apply for and obtain orders for a light railway, under the provisions of the Light Railways Act or other statute, beeween Blyton and Frodingham, Lincs., and to carry on the same.

Aberavon District Tramways Syndicate, Limited.—Capital, £2,000. Objects: to apply for a provisional order or Act of Parliament authorising the construction of an electrically-equipped tramway in the parishes of Aberavon and Margam, Glamorganshire, and elsewhere; to construct or acquire tramways, etc. Registered office: Arlington-chambers, 4-5, Commercial-street, Newport, Mon.

Mors, Limited.—Capital, £15,000. Object: to acquire English patents relating to motorcars of the Société Anonyme d'Electricité et d'Automobiles Mors, or others, to manufacture and sell in the United Kingdom and British Colonies and dependencies motorboats and accessories, etc., including those made by the Compagnie Française des Voitures Electromobiles. Registered office: 55-59, Shaftesbury-avenue, W.C.

Marlborough Electric Supply Company, Limited.—Capital, £1,000. Objects: to carry on the business of suppliers of electric light and power, electrical engineers, electricians, contractors, tramway and railway proprietors, etc., and to enter into an agreement with the Bristol Trust, Limited, whereby the said trust undertakes, in consideration of £250, to pay the costs of formation and registration and certain preliminary expenses.

Climax Motors, Limited.—Capital, £5,000. Object: to manufacture and deal in motors, carriages, and vehicles, whether for propulsion by steam, electricity, oil, or other power

Liens Registered.

Chiswick Electricity Supply Corporation, Limited, London, E.C.—Lien registered Dec. 1, for £500 4½ per cent. debentures, part of £50,000; amount previously issued, £33,000. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being.

Perth Electric Tramways, Limited, London, E.C. — Lien registered Nov. 25, for £500 6 per cent. debentures, part of £50,000; amount previously issued, £35,500. No trustees. Charged on the benefit of certain agreements, deposit, provisional order, and Acts of Parliament, tramways and tramway undertaking, plant, machinery, etc., in Perth, Western Australia.

Milford-on-Sea Electric Supply Company, Limited.—Issue on Nov. 12 of £850 debentures, part of a series created Sept. 3, 1904, to secure £2 000, charged on the company's whole property, present and future. No trustees. No previous issue of same series.

APPOINTMENTS VACANT.

Car-Shed Superintendent, Blackburn Corporation tramways. Wages, £2. 10s. per week. Applications by Dec. 22. See advertisement.

Works Manager, small accumulator works. Salary to commence, £150 per year. See advertisement.

Electrician, National Telephone Company, Limited, Royal Exchange, Glasgow. Salary to start, £100 per annum. See advertisement.

Publicity Department Manager, electricity works, Croydon. Salary, £150 per annum. Applications by Dec. 27 to Borough Electrical Engineer.

Electrical Engineer, Elland Urban District Council. Applications by Dec. 17 to Mr. James Clarkson, Council Offices, Southgate, Elland.

Electrical Engineer, Worcester Corporation. Salary £400, rising by instalments of £20 per annum to a maximum of £500. Applications to the Town Clerk by 10 a.m. on Dec. 19.

Various, Bridlington Town Council. Assistant Engineer, £100 per annum; Clerk, £75 per annum; Engine-Driver, 35s. per week; Jointer, 30s. per week; Arc Lamp Lighter, 30s. per week; Stoker, 13s. per week; Cleaner, 21s. per week; Jointer's Mate, 12s. per week; Trimmer's Mate, 12s. per week.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Guirgia (Roumania).—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Erith.—The Urban District Council invite tenders for motorcars, trucks, motors, and equipments, track sweeping and watering car. Tenders by Dec. 19.

Neath.—The Corporation invite tenders for the supply and delivery of electric wattmeters. Specification on application to the Town Clerk. Tenders by Dec. 28.

Paris.—Tenders are required for electric cable, bronze and copper wire. Particulars from Post and Telegraph Department, 103, Rue de Grenelle. Tenders by Dec. 21.

Swindon.—The Corporation invite tenders for the supply and erection of one 300-kw. steam dynamo, or, alternatively, one 400-kw. steam dynamo. Tenders by Dec. 20.

Bradford.—The Corporation invite tenders for the supply of miscellaneous stores required by the tramways department during the year ending Dec. 31, 1905. Tenders by Dec. 17.

Almendrajo (Spain).—Tenders are invited for public electric lighting for 10 years. Particulars may be obtained from the Secretary of the Ayuntamiento of that town. Tenders by Dec. 22.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Rochdale.—The Corporation invite tenders for high-tension three-phase switchgear and extensions to the low-tension continuous-current switchboards. Tenders to Mr. Wm. Henry Hickson, town clerk, by 27th inst.

Sunderland.—The Corporation invite tenders for the supply of one wooden cooling tower capable of cooling the circulating water for a surface condenser dealing with 30,000lb. of steam per hour. Tenders by Dec. 30. See advertisement.

Madrid.—The call for tenders for the service of the electric lighting of Almendralejo was without result. The conditions of contract have, therefore, been modified in certain respects, and tenders are to be called for to be opened on Dec. 22.

Fulham.—The Council require tenders for the supply and erection of a 3,000-volt steam alternator of 1,000 kw. capacity, coupled to a Belliss engine, at their generating station, Townmead-road. Tenders to Town Clerk not later than 12 noon on Dec. 20.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

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Port Elizabeth.—Messrs. Davis and Soper, 54, St. Mary-axe, E.C., agents of the Municipal Corporation of Port Elizabeth, South Africa, invite tenders for various works in connection with the Corporation electricity supply undertaking. Tenders by Jan. 16, 1905.

Erith.—The Urban District Council invite tenders for overhead line equipment, poles, etc.; underground feeder cables, boxes, etc.; rotary converters, transformers, and motor-booster; and main high and low tension switchboards, cable connections, etc. Tenders by Jan. 9. See advertisement.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 83, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Southend-on-Sea.—The Corporation invite tenders for additional plant for their generating station, comprising the following: two boilers, one steam dynamo, one fuel economiser, two electrical feed pumps. Tenders to be delivered at the offices of Mr. William H. Snow, town clerk, Southend-on-Sea, by Dec. 21.

Glasgow.—The Corporation invite tenders for the supply of 100 electric motor equipments and spare parts for same. Specification, etc., can be obtained on application to Mr. James Dalrymple, general manager, 102, Renfield-street, Glasgow. Tenders must be lodged with Mr. James G. Monro, town clerk, City Chambers, Glasgow, by 10 a.m. on Dec. 22.

Spain.—The *Gaceta de Madrid* of Dec. 6 notifies an application by the Compañia General de Tranvias for the concession of an electric tramway from Sans to Coll-Blanch. One month from the date of the publication of this notice is allowed in which other proposals on more favourable terms, duly guaranteed, may be made. The *Gaceta* may be seen at the Commercial Intelligence Branch of the Board of Trade.

Valladolid.—Tenders are required for the public lighting by means of electricity of the city of Valladolid. Fifteen hundred incandescent lamps of 17 c.p. will be required. The concession will terminate on Dec. 31, 1911. The annual payment to the concessionnaire will be about £965. A deposit of £48 is required to qualify any tender. The adjudication will take place at 11 a.m. on Dec. 26, at the Casa Consistorial, Valladolid.

Perth (Australia).—Tenders are invited by the Duputy-Postmaster-General for the supply of the following telephone material; 19½ miles 26-pair lead-covered cable, dry core, to standard specification No. 7; 5,000 paper sleeves, 3in. long by $\frac{7}{16}$in. diameter; 350 yards paper strips, 2in. wide. Conditions, etc., may be obtained at the General Post Offices at Perth, Adelaide, Melbourne, Sydney, Brisbane, and Hobart. Tenders by Dec. 28.

Ilford.—The Urban District Council invite tenders for the installation of a telephone fire-alarm system on the double or metallic principle. Particulars and form of tender may be had on application to Mr. H. Shaw, A.M.I.C.E., surveyor, Town Hall, Ilford, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders, addressed to the Chairman, must be sent to Mr. John W. Benton, clerk, town Hall, Ilford, by Dec. 19.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

Bromsgrove (Worcs.).—The Visiting Committee invite tenders for the supply and erection at their new lunatic asylum of the following plant: (Section A) engines, dynamos, booster, and steam services; (B) storage battery and accessories; (C) main switchboard, ring main, feeders, distribution boards, wiring, lamps, and accessories. Specification, etc., may be obtained from Mr. Robert J. Oliver, clerk of the Visiting Committee, Shirehall, Worcester, on payment of £5 for each section of the work as above, which will be returned on receipt of a bona fide tender.

London, W.—The Great Western Railway Company invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, etc.: (Specification No. 8) steel conductor rails, cast-iron and steel ramps and fastenings; (9) porcelain insulating supports and their fastenings for conductor rails; (10) copper bonds, insulated cable connections, cable terminals, bonding presses, and accessories for connecting up conductor rails. Tenders, addressed to the Secretary, Great Western Railway, Paddington Station, W., will be received on or before Jan. 3.

Cardiff.—The Corporation invite tenders for the following plant for the extensions to their power station on the extra high-tension three-phase system—viz.: two 1,600 slow-speed vertical engines, two 1,100-kw. three-phase alternators, four Lancashire boilers with accessories, steam and other piping, switchboard gallery and staircase extensions to central service gangway, extra high-tension three-phase feeder cables. General conditions, specification, and form of tender may be obtained on application from Mr. Arthur Ellis, M.I.M.E., M.I.E.E., borough electrical engineer and manager, Central Offices, The Hayes, Cardiff. Tenders to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by Dec. 19.

Madrid.—Tenders are invited for the public lighting by means of electricity of the town of Villanueva y Geltru for a term of 10 years. Twenty-four arc lamps of 500 c.p. and 239 incandescent lamps of 20 c.p. will be required. The concessionnaire will be allowed to supply private individuals without payment of a municipal tax subject to his supplying, free of charge, the Casa Consistorial with 75 kw. per month. He will be required to maintain a duplicate set of machinery in order to avoid the possibility of the town being left in darkness through a breakdown. The annual payment (upset price) to the concessionnaire will be 23,145 pesetas (about £678). The adjudication will take place on Dec. 24. A deposit of £68 is required to qualify any tender.

Madrid.—The *Gaceta de Madrid* of Nov. 9 publishes a notice inviting tenders for the construction and working for 60 years of an electric tramway between Azcoitia and Zumaya (Province of Guipúzcoa), in accordance with certain conditions set out in the *Gaceta*. An application for this concession has already been received from Don Dionisio Sorseta Garcia, who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on the reduction of the tariff fixed for the conveyance of passengers, etc.; in the event of equal terms being offered, it will turn on a reduction of the period of concession. Adjudication of tenders will take place before the Director-General of Public Works, Madrid, on Jan. 10. A deposit of 16,297 pesetas (about £475) is required to qualify any tender

Manchester.—Tenders are invited for (Contract C) switchboards, mains, feeders, etc., for supply of electric current for power and lighting, and for arc lamps, etc., in connection with the new dock works, Salford, for the Manchester Ship Canal Company. (Contract D) for mains, feeders, etc., for the supply of electric current for power and lighting, and for arc lamps, etc. Drawings for both contracts can be inspected and copies of specifications, bills of quantities, and forms of tender can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester, on payment of a sum of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders to be addressed to Mr. F. A. Eyre, secretary, Manchester Ship Canal Company, 41, Spring-gardens, Manchester, by 10 a.m. on Dec. 22.

RESULTS OF TENDERS.

Belfast.—The North-Eastern Steel Company, Middlesbrough, have obtained an order for 10,000 tons of rails for the Belfast tramways.

Whitby.—The Urban District Council have accepted the tender of Babcock and Wilcox, at £945, for a new boiler, including mechanical stoker.

Walsall.—The Electricity Committee have ordered from J. Russell and Co., Limited, Walsall, the steam connection for No. 6 boiler, at a cost of £83.

Monte Video.—A tender of J. G. White and Co., Limited, 22A, College-hill, E.C., exceeding £400,000, has been accepted for the reconstruction of the tramways.

Tooting Bec Asylum.—The Asylums Board have accepted the tender of F. W. Potter and Co., at £32. 10s., for supplying and fixing dynamo belt guards for electric light plant.

Cardiff Asylum.—The sub-committee have recommended that the tender of Messrs. Bradford, of London, amounting to £3,000 odd, for machinery for the laundry, to be driven by electricity, be accepted.

Deptford.—The Borough Council have accepted the tender of the Hart Accumulator Company, Limited, Marshgate-lane, Stratford, E., for additions and alterations to the existing battery installed at the public baths, New Cross S.E.

Colliery Power Plant.—The British Electric Plant Company, Limited, Alloa, have been awarded by the Alloa Coal Company the contract for a complete electric power plant on the direct current system for the Bannockburn Collieries, together with engines for the same.

Lowestoft.—The Town Council have accepted a tender for supply of 1,500 yards of cable for crossing the harbour of W. E. Dennis and Co., of 49, Queen Victoria-street, London, at £23 per 100 yards, provided a guarantee of electrical maintenance for five years be given, that the firm test after the cable is laid up to 1,000 volts at their own expense. The tender of the Callender Cable and Construction Company to supply feeders at £535 per 1,000 yards has also been accepted. N.B.—The engineer has stated that he would lay the feeders with his own staff at a cost for labour of about £100.

Burslem (Staffs).—The Guardians of Wolstanton and Burslem Union have accepted the following tenders for the supply and erection of the electric lighting plant at the workhouse, Chell—(Section A) water-tube boilers, etc.; (C) two 25-kw. steam dynamos and booster; (D) switchboard; (E) cables and wiring; (F) accumulators; (G) arc lamps: (A) Stirling Boiler Company, Motherwell, at £550; (C) McClure, Whitfield and Co., Stockport, £764. 7s.; (D) Electric and Ordnance Company, Limited, Birmingham, £183. 19s. 8d.; (E) E. M. Evans, Manchester, £644. 5s. 8d.; (F) Pfluger Company, London, £297. 2s. 6d.; (G) Crompton and Co., London, £148.

Yarmouth.—Fourteen tenders have been received for steel rails, fishplates, soleplates, tiebars, and bolts for the Gorleston tramways, but only six were complete quotations. Of these three were for Belgian manufactured material, one did not state the place of origin, and the other two were from Barrow-in-Furness and Leeds. Two partial tenders came from Middlesbrough. The schedule on which all tendered was for 800 tons of straight rails, 25 tons curved rails, 50 tons of fishplates, 13 tons soleplates, 21 tons of tiebars, and 10 tons of bolts and nuts. The totals of the tenders worked out thus: Jacobs Bros. and Co. (Belgian), £4,665. 16s. (accepted); Le Bas (Belgian), £4,749. 8s. 2d.; A. Penny and Co. (Belgian), £4,919. 7s. 6d.; MacClellan and Co. (not stated), £5,141; Barrow Steel Company (English), £5,174. 2s. 6d.; W. Scott (English), £5,651. 10s. The surveyor stated that the total for two other English firms, both of Middlesbrough, could be made up thus: Bolckow, Vaughan, and Co., £5,257. 12s. 6d., and North-Eastern Steel Company at £5,400. 2s. 6d. The surveyor added that the tenders are extremely low, and it is in the interest of the Council to accept one at an early date. The lowest tender is £4. 17s. per ton for rails, against £5. 18s. 6d. per ton paid for the last work, and all the other items are proportionately low, the total saving working out at upwards of £950.

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BUSINESS NOTES.

TRACTION.

Chesterfield.—A proposal to poll the ratepayers on the question of Sunday running was defeated.

Glasgow.—The Corporation have approved of the extensions, for which sanction is to be sought.

Wolverhampton.—It is reported that the Hampton-road route is to be reopened as far as Hunter-street.

Prestwich.—The line from the Grand Lodge to Heaton Park Station is expected to be opened to-day.

Colchester.—An extension of the Corporation tramways, estimated to cost about £8,000, has been decided upon.

Kilmarnock.—The Corporation tramways were opened on Saturday, and a full account appears in another column.

Bradford.—During the past year 250,000 parcels have been carried on the trams, yielding an income of upwards of £1,000.

Bath.—The Tramways Committee recommend the Corporation not to sanction the company's proposed extension along Westgate-street.

Liverpool.—The Corporation have decided to promote a Bill for the construction of tramways in Walton, West Derby, Fazakerley, and West Derby rural.

Wigan.—The Board of Trade have sanctioned running on the line between Ince and the Royal Hotel. So far negotiations with Hindley have not been completed.

Croydon.—A proposal to delete the Upper Norwood route from the Corporation's Bill, on the ground of expense and unpopularity in the neighbourhood, was negatived.

Leith.—The Corporation have decided, before settling estimates, to make enquiries of contractors and of other towns as to their experience with the motors for the cars.

South Shields.—The Tramway Committee recommend that tenders be invited for laying the track in Fowler-street and other sections where work can be proceeded with forthwith.

Proposed Light Railway.—Application is to be made to the Light Railway Commissioners for power to construct a light railway, to be worked by electricity or other motive power, between Warrington and Knutsford.

Bootle.—The Town Council have decided to oppose the Liverpool Corporation's scheme for running trams into Bootle. Each of these authorities is desirous that the parish of Orrel shall be incorporated within its area.

Kirkcaldy.—The Tramways Committee have given a general approval to heads of an agreement for through running between the Corporation lines and a system from Leven, which a private undertaker contemplates constructing.

Spen Valley.—After running only a reduced service of cars in and out of Heckmondwike for about four months, owing to a disagreement with the District Council as to the price to be paid for extra current required, the traction company on Saturday resumed a full service.

Salford.—At last week's meeting of the Council the Chairman of the Tramways Committee, replying to a member, stated that the committee had no objection to publishing the weekly returns for the information of members, whether they were members of the committee or not.

Tranent.—At a meeting of Tranent Burgh Commissioners, a letter from the National Electric Construction Company was laid before them enquiring if they would favourably entertain a proposal to extend the electric tramways from Leavenhall to Tranent. It was unanimously decide to approve the proposal.

Walsall.—At last week's meeting of the Town Council it was stated that the tramway profits to the end of the year were estimated at £6,000. Apparently ½d. fares have answered well, and the Council are disposed to give favourable consideration to an application that has been received for additional ½d. stages.

Swansea.—The town clerk has issued to members of the Corporation notice of a special meeting to sanction a Bill which will provide, *inter alia*, for the acquisition of the Swansea Tramways Company's system, with powers to extend same. At this meeting the position of the Corporation is to be fully explained.

Cardiff.—The Corporation have referred back to committee the scheme of revised fares, which comprises considerable increases. A section of the Corporation considered that the present fares were quite high enough as compared with other towns, and one councillor suggested the introduction of ½d. stages.

Heywood.—From the report of last week's meeting of the Town Council it appears probable that terms will be arranged whereby Heywood will run steam cars over the Rochdale and Bury lines, the latter running their electric cars over the Heywood system. Negotiations for the construction and working of the Heywood lines electrically appear to have dropped.

Sunderland.—The following figures were given at a meeting of the Tramways Committee: for the month of November the returns were as follows—passengers, 1,122,590; mileage, 121,359; receipts, £4,667. 6s. 1d.; receipts per car mile, 9·2d. Compared with November, 1903, there is an increase of 64,937 passengers, 10,116 miles, and £259. 17s. 4½d. in receipts. The takings per car mile, however, show a slight decrease.

Leicester.—November was the first complete month during which the tramways of the town—except one uncompleted route—have been served wholly by electric cars, and the passengers reached a total of 1,718,802. This is a good showin for an unfavourable month like November. During the week ending the 3rd inst. 390,280 passengers were carried. The Groby-road route will probably be completed early in the new year.

Ayr.—It has been decided to proceed with the extension of loops in Carrick-road and at Chapel-park at a cost of about £650. A request from the Prestwick Town Council that the terminus should be at a point south of the Cross was referred to the convener and manager, with powers. The Council have approved the manager's experiment in regard to a new department of the parcel express to convey workmen's dinners along the Prestwick route.

London Tramway Improvements.—The Improvements Committee of the County Council recommend an expenditure on capital account up to £320,000 for street widenings in respect of the tramways sanctioned by the Tramways and Improvements Act, 1904. These are the tramways from Lordship-lane to Forest Hill, Lewisham High-road to Forest Hill, New Cross-road to Lee Green, Catford to Greenwich, and Beresford-square to the county boundary.

Newcastle.—The report issued to members of the Tramways Committee on the accounts from March 25 to Sept. 29 last by the Corporation auditor (Mr. Thomas Bowden) states that rolling-stock should be adjusted by the writing off to revenue of such expenditure under this head as cannot reasonably be considered to have increased the value of the asset, and he also mentions that beyond the depreciation represented by the repayment of loans, no provision has been made under this head.

Wolverhampton.—The accounts of the Corporation tramways for the six months ending Sept. 30 show total receipts of £18,678. 7s. 7½d., against £12,460. 17s. 11d. in the corresponding period of last year. The receipts per car mile work out at 11·85d. A profit of £1,442 for the six months is shown, against a loss of £262 last year. This great improvement is apparently attributable to reduced operating costs, the figure under this head having descended from 5·08d. to 4·72d. per car mile.

Perth.—At a meeting of the Town Council on Monday, a discussion took place as to why the £5,000 estimated to be spent on the construction of the tramways with the Dunkeld-road had not been included by the Finance Committee in their recommendation to borrow £45,000 for the reconstruction of the present system. It was pointed out that the Council had not yet agreed to go on with this section of the undertaking. The Tramways Committee are to deal with this question at an early date. The Finance Committee's recommendation to borrow £45,000 was agreed to.

Ashton.—At the meeting of the Town Council the deadlock between the Corporation and the Joint Tramways Board was again discussed. Mr. Hallam, the chairman of the Tramways Committee, said that the last proposals submitted to the Corporation were such that they could not entertain them. The Ashton sub-committee had suggested other proposals, which included alternate running between Stalybridge and Ashton, Ashton and Dukinfield, and through cars from Mossley to Ashton and Hyde to Ashton. They hoped that in the interests of the public these counter proposals would be agreed to.

Aberavon.—A company has been formed, under the title of the Aberavon District Tramways Syndicate, Limited, to apply for powers authorising the construction of an electric tramway in the parishes of Aberavon and Margam. The matter was discussed at a meeting of the Margam Council, when it was reported that the proposed tramways would run along the main road from the boundary on Aberavon Bridge to the Lady Charlotte-road junction; from the Forge-road and main road junction along the Council's road in front of the Grugos and Curwen terraces, to terminate at a generating station to be erected on the site of the Old Margam works. The matter was referred to committee.

North-Eastern Railway.—At a largely-attended public meeting the following resolution was passed: "That this large and influential meeting of residents on the route of the electrified portion of the North-Eastern Railway protests strongly against the manner in which the North-Eastern Railway Company is treating its passholders and the travelling public, and urgently requests the directors of the company to immediately take steps to improve matters, so that accommodation equal to that in existence before the era of electric trains may be assured, failing which, representations be made to Parliament, and to the Railway Commissioners, and that a guarantee fund be opened, and that a copy of this resolution be forwarded to each of the directors." A fund has been opened. Petrol-electric cars have superseded steam trains on the line from Bellingham to Port Clarence.

Ashton-Stalybridge.—At the monthly meeting of the Stalybridge Town Council on Tuesday night there was considerable discussion about the new joint tramways and the deadlock between Ashton and Stalybridge as to inter-running powers. One councillor criticised the tramways system as a whole, and said that people were getting dissatisfied all round, and that they were losing a lot of money every week. He asked the chairman how soon there was likely to be an agreement between Ashton and Stalybridge. Mr. Alderman Ridyard, the chairman of the Joint Tramways Board, said he wished he could answer the question. They had offered to Ashton similar terms to those which applied between Manchester and Ashton, but Ashton had not accepted their proposal. He had suggested that they should invite Mr. Boyle, the chairman of the Manchester Tramways Committee, with Mr. McElroy (the manager) to preside over the next conference, but Ashton would not agree.

Kettering.—A communication was read at the meeting of the Rural District Council from the British Electric Traction Company, Limited, with regard to the Wellingborough and district tramroad and electricity supply. The company stated that they were applying to Parliament to extend the time for constructing the authorised tramroads between Wellingborough and Raunds *via* Higham Ferrers, and for powers to abandon those running through Finedon and Irthling-

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borough, as well as a part of those in Rushden. With this application they were also applying for powers to supply electrical energy in bulk, and for power purposes within a considerable area, including the area of the Council, and they hoped by uniting the two schemes to be able to give the public the travelling facilities that were required, and at the same time to meet the urgent need of a cheap supply of power throughout the district. In this they were working in conjunction with the County of Northampton Electric Power and Traction Company, Limited, and they asked the support of the Council to the scheme. They proposed to have a central generating station, with sub-stations in different portions of the area, and to connect these thoroughly, so that they might be in a position to give a supply wherever required throughout the area. The matter was referred to committee.

Ayr.—We have received the following particulars of the working of the tramways for the year ending May 15: gross capital expenditure, £77,259; mileage of track—single, 3 miles 5 furlongs; double, 2 miles—total, 7 miles 5 furlongs; population, 33,000; traffic revenue, £13,957; total revenue, £14,328; working expenses, £7,621; interest on capital, £2,298; sinking fund, £891; net balance carried to depreciation, renewal, and reserve accounts, £3,518; car miles, 353,945; passengers carried, 3,316,380; total number of units used, 324,157; number of units used per car mile, ·91; average number of cars in use for 13 hours per day, 10; percentage of working expenses to receipts, 53 per cent.; average traffic revenue per car mile, 9·46d.; average traffic revenue per mile of single track, £1,830; average total revenue per car mile, 9·71d.; average car miles per day per car, 97; average speed per hour, 8; average car hours per day, 13; average working expenses per car mile, exluding power cost, 3·97d.; average working expenses per car mile, including power cost, 5·16d.; average fare charged per mile, ½d.; average fare paid per passenger, 1d.; average number of passenger per car mile, 9·36; average journeys per head of population per annum, 100; number of cars in stock, 17; total amount of sinking fund, etc., £2,163. 4s. 11d.; amount applied in reduction of debt, £1,665. 15s. 6d.; amount of reserve or renewals fund, £2,931. 7s. 4d.; amount of depreciation fund, £5,484. 15s. 4d.

Musselburgh.—The tramways and electricity works were formally inaugurated on Monday. The tramways will extend from the terminus of the Edinburgh cable system at Joppa on the west to Levenhall on the east, a distance of just over three miles. The track is double for two thirds of the distance—namely, between Joppa and the New Stone Bridge, Musselburgh, and between Musselburgh Town Hall and Loretto—and there are convenient loops where the track is single. The system is the overhead trolley. For the whole distance the fare will be 2d. There are several 1d. stages, and two stages of ½d. each in Musselburgh and Fisherrow. Workmen's fares will be half price, and workmen's cars will be liberally provided morning and evening. There was a large gathering at the inaugural ceremony, including the provost and members of the Town Council; Mr. R. Stewart Bain, chairman of the National Electric Construction Company; Messrs. J. T. Jervis, B. Bernheim, and W. Herbert Fowler (directors), and Mr. W. B. Cownie (general manager and secretary of the company); Mr. M. Buchan, of Buchan and Hogarth, Edinburgh, consulting engineers for the undertaking; and Mr. J. E. Pitcairn, manager of the Edinburgh and District Tramways Company. Mr. Stewart Bain, in a short speech, hoped that the tramways would bring prosperity to the town, and that they would soon extend, not only through Musselburgh, but along the beautiful coast in the district. The National Electric Construction Company was grateful for the support it had received from the provost and Council. He then presented souvenirs to the wives of some of the councillors. Already the demand for electric current for lighting purposes is equivalent to 4,000 8-c.p. lamps. A number of other speeches followed. The service was then formally opened. The National Electric Construction Company, owners of the system, have completed it with great expedition, as a start was not made until May. In the evening the company gave a dinner, which was attended by a numerous party.

Raworth's Traction Patents.—A company has been formed under the title of "Raworth's Traction Patents, Limited," to acquire the British patents granted to Mr. J. S. Raworth for his system of automatic regenerative control for electrically-propelled vehicles and for the demi-car. The capital is to consist of 15 000 preferred ordinary shares of £1, and a similar number of deferred ordinary shares at the same price, of which the whole of the first-named stock is offered for subscription. The vendor takes the deferred shares, and cash to the amount of £3,600. The general principles of the inventions to be worked are succinctly defined in the prospectus as: "(1) To provide a motor for use upon an electrically-driven tramway car or railway train which utilises the impetus of the car either when descending a gradient or when reducing speed to regenerate electrical energy which passes back to the trolley wire. (2) To provide an electrical tramway car which, while complying with Board of Trade requirements, is suitable for working by one man only." The policy of the company will be to carry out conversions of existing cars for regenerative control by their own staff, and to grant licenses to the principal electrical manufacturing companies on equitable terms. The demi-car, which is principally applicable to the numerous lines on which the traffic is light and the profits are small, is designed to save half the labour and half the energy required by a large car. Cars to the number of 15 have already been equipped under these patents for various English tramways, and 65 more are on order. Besides these, negotiations for several other orders from corporations and companies are in an advanced stage. The company will have the benefit of improvements to the patents. Letters patent for the system of regenerative control have been granted to Mr. Raworth in the United States of America, and the certificate of allowance has been issued in Germany. Mr. Raworth will act as managing director of the company for the present. In our issue of July 29 appears an account of a trial of the system. Recently, the secretary of the company, Mr. J. I. Hall, read a paper upon the Raworth system of regenerative control before the Tramways and Light Railways Association, when the reception it met with was generally favourable. During the week new installations of regenerative control have been made at Birmingham, Bournemouth, and Havre, in each case with a pattern of motor which has not previously been tried—viz., Brush 1,002 B, Westinghouse 49 B, and G.E. 1,000. An order has also been received to fit up a car for the Corporation of West Ham.

London County Council.—The agenda of the Council's meeting on Tuesday contained a recommendation by the Highways Committee that a supplemental grant of £500 be made in connection with top covers for the cars, this sum including extra work intended to enlarge the usefulness of the covers. The covers have proved so successful that the committee recommend that another 100 cars be similarly fitted, at an estimated cost of £8,500, the work to be done by the Council's staff. The receipts from April 1 to the 3rd inst. amount to £452,688, as against £354,824 last year. The Highways Committee recommend that the amended plans of the Baker-street and Waterloo Railway in regard to the entrances and exits at Baker-street, Kennington-road, and the Elephant and Castle be approved. At yesterday's meeting of the Court of Common Council at the Guildhall, Alderman Sir John Bell presented a petition from the ratepayers asking the Corporation not to give its assent to the proposal of the County Council to run tramways along the Victoria-embankment. A resolution was read from the precinct of St. Ann, Blackfriars, approving of the proposal, providing that the suggestion for widening the north-western corner of Blackfriars Bridge at the angle opposite the Royal Hotel is carried out. Mr. N. Fortescue moved that the Bridge House Estates Committee be instructed to consider the advisability of widening the north end of Blackfriars Bridge so as to do away with the acute angle which now exists at its junction with the Thames Embankment, and thereby greatly facilitate the traffic at this point. The Streets Committee of the City Corporation have decided to adjourn the further consideration of the proposed line over the Embankment until the new year, in the hope that by that time the report of the Royal Commission on London traffic will be in the hands of the Corporation. The London County Council, by their delegates, have assured the Corporation that they do not propose to take away their veto as the tramway authority in the City, and would be ready to pay any reasonable or proper charge for the use of Blackfriars Bridge. They are also agreeable to the City police having absolute control of the tramway traffic within the City, and would be prepared to maintain the lines and streets in a condition satisfactory to the City authorities. At the Surveyors' Institution, Westminster, evidence has been taken by Major Cardew, sitting as arbitrator, in reference to the claim for £85 813 made by the Woolwich and South-Eastern Tramways Company, Limited, for compensation on the transfer of their system to the County Council. The sum of £25,000, which is included in the claim in respect of street widenings, it was decided to exclude pending a decision in a similar case in the Court of Appeal. Mr. Joseph Kincaid gave details of his valuation of the permanent way at £25,917. He considered the life of the line should be taken at 25 years, which meant that it would have to be relaid at the end of three years from this date. Mr. Hopkins stated that he put the constructional value of the line at £38,225, and after making allowance for depreciation, he considered the present value of the permanent way was £23,051.

LIGHTING AND GENERAL.

Loughborough.—The electrical engineer in his last report stated that 28 applications had been received for the supply of current.

Wrexham.—The Town Council have declined to grant the Telephone Company's application to lay cables for the wires in the streets of Wrexham.

Croydon.—Clause 23, taking power to supply electric fittings and wire houses for the electric light, has been deleted from the Corporation Bill.

Hereford.—The Electric Lighting Committee are buying new positive sets of plates, at £1. 5s. 8d. per set, to be used when overhauling the accumulators.

Larne.—The Larne Electric Light Company have obtained permission to place two transformer tanks under the footpath in Main-street to replace existing transformers on the poles.

Heywood.—The consumption of electricity for the month of October, 1904, was 6,107 units, as against 5,200 units for the corresponding period of last year, showing an increase of 907 units.

Bray.—Consideration of the electrical engineer's report on arc lighting, etc., and a special report by him on present method of charging for current, suggesting a sliding scale, has been postponed.

Sheffield.—Mr. S. E. Fedden, A.M.I.C.E., general manager of the Corporation electricity supply department, has presented to the Council an interesting report dealing with his recent visit to America.

Whitby.—The Urban District Council propose to apply for sanction to borrow £1,000 for electric lighting service lines and meters, and £500 for lamps, there having been applications for 840 c.p. lamps recently.

Inverness.—Messrs. Edmundson's Electricity Corporation, Limited, have presented a petition for the erection of an electric lighting generating station in Waterloo-place, Inverness. The buildings are to cost £4,000.

Greenock.—The Corporation have agreed to increase the electric energy supplied to the tramway company from 500,000 to 600,000 units per annum. The company are to pay for the additional 100,000 at 1½d. per unit.

Broughty Ferry (Dundee).—During November the amount of current generated at the electricity station was 9,302 units, an increase of 410 over the same period last year. It has been decided to lay a new cable at a cost of about £50.

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Southport.—One of the Corporation public bowling greens has been fitted with electric lights. This is to admit of the game being played after sunset in the winter. If it is successful and popular, other public greens will also be lighted in a similar way.

Paddington Electrical Exhibition.—The Metropolitan Electric Supply Company are organising an exhibition of electrical appliances for lighting, power, heating, etc., to be held at the Paddington Public Baths, Queen's-road. Particulars in another column.

Chilian Electric Tramway and Light Co.—The profit of the lighting departent in Santiago for the month of November is 22,573dol., which makes the total profit of the company for the month 105,351dol., as against 855,597 for November, 1903.

Bournemouth.—The Corporation recently decided to apply to the Postmaster-General for a municipal telephone license. At the meeting of the Town Council on Tuesday, however, it was resolved after a long debate to abandon the scheme, and also to discharge the Telephone Committee.

Galloways, Limited.—The directors have declared a final dividend at the rate of 5 per cent. per annum on the preference shares. Warrants in respect to this dividend and for half-year's interest on the 4 per cent. first mortgage debenture stock of the company will be posted on Dec. 30.

Manchester.—During the past five weeks the call on the Corporation electricity supply has increased to the extent of over 20 per cent. as compared with the corresponding period last year. The increase is confined almost entirely to power and light requirements, demand for the purpose of tramway haulage having practically reached its limit for the present.

East Barnet.—A letter of the North Metropolitan Electrical Power Distribution Company, proposing to undertake the supply of electricity in the district on similar terms to those they have arranged with the Barnet Urban District Council, has been referred to committee. The Council will also interview the Board of Trade with regard to their provisional order.

Louth.—The Electric Lighting Committee recommended on Tuesday the adoption of James-street Mill as the site for a generating station and the approval of the plans prepared by Messrs. Handcock and Dykes. The committee also recommended that steam power be employed to drive the dynamos. An amendment was adopted referring the matter to the Council in committee.

St. Pancras.—Provided the Council agree to the extension of a feeding main into Hawley-road, at an estimated cost of £2,850, the electricity department will be able to give employment to about 45 labourers for a period of three weeks. The work would be commenced about the third week in January next, subject to the price of copper being favourable for placing the contract for the same.

Huddersfield.—In reference to the alleged insufficiency of the telephone service between Milnsbridge and Huddersfield, the secretary of the Chamber of Commerce has ascertained that there are nine lines of communication between Huddersfield and Milnsbridge serving 157 subscribers at Milnsbridge, and that 21 of these have been added since the lines were added between that place and Huddersfield.

Purley.—At a public meeting of the ratepayers in the Purley portion of the parish of Beddington last week a resolution was passed expressing the opinion that the District Council should oppose the application for a provisional order now being promoted by the County of London Electric Supply Company, and should enter into negotiations with the Corporation of Croydon for the supply of electricity in the district of Beddington.

Electrical Weaving.—It is reported that the first electrically-driven weaving shed in the Burnley district, if not in Lancashire, was started on Saturday. It has been built at Heasandford, Burnley, by Messrs. A. Altham, Limited. It will have a complement of 1,600 looms, which will find employment for about 550 operatives. Four hundred looms are now ready for weaving, and the remainder will be started as soon as they can be got ready.

Erith.—To-day has been fixed for the Local Government Board enquiry into the application of the Council for sanction to borrow the further sum of £20,000 for the purposes of the electricity undertaking. The consulting engineers have recommended that an apparatus for softening the crude water and chemically purifying the condensed water should be installed at the works, but before coming to a decision upon this matter have directed an analysis of the well water to be made.

Glasgow.—With reference to the proposal to abolish or modify the minimum annual charge of £2, the Electricity Committee of the Corporation recommend that the charge of £2 be not abolished, but that in all cases where a supply of current is taken for power and lighting purposes by the same consumer, the total amount payable in respect of both supplies should be set off against the annual minimum charge, the arrangement to take effect as from the commencement of the present financial year.

Stock Exchange.—The Stock Exchange Committee have appointed Dec. 21 special settling day for Calcutta Electric Supply Corporation, Limited, further issue of 20,000 ordinary shares of £5 each, £3 paid, Nos. 60,001 to 80,000, and have ordered the said securities to be quoted in the official list. The committee have also been asked to allow Auckland Electric Tramways Company, Limited, further issue of £85,100 5 per cent. first mortgage debenture stock, redeemable, to be quoted in the official list.

Hammersmith.—The premises of 17 additional consumers, representing a maximum of 486 8-c.p. lamps, have been connected to the mains, and six consumers have been disconnected. The present number of consumers taking current from the mains is 1,532. The agreement between the Council and the Society of Motor Manufacturers and Traders, embodying the terms on which the Council agreed to give a supply of electric current to the Olympia, has been exchanged, and the work of laying the cables is now in progress.

Bootle.—On the proceedings of the Electric Lighting Committee coming up for consideration at the last Town Council meeting, it was asked if there could not be a scheme for the payment of the cost of wiring by instalment. Alderman Brewster said there were such facilities, but they were not taken advantage of. The committee would free wire any premises at the request of the landlord, but could not do so for the tenants alone. If a number of tenants got the consent of the landlords, they could have free wiring.

Beckenham.—The officers' reports and the claims by the South Metropolitan Electric Light and Power Company in the sum of £7,897. 2s. in respect of their rights of supplying that part of the district of Beckenham which is covered by the Crystal Palace Electric Lighting Order, 1893, have been submitted to the Electric Lighting and Tramways Committee, who find, having regard to the provisions of the last-named order relating to the purchase by Beckenham, that the company's claim is excessive, and recommend that the matter of price be referred to arbitration.

Tottenham.—At a meeting of the District Council last week the Electricity Committee submitted a recommendation that the Council should accept either proposal "A" or "C" of the North Metropolitan Electric Power Supply Company, noted in a previous issue, for the supply of electricity in bulk or otherwise, but before entering into any agreement the opinion of an independent expert should be obtained on the two proposals as to which would be most advantageous to the district. Finally it was agreed to take expert opinion on "B" and "C," and then to confer with the company.

Worthing.—Alderman Fraser has been appointed chairman of the Electricity Committee for the ensuing year. The Council have offered to recast the charges made for current at the theatre for lighting purposes as follows: in the event of the consumption exceeding 15,000 units per annum a discount of 25 per cent. be allowed off the whole of that consumption; in the event of the consumption not reaching that figure, the rates of discount are to be the same as now in force—viz., 1,000, up to and including 5,000 units per annum, 7½ per cent. discount; over 5,000 and including 10,000 units per annum, 10 per cent. discount.

Eastbourne.—Mr. J. Kempe Brydges, A.M.I.C.E., the borough electrical engineer, in his annual report states that the cost of working the undertaking is being reduced year by year, while on the other hand the use of electricity, both for lighting and motive power, is largely increasing. Some 35½ miles of cable are now laid, the old low-tension cables being rapidly replaced by other of the latest type. The number of units sold last year was 897,193, producing a revenue of £20,240, part of the profit on which has been applied to the reduction of the rates. The Corporation now contemplate the extension of the cables to Willingdon, an inland village adjoining the borough, which is being rapidly developed.

Broxburn and Uphall.—The switching on of the electric light for Broxburn and Uphall took place on Wednesday, Mr. Robert Allan, county councillor, Whitburn, performing the ceremony. The installation has been carried out by Messrs. Drake and Gorham, Glasgow. The main cables measure about 2½ miles, and are laid on the three-wire system. Arc lamps of the Jandus pattern are placed in the main thoroughfares, and these have a total candle-power of 10,200, and in the less busy streets are a number of Nernst lamps giving a total candle-power of 5,125. At the power station there is a Hornsby-Ackroyd oil-engine of 32 h.p., driving a two-pole continuous-current dynamo giving an output of 13·8 kw. Ample provision has been made for extension, and a provisional order has been applied for in order to supply private consumers.

Ludlow.—The Town Council have agreed to consent to the application of Mr. William Norton, 14, Corve-street, Ludlow, for a provisional order to produce, store, and supply electricity in the borough on the conditions that the undertaker agrees: (1) to give the Corporation the option of purchasing the undertaking at the end of the first 20 years, instead of 25 years, as stated in the letter of Nov. 23; (2) to agree that all openings in the streets, etc. (other than the original laying of the cables, etc.), shall be done by the borough surveyor, and shall be paid for by the undertaker on the following terms—up to 10 yards, 10s., over that distance 1s. 6d. per yard; (3) to consult and agree with the Corporation on the position of the cables, feeding boxes, etc., before doing the work; (4) not to construct any overhead wires, etc., without first obtaining the permission of the Corporation; and (5) the price of the current to be charged to the Corporation for the supply to the public buildings, street-lighting, etc., to be 4d. per Board of Trade unit, but should the charge to the general public be reduced to 5d., then the charge to the Corporation to be reduced in like proportion.

Northfleet.—The clerk reported at the last District Council meeting that the town clerk of Gravesend, at a personal interview, had proposed the following compromise of the following points outstanding in the agreement between the Council and the Corporation: (1) As to public lighting—the town clerk suggested that the Council should not be bound to take electricity for any of the public lamps so as to avoid the question of maintaining the light at 100 c.p. at the price stipulated. (2) As to purchase—the town clerk proposed that the Council should allow the 21 years to stand, and not insist upon 14 years if the Corporation did not insist upon the Council paying loss which might be incurred by the Corporation. (3) As to an undertaking that a main should enter the district at the hamlet of Perry-street—the town clerk thought that this could be arranged. After consideration it was decided as follows: (1) As to public lighting—that the Council should be satisfied with the suggestion provided they have an option to accept the terms of the Corporation detailed in the draft agreement. (2) As to purchase—that the Council can neither debar themselves for more than 14 years from acquiring the undertaking, nor pay the loss (if any) which the Corporation may incur.

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British Electrical Friendly Society.—At the third annual meeting of this society on Monday, Mr. W. G. A. Bond, chairman of the central committee, presided. The report stated that at the close of the financial year there were 1,950 members, and the receipts from all branches (29) amounted to £3,574. During the year 693 members claimed sick pay, amounting to £2,044. The increase of £199 as compared with the sick pay in 1903 was mainly attributable to accidents. The report was adopted, and revised rules to meet the altered conditions consequent on the institution of a pension fund were approved.

St. Marylebone.—The Electric Supply Committee have again appointed Councillor E. R. Debenham chairman of the committee. At last night's meeting the committee recommended that the Council take the necessary steps to oppose the Bills of which parliamentary notice has been given, and any others that may be introduced, so far as the same relate to the supply of electricity in the borough of St. Marylebone, and that Messrs. Sharpe, Parker, and Co. be retained as parliamentary agents for the purpose, and that such counsel be retained and engaged as the Electric Supply Committee, acting on the advice of Messrs. Sharpe, Parker, and Co., may think advisable.

Colchester.—The following statistics are taken from the report of the electrical engineer: output of electricity in units during October, 1904, 91,558 (1903, 43,830; 1902, 28,912); number of consumers at end of October, 576 (387; 300); total number of 8-c.p. lamps connected, 27 681 (24,015; 18,302). The engineer has also reported that he cost of keeping the arc lamps at the electricity station burning all night is rather heavy, and a tender has been accepted for executing the work of supplying and fitting a number of incandescent lamps so as to reduce the expense of lighting by Messrs. Joslins Limited for £225. 10s. One of the engine-drivers is to be solely employed to execute repairs and do all fitters' work.

London Gazette.—The last day for receiving proofs in the estate of Benjamin George Hodges, electrical engineer, 20, St. Luke's-street, Derby, is Dec. 23. The order of the High Court of Justice, Chancery Division, dated Nov. 29, 1904, confirming the reduction of the capital of the Nernst Electric Light, Limited and Reduced, from £320,000 to £90,000, was registered Dec. 6. A meeting of the stockholders of the Blackpool Electric Tramways (South), Limited, will be held on Dec. 22, 1904, at the Law Association Rooms, Cook-street, Liverpool. An adjudication order has been made out *re* William Watson and George Huntingdon, electricians, trading as Watson and Huntingdon, 83, Battersea-rise, London.

Islington.—The Borough Council agree with the London County Council with regard to rating Government telephone wires, and have decided that a communication be addressed to the Postmaster-General asking him to make provision for contributions in lieu of rates to be made to local authorities in London in respect of Post Office telephone wires. Concerning the Bills now being promoted by the Electric Power Development Company and the Charing Cross and Strand Electricity Corporation for the purpose of supplying electrical energy in the London district for use in bulk by existing undertakings and for power purposes, it will be recommended at to-night's meeting that the Council present petitions under seal against the Bills when introduced, with a view to the protection of the interests of the ratepayers.

Swindon.—Councillor A. W. Deacon has been elected chairman of the Electricity Committee for the ensuing year and Councillor J. T. Smith vice-chairman. The town clerk has been instructed to advertise for tenders for carrying out extensions to the generating station. The sub-committee appointed in August to consider as to the desirability of erecting a refuse destructor in connection with the electricity station has been discharged, and the chairman and vice-chairman, and Councillors Mayell and Walters, with the electrical engineer, together with the sub-committees appointed by the Works, etc., Health, etc., and Farm, etc., Committees have been appointed a sub-committee to consider the desirability of the Corporation erecting a refuse destructor, and to report. The coal bunkers at the electricity works are to be covered in, and the borough surveyor is to prepare a plan and estimate of the cost, and obtain tenders from local tradesmen.

Staff Dinner.—To the number of 94, the staff of the Sunderland Corporation electrical department and their friends dined together in the Bells Restaurant on Dec 7 under the presidency of their chief, Mr. J. F. C. Snell. Supporting the chairman were the Mayor (Councillor Foster), the town clerk (Mr. F. M. Bowey), Alderman Bruce, Councillors Dixon, Summerbell, Bell, and Bryers, Dr. Baillie, and Mr. A. R. Dayson (tramways manager). The Mayor, in responding to the toast of "The Mayor and Corporation of Sunderland," said the gathering that night spoke volumes for the mutual confidence which existed in the Corporation electrical department. His Worship paid a high tribute to the services rendered by Alderman Bruce, chairman of the committee, and to Mr. Snell, the electrical engineer. He wound up by expressing on behalf of his fellow-consumers of electric light in the town the hope that the cost of the current would be reduced.

Lowestoft.—The engineer in his last report states that there are now connected to the mains 565 consumers, representing 28,014 8-c.p. lamps. During the month 11 new consumers have been connected, representing 361 8-c.p. lamps. He also reported that he had submitted plan of the proposed method of crossing the harbour with the electric light cables to the Great Eastern Railway Company, but that the company had been unable to approve same. He now suggested that the cables should not be taken across in pipes, but that cables with a helical steel armouring should be laid in the harbour from 6ft. to 10ft. below the bed of the harbour. The report was adopted. We deal with the accepted tenders in another column. The engineer was also instructed to order the cable required for Royal-avenue public lighting, and to report to the next meeting as to the cost of laying a cable for private lighting in the road.

West Hartlepool.—The Town Council have entered into an agreement with the National Telephone Company whereby, in return for permission to lay underground wires, the company undertakes to effect certain reductions in the charges to subscribers. The reduced rates will be applicable to all present, as well as future, subscribers, and any existing subscriber will be at liberty to cancel the existing agreement, and avail himself of the new agreement by giving to the company 14 days' notice in writing prior to the next date for which payment of rental is due. The rates are a uniform charge of £8 for the first instrument and £6. 16s. for the second, additional connections to be available to any member of the firm having the first connection; £7 to cover 1 200 calls per annum (receiving an unlimited number), £6 for 900 calls, and £5 for 600 calls, the calls in excess of this number to be still at the rate of 1d. a call. An enquiry has been held into the application of the Corporation for sanction to borrow the sum of £13,861 for purposes of electric lighting.

East Ham.—The Electric Light and Tramway Committee last week paid a visit to the generating station in order to inspect the extensions recently completed, which consist of a new engine and generator, two 350-h.p. boilers, with condensers, pumps, water purifiers, etc., the total estimated cost of the extensions being nearly £15,000. The chairman of the committee, Alderman J. Savage, started the engine, which was built by Messrs. John Musgrave and Sons, Limited, of Bolton, and supplied by Messrs. Dick, Kerr, and Co., Limited, Preston. It is of the compound vertical type, running at a speed of 100 revolutions per minute, its full load capacity being 1,250 h.p. The total machinery now installed in the station amounts to 3,100 h.p. The boilers duplicate those previously supplied by Messrs. Babcock and Wilcox, who are also the contractors for the condensers, steam-piping, pumps, and water purifiers. The generating station was opened in June, 1901, when it was estimated that at the end of three years there would be a total of 15,000 8-c.p. lamps installed in the district, but owing to the rapid developments and to the cheap rate at which the Council supply current, there are at the present connected 752 consumers, with an equivalent of 29,360 8-c.p. lamps.

Electrical Contractors' Association.—On Friday, Dec. 2, the second annual dinner of the Newcastle branch of the Electrical Contractors' Association (Incorporated), was held at the Continental Restaurant, Newcastle, Mr. Wm. Cross presiding, and Mr. A. Andrews, vice-chairman. There were present as guests, Mr. Harford (Liverpool), Messrs. Giepel and Prescott (West Hartlepool), Mr. W. P. Steinthal (Bradford), Mr. Eugene Brown (Newcastle), Messrs. Gowdy, Usher, and R. Robson (hon. secretary), members of the committee, and other gentlemen. After the usual loyal toasts Mr. Cross proposed "The Association." Mr. Harford replied. Mr. Steinthall proposed "The Newcastle Branch," and Mr. Andrews replied. Mr. Gowdy proposed "The Guests," and Mr. Giepel replied. The Chairman gave a very concise report upon the work of the association during the last year, and the great deal of work the incorporation threw upon the leading members. Mr. Steinthall said he was glad to propose the toast of "The Pioneer Association," and was pleased to see four of the original five members present that evening. Mr. Andrews remarked that the meeting held the evening before was the fiftieth general meeting of the Newcastle Association. Several songs were given during the course of the evening.

London County Council.—The Highways Committee reported on Tuesday that the Council on Nov. 12, 1901, accepted the tenders, amounting to £25,964 and £46,626, of Messrs. Dick, Kerr, and Co., Limited, for the supply of continuous-current plant and three-phase plant respectively, required for the Council's electricity generating stations. The engines in connection with the continuous-current plant had since been installed at the Loughborough generating station, and those in connection with the three-phase plant at the Deptford generating station. Under the terms of the specifications for the engines supplied under each contract, the contractors were entitled to a bonus at the rate of £300 a pound for every pound or fraction of a pound by which the steam consumption of each engine falls short of 24lb. per kilowatt-hour. In order that this might be clearly understood, they pointed out that a generating set produces 21,000 kilowatt-hours per day, or over 7,500,000 kilowatt-hours per year. The saving of 1lb. in steam per kilowatt-hour results in a saving of about 380 tons of coal per annum on each engine. A series of tests had been made with a view to ascertaining the steam consumption of the engines, with the result that the actual consumption was found to be 22·35lb. per kilowatt-hour at full load. This corresponded to a reduction of 1·65lb. per kilowatt-hour on the guarantee required by the specification, and the contractors were accordingly entitled to a bonus of £495 on each of the four engines, making a total of £1,980.

PROVISIONAL PATENTS, 1904.

DEC. 5.

26391. Improvements in mechanism for use in conjunction with apparatus for utilising electromagnetic or "Hertzian" waves. Michael Holroyd Smith, 26, Cambridge-street, Pimlico, London.

26439. A new method for inserting electric light in flowers and foliage, artificial or natural, for use and decoration. Eliza Bickersteth, 24, Ladbroke-grove, London.

26445. Improvements in brushes for electric machines. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Charles Wirt, United States.)

26446. Improvements in and relating to electrical rheostats or resistances. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Charles Wirt, United States.)

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26449. Improvements in and relating to insulator for electric wires. Samuel Buckner Flynt and Leaman Ambrose Maiden, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26475. Improvements in electric fire-alarms and thermo-indicators. Alfred Henry McNeil, 40, Chancery-lane, London.

DEC. 6.

26527. Improvements in electric ignition apparatus. August Eckstein and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

26529. Improvements in or relating to electric storage batteries. Richard Joseph Crowley and Alfred Blackman, "St. Brelade," Glamorgan-road, Hampton Wick, Middlesex.

26538. Improvements in electrical fuse boxes, ceiling boxes, wall plugs, and the like. Frank Herbert, 104, Clarendon-road, Putney, London. (Complete specification.)

26552. Improvements in lanterns for use in lighting by electricity or gas. Simon Biheller, 1, Great James-street, London.

26557. Improved process and apparatus for the production of metals of the alkali group by electrolysis. Alfred Julius Boult, 111, Hatton-garden, London. (Edgar Arthur Ashcroft, Algeria.)

26582. Improvements in direct-current dynamo-electric machines. Cyril Ernest Davies, 322, High Holborn, London.

26588. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26589. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26602. Improvements in and apparatus for the production of reactions in gases by means of electric arcs. James Yate Johnson, 47, Lincoln's inn-fields, London. Badische Adilin und Soda Fabrik, Germany.)

26603. Improvements in and apparatus for forming devices for holding or suspending overhead electric conductors or trolley wires and the like. Isaac Everson Winslow, 47, Lincoln's-inn-fields, London.

DEC. 7.

26618. Improvements in and relating to appliances for shifting the points of electric and other tramways or railways. Alexander Taylor, jun., 96, Buchanan-street, Glasgow.

26656. Improvements in electric lamps, said improvements being also applicable to the globes, chimneys, or shades of gas, oil, or other lamps or lights. William Goulton, 114A, Chancery-lane, London.

26679. Improvements in or relating to electric current protecting devices. Walter Schäffer, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Dec. 9, 1903, being date of application in Germany.) (Complete specification.)

26686. Improvements in electric telegraphs. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

26696. Improvements in and relating to apparatus for wireless telegraphy or telephony. Simon Eisenstein, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26699. Improvements in motor-controlling systems. Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Complete specification.)

DEC. 8.

26704. Improvements in clips for supporting electricity conductors or wires. Arthur Reginald Walmsley, Penny Bank-chambers, Halifax.

26708. Improvements in and relating to automatic starters for electric motors. Charles William Webster, Sunbridge-chambers, Bradford.

26709. Improvements in and relating to fuse or terminal boxes for use in electrical mains or the like. Alfred Sutherland Blackman, Sunbridge-chambers, Bradford.

26748. Improvements in apparatus for controlling telegraphic recorders and other instruments. Marconi's Wireless Telegraph Company, Limited, and Edward Priddle, 24, Southampton-buildings, Chancery-lane, London.

26757. Improvements in signalling bells worked by electrically-controlled compressed air or other gas. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

26761. Improvements in and relating to electric arc lamps. John Morecraft Wellington and Walter Francis Daniell, 88, Chancery-lane, London.

26772. Improvements in and relating to electromagnetic apparatus. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Carl Joseph Schwarze and Amos Martin Kells, United States.) (Complete specification.)

26769. Improved coil trembler for electrical ignition apparatus of high-speed engines for motorcars and similar vehicles. Sidney James Williams, 149, Strand, London.

26786. Improved means for rendering the insulation of electric conductors fireproof. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Felten und Guilleaume Carlswerk Act.-Ges., Germany.)

26791. Improvements in connections for compounding transformers and like apparatus. Alexander Heyland, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Dec. 8, 1903, being date of application in Belgium.) (Complete specification.)

26799. Improvements in holders for electric incandescent lamps. John Cox Dear, 40, Chancery-lane, London.

26805. A new or improved alternating-current electromotor. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

DEC. 9.

26829. Improvements in electrical switches and cut-outs. Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Bagge, Ordsal Electrical Works, Salford. (Complete specification.)

26849. Improved apparatus for electro-deposition of metals. Bertram Morley Bailey, 77, Colmore-row, Birmingham.

26887. Improvements in three-phase ground detectors. Paul MacGahan, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 20, 1904, being date of application in United States.) (Complete specification.)

26906. Improvements in or connected with electric demand indicators. John Reid Dick and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

26915. Improvements in electrodes for arc lamps. John Thomas Henry Dempster, 83 Cannon-street, London. (Date applied for under Patents Act, 1901, Dec 10, 1903, being date of application in United States.) (Complete specification.)

26916. Improvements in arc lamp electrodes. Charles Proteus Steinmetz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26917. Improvements in electrodes for arc lamps. Willis Rodney Whitney, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26918. Improvements in arc lamps and electrodes therefor. Johannes Härdén, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26919. Improvements in arc light electrodes. Johannes Härdén, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26920. Improvements in arc light electrodes and methods of making the same. Charles Fowler Lindsay, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26921. Improvements in electrodes for arc lamps and method of making the same. William Stone Weedon, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26922. Improvements in arc light electrodes. William Stone Weedon, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 10, 1903, being date of application in United States.) (Complete specification.)

26923. Improvements in and relating to electric rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26925. Improvements in electrical measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

DEC. 10.

26948. Storage batteries. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Thomas Alva Edison, United States.) (Complete specification.)

26957. Improvements in signalling on electric tramways and railways. Charles Henry Pym and Edward James Witcombe, 9, St. Matthew's-road, Cotham, Bristol.

26985. Improvements in and relating to electrical switches. George Page, Alfred Holmes, John Henry Holmes, Leonard William Holmes, and Ellwood Holmes, 1, Queen Victoria-street, London.

26986. Improvements in and relating to electrically-controlled and variable speed gear. Henry Vincent James and Robert Alfred Marples, 1, Queen Victoria-street, London.

26997. Improvements in or relating to telephone apparatus. William Mudd Still and Andrew George Adamson, 46, Lincoln's-inn-fields, London.

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27009. Improvements in and relating to electromagnets. David Leonard Lindquist, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

27003. Improvements in electric switches. Antoine Bénassy, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 17, 1903, being date of application in Switzerland.) (Complete specification.)

27011. Improvements in vapour electric apparatus. Osias Otto Kruh, 83, Coleman-street, London. Date applied for under Patents Act, 1901, Dec. 12, 1903, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 29, 1904.

1903.

18854. Telegraphic recording and perforating apparatus. Armstrong and Orling.

18980. Electrical signalling on railways and tramways. Tunstall.

19063. Electro-capillary detectors, relays, and recording apparatus. Armstrong and Orling.

26465. Systems of electric motor control. The British Thomson-Houston Company, Limited. (General Electric Company.)

27171. Method of insulating electrical coils, conductors, and the like Chitty.

27173. Connector for electric circuits. Kelsey.

27298. Magnetic separators for ores or the like. Dawes.

27512. Electric igniting devices for explosion motors. Treskow.

1904.

456. Manufacture of chlorine by electrolysing sodium chloride solution and apparatus therefor. Leetham and Bousfield.

984. Electrical alarums for clocks. Sturgess.

2455. Control of alternating-current electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

2581. Machines for making stems for incandescent electric lamps. British Thomson-Houston Company, Limited. (General Electric Company.)

2715. Electric arc lamps. British Thomson-Houston Company, Limited, and Murphy.

3657. Gas or vapour electric lamps. Le Tall. (Cooper Hewitt Electric Company.)

3666. Electric switches. British Thomson-Houston Company, Limited. (General Electric Company.)

8819. Incandescent electric lamp fittings. Löti and Latzko.

15155. Automatic electrical balance. Dworzynski.

18252. Automatic electric telegraphic transmitters. Henn.

18403. Electrolytic process and apparatus therefor. Townsend.

18910. Electrical heaters. Pemberton. (Date applied for under International Convention, Jan. 4, 1904.)

18987. Gas and vapour electric devices for lighting, rectifying, alternating currents, and the like. Thomas. (Date applied for under International Convention, Sept. 4, 1903.)

21402. Electrodes for electric accumulators with invariable electrolyte. Jungner. (Date applied for under International Convention, Oct. 7, 1903.)

22652. Electric circuit breakers. McFeatters and Christmas.

22665. Electric circuit breakers. McFeatters and Christmas.

23009. Intercommunication telephone systems. Birnbaum and White.

23677. Electric tremblers or switches. Aron. (Langumier.)

23820. Electrical choke coils. Carson. (Date applied for under International Convention, March 30, 1904.)

23828. Terminal for electrical apparatus. Prested.

23972. Electrical indicating or measuring instruments having springs to convey the current to a movable system. Siemens Bros. and Co., Limited. (Siemens und Halske, Akt.-Ges.)

24078. Manufacture of single or multiple electric conductors. Soc. Industrielle des Téléphones. (Date applied for under International Convention, March 11, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	15/32-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-5⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	–	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅛-3⅛
—— 4 per cent. Mortgage Debenture Stock	100	–	88-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	⅜-½
—— Non. Cum., 6 per cent. Pref.	2	–	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	68-72
Callender's Cable, Debentures	100	–	104-106
—— Ordinary	5	–	9½-10
—— 5 per cent. Pref.	5	–	5⅛-5⅜
Crompton and Co.	3	–	1⅝-1¾
—— 5 per cent. Debentures	100	–	93-98
Edison and Swan United, "A" Shares, 1-99,261	5	–	⅝-¾
—— "A" Shares, 01-017,139	5	–	1-1¼
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼-1½
—— 7 per cent. Cumulative Pref.	2	–	2⅛-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10½-11
—— 4½ per cent. Preference	5	–	5⅛-5⅜
—— 4½ per cent. Debentures	100	–	110-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	15-16
—— 4 per cent. Debentures	100	–	99-102
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	78 80
—— 5 per cent. Bonds	100	–	103-105

Electric Lighting and Supply.—

Bournemouth and Poole, Ordinary	10	–	12-13
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock. Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5⅛-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	7⅜ 8
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12½-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	104-107
Charing Cross and Strand, Nos. 1-70,000	5	–	8¼-8⅜
—— 70,001-80,000	5	..	8-8¼
—— 4½ per cent. Cum. Pref.	5	–	5 9/16-5 13/16
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4⅞-5
—— 40,001-80,000	5	..	4⅞-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	103-105
Chelsea Electricity Supply	5	–	6⅛-6⅜
—— 4½ per cent. Debentures	100	–	108-111
City of London, Ordinary	10	–	10⅜-11
—— 6 per cent. Cumulative Pref.	10	–	13¼-14
—— 5 per cent. Debenture Stock	100	–	125-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	103-105
County of London Electric Supply, Ordinary	10	–	9 9¼
—— 6 per cent. Cum. Pref.	10	–	12-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	101-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	6⅛ 6⅜
—— 6 per cent. Cum. Pref.	5	–	6-6¼
—— 4½ per cent. First Mort. Deb.	100	–	106-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2¼
—— 5 per cent. Debenture Stock, Red.	100	..	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	102-105
Havana Electricity, Limited, 1-15,000	10	–	9¼-10⅛
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7⅛-8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	..	100-102
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	9/16-11/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5		12¼-13½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10⅛
London Electric, Ordinary	3	–	2-2⅛
—— 6 per cent. Pref.	5	–	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	97-99
Metropolitan Ordinary	10	–	16¼-16⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5 7/16-5 9/16
—— 5½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.	100	–	95-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	–	14¼-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	101-105
Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,510	5	–	6⅛-6⅜
—— 4 per cent. Debenture Stock	100	–	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	3⅜-3½
—— 4 per cent. Debenture Stock	100	–	83-87
South London, Ordinary		–	4¼ 4⅜
South Metropolitan Electric Light and Power Co., Ord.	1	..	13/16-15/16
— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	107-110
—— Ditto, June, 1904		..	
St. James's and Pall Mall, Ordinary, 101-80,000	5	–	14-14½
—— 7 per cent. Pref.	5	–	8¼-9
—— 5½ per cent. Deb.	100	–	99-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	–4	15/16-5 1/16
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–4	15/16-5 1/16
Westminster, Ordinary	5	–	12¼-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6½-7

Electric Tramways.—

Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5⅜-5⅝
—— Ord.	5	..	7¼-7⅜
—— Permanent 6 per cent. Debenture Stock. 1888	100	–	143-146
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	106-107
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	10¼-11
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9¼-9⅜
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	91-96
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.	1	..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅛-13⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103
—— Ord Pref.	100	–	100-103
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	–	102-104 p c
—— 4½ per cent. Vancouver Power Deb.	100	–	98-101
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9¼-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10¾-11
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100		95-97

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	–	3 11/16-3 13/16
—— "A" 5 per cent. Cm. Pf., 1-40,000	5	–	5⅝-5¾
—— "B" 5 per cent. Cm. Pf., 1-27,500	5	–	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	–	106-108
—— Prov. Cert., all paid	100	–	103-106
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7⅛-8¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways ,Nos. 1-480,000	1	–	1 7/16-1 9/16
City of Birmingham Tramways, 5 per cent. Cum. Pref. ..	5	–	4⅞-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100		101-104
Cork Electric Tramways and Lighting Co. Ordinary	10		9¼-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 5 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5		5¼-4
—— 4 per cent. Debenture Stock	100	–	90-93
Kidderminster and District Lighting and Traction, Pref.	5	–	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10⅜-10⅞
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103 105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	103-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	⅞-1
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	..	103-105
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	–	¼-1½

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12½
—— 5 per cent. Cum. Pref.	10	–	9⅜-9¾
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk.	100	–	103-106
Potteries Electric Traction, Ordinary £0,001-40,00 0	10	–	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8¾
—— 4½ per cent. Debenture Stock	100	–	99-102
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,132 6 per cent. Preference	1		1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	–	100 p.c.

Electric Railways.—

Central London, Ordinary	100	–	91-93
—— 4 per cent. Pref.	100	–	101-103
—— ,, ,, deferred	100	–	84-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid).	100	–	108-110
City and South London, Consolidated Ordinary	100	–	46-47
—— 4 per cent. Debenture Stock	100	–	104-107
—— 5 per cent. Pref. Stock '81	100	–	122-126
—— ,, ,, ,, '86	100	–	117-120
—— ,, ,, ,, '01	100	–	115-118
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10¼
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700..	—	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	–	97-98
Waterloo and City, Ordinary	100	–	88-90

Telephones.—

National Telephone, Preferred	100	–	108½-109½
—— Deferred Stock	100	–	98½-99½
—— 6 per cent. Cum. First Pref.	10	–	13-14
—— 6 per cent. Cum. Second Pref.	10	–	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅜
—— 5½ per cent. Deb. Stock, Red.	100	–	98½-99½
—— 4 per cent. Deb. Stock, Red.	100	–	104½-105½
—— 4 per cent. Prov. Cert.	—	..	67½-68¾
Oriental Telephone and Electric Company	1		15/16-1 1/16
—— 6 per cent. Cum. Pref.	1	..	1⅛-1⅛

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 10	1,035	1,079	– 43	+ 5,727*h*	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 10	165	169	– 4	+ 489	8	8	,, 15	14,160	3,201,586	336,049	1·03	10·11	1,770	5·04
Barking Corporation	,, 10	60	35	+ 25	+ 47	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 11	939	975	– 36	– 512	23·53	23½	March 31	56,073	11,327,932	1,319,701	1·158	9·98	2,383*b*	6·1
Birmingham Corporation	,, 10	325	—	—	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 10	5,053	4,893	+ 160	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 9	738	738	+ 1	+ 3,334	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·89
Blackpool Corporation	,, 2	278	247	+ 31	+ 5,934	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 10	157	159	– 2	+ 383	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	,, 11	1,626	1,660	– 34	+ 488	38	38	March 31	94,151	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 7	762	770	– 8	+ 2,035	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 3	3,607	3,314	+ 293	+26,433	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 11	719	721	– 2	+ 3,280*h*	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 9	4,534	4,309	+ 225	—	51½	51½	Dec. 31*g*	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 10	943	747	+ 195	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 4	274	268	+ 6	—	8½	—	March 31*j*	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 3	1,816	1,700	+ 116	+ 1,653	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 10	166	169	– 3	+ 209	—	—	Dec. 31*g*	9,937	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 10	7,099	7,053	+ 46	– 183*h*	6	6	,, 31	362,471	44,933,938	1,292,674*a*	1·87	64·87	58,229	35·60
City & South London Railway	,, 11	3,312	3,458	– 146	– 2,506*h*	6½	6⅝	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Colchester Corporation	,, 7	154	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 8	430	384	+ 46	– 2 466	—	—	,, 31*g*	25,657	6,353,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 9	206	196	+ 10	+ 78	7·23	7·23	March 31*a*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 10	172	176	– 4	– 283	4½	4½	,, 31	11,255	2,871,332	280,901	0·94	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 9	100	84	+ 16	— *h*	7	6½	Dec. 31*g*	6,234	588,905	107,164	3·88	14·09	932	7·39
Dublin U. T., electric cars	,, 9	3,697	3,575	+ 122	} —	47	46	,, 31*g*	134,643	—	3,429,356	—	—	—	— *h*
Dublin S. District, Electric	,, 9	818	758	+ 60											
Dundee City Tramways	,, 7	838	768	+ 40	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 10	583	563	+ 20	+ 1,485	10·77	10·75	March 31	34,312	12,950,259	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 10	13,418	13,582	– 64	+20,115*h*	143	123	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	,, 7	209	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	Nov. 30	2,187	2,158	+ 29	+ 3,901	33	30½	March 31	68,283	16,322,054	1,387,885	1·00	11·79	2,069	8·77
Huddersfield Corporation	,, 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	Dec. 10	2,037	1,822	+ 214	+10,309	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 10	340	313	+ 27	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 7	93	110	– 7	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 7	195	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 10	5,186	4,938	+ 248	—	89	81½	,, 25	280,562	60,739,234	6,215,798	1·10	10·94	3,407	—
Leicester Corporation	,, 10	1,659	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 3	9,691	9,317	+ 374	+ 4,096	103	103	Dec. 31*g*	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 11	1,384	1,512	– 128	– 2,032*h*	6·57	—	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *e*
London County Council	,, 3	11,403	8,272	+3,131	—	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 10	133	134	– 1	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 8	87	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 10	11,400	10,737	+ 663	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 9	1,877	976	+ 900	+12,403*h*	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 10	101	93	+ 8	+ 1,284	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 10	3,434	3,436	– 2	—	45	38½	,, 25	185,027	39,715,120	4,059,907	1·1	10·94	4,111*b*	—
Newport (Mon.) Corporation	,, 10	492	422	+ 70	+ 595	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 10	1,333	1,287	+ 46	+ 5,729	29	29	,, 31	91,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31*g*	5,416	925,281	127,456	1·38	10·27	—	—
Rotherham Corporation	,, 8	399	364	+ 35	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6·68
Scarborough Tramways Co.	—	—	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 11	4,374	4,193	+ 181	+ 3,585	34½	—	,, 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	—
Southampton Corporation	,, 8	805	861	– 55	– 2,327	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	7·0
Southend-on-Sea Corporation	—	—	—	—	—	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 9	408	393	+ 35	+ 7,909	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 11	1,058	988	+ 70	+ 1 042	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	—
Swindon Corporation	—	—	—	—	—	3¾	—	—	—	—	—	—	—	—	6·08
Wallasey U.D.C.	,, 10	620	572	+ 47	+ 1,772	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·90
West Ham Corporation	,, 8	1,023	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 7	693	355	+ 338	—	7½	—	,, 31*g*	20,878	4,263,066	417,335	—	12·006	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *e* Including one section of horse traction. *g* 1903. *h* Train mile. *k* Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

Zurich.—A great scheme is reported for the utilisation electrically of water power at Zürich. It is proposed to construct a barrage of the Sihl with a stone dam 30 yards high, and containing 20,600 cubic yards of masonry, the work to continue as far as the defile of Im Schlagen, and to construct embankments, the result of which would be to form a lake exceeding seven square miles in extent, and containing 96 5 million cubic metres of water, capable of providing force to the extent of 20,000 h.p. for 24 hours daily or 60,000 h.p. for 11 hours daily.

Solar Electricity. — A Portuguese scientist, Prof. Himalaya, claims to have demonstrated that the origin of the sun's heat and rays is electrical. For the purpose of his experiments he designed the "pyrheliophoro," or sun motor, by means of which he is reported to have found that the heat of the sun is more than double that of the electric arc, which has hitherto represented the highest known temperature. It is stated that there is no known substance, not even asbestos, that will not fuse in his sun furnace into which the concentrated rays of his mirror reflector and concentrator are thrown.

The Institution.—Mr. Adams's paper on "The Combination of Dust Destructors and Electricity Works Economically Considered" gave rise to some humorous remarks last week, the author being responsible for one of them. Referring to the electricity latent in the cat, Mr. Adams described it as "electrified pussy"; then, alluding to the number of feline corpses which find their way into the works with the refuse and contribute to the generation of energy, he quoted it as an instance of "pussified electricity." When 9.30 arrived, and there were still several likely speakers, the discussion was adjourned until the 12th prox., when, time permitting, Messrs. Booth and Kershaw will present a paper on "Fuel Economy in Generating Stations."

Rubber Cultivation in Ceylon.—Tests have indicated that rubber can be successfully produced in Ceylon, and several applications have been received for land on which it is desired to cultivate rubber-producing plants experimentally. A notice will be issued very shortly giving full details of the terms and conditions on which Government is prepared for a limited period to lease land at specially low rates for pioneer cultivation. Briefly, these terms are that if the purchaser will undertake to plant the land with rubber, a lease for 50 years will be granted at a minimum rate of 2s. 1d. per acre, or 3s. 4d. per acre if the land is irrigable from a Government tank. Applications for land on these special conditions must be made before a date in next year to be announced, as after that the land will be disposed of in the usual way.

The Jones Underfeed Stoker.—From the *Journal* of the Franklin Institute for the present month we gather that a committee appointed by the institute has investigated the merits of the Jones underfeed stoker, and in consequence has awarded Mr. E. W. Jones, the inventor, the John Scott legacy premium and medal. The wording of the award is that it is made in consequence of the good work done by Mr. Jones in designing his underfeed stoker, and in view of the simplicity of the device from a mechanical standpoint, both in construction and operation. The figures collected by the committee as to the working of the stoker, which is now becoming well known in this country, are exceedingly valuable, and the full report of the committee should be read by all interested in steam raising. The history of the invention is given, but, what is more valuable, there is a series of tables at the end of the report giving actual results obtained from the stoker in four different installations. These speak well of the working of the stoker in extended trials.

A Big Scheme.—A Bill entitled "The Administrative County of London and District Electric Power Company" has just been lodged in the Private Bill Office, and will come before Parliament in the ensuing session. This ambitious project was referred to in our issue of the 2nd inst. The object of the Bill is to incorporate a company with a capital of £5,000,000, in 500,000 shares of £10 each. Messrs. J. H. Armstrong, L. C. Cunliffe, and James Falconer are named as the first directors, while the subscribers include the names of Lord Armstrong, Sir George Taubman Goldie, Sir James Joicey, and the Hon. W. J. Armstrong. The proposed area of supply embraces the city of London, the city of Westminster, the boroughs of Kensington, Battersea, Chelsea, Fulham, Hammersmith, Hampstead, Holborn, Paddington, St. Marylebone, Wandsworth, and Ealing; the urban districts of Acton, Brentford, Chiswick, Hampton, Hampton Wick, Heston and Isleworth, Southall, Norwood, Teddington and Twickenham; the boroughs of Croydon, Kingston-on-Thames, and Richmond, with a number of urban district councils in Surrey, and also Bromley, Beckenham, and Penge in Kent. The area will also include Woolwich, West Ham, Ilford, and Gravesend.

Municipal Loans.—An amusing instance of how far the Local Government Board will sometimes go in absurd details is afforded by the statement of the inspector sent to enquire into the application of the Blackpool Corporation for permission to borrow the sum of £9,000 for the erection of new baths. The inspector was informed that the cost of the electric lamps at the baths would be 1s. each, and that there would be 300 lamps. He stated that in accordance with special instructions from the Board the amount of the loan would be decreased by £15, because these lamps could not last as long as the building. This plan of striking out any items which will not last the full life of the building would, if carried to the extreme, mean the omission of all machinery in a loan for an electric lighting station. It is a well-known fact that the Local Government Board have allowed for the inequality in the lives of the various items by assuming a mean period for the whole. If, then, they are going to strike out items like electric lamps, the mean period should be increased. This, of course, is not an important matter, but the detailed labour involved is, and the Blackburn case shows the futility of the discussion of such small items. The replacement of these lamps would, of course, come out of revenue account, and at the expiration of the term of the loan, presuming the baths were still in use, there would be good lamps in position, so that no financial trouble would ensue.

New Publications.—"Maxwell's Theory of Wireless Telegraphy" (London: Archibald Constable and Co., 10s. 6d.), by H. Poincaré and F. R. Freeland.—The Electric Club *Journal* for December contains articles on "Modern Practice in Switchboard Design," by H W. Peck; "Opportunities of the Apprenticeship Course," by W. M. McFarland; "Electric Railway Braking," by E. H. Dewson. The series of articles on "Applications of Alternating-Current Diagrams" and "Factory Testing of Electrical Machinery" are continued by Messrs. V. Karapetoff and R. G. Workman respectively; and there are articles on shop experience in connection with "Interphase Connections on Two-Phase Generators securing Low Voltages for Starting Induction Motors," "Braking of Armature Leads on Small Armatures"; and "Repairing Pitted Commutators."—"The Central": The issue for November of the organ of the Central Technical College has an

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illustration of the Manhattan Railway power station as its frontispiece, and Mr. W. A. Delmar contributes a description of the equipment. Prof. H. E. Armstrong continues his articles on "The Mechanism of Combustion," and other subjects dealt with are "The Vacuum Cleaner Machine," by H. C. Booth; "The Colonial Sugar-Refining Company of Australia," by Dr. G. Harker; "Transmission and Distribution of Power to the North-Eastern Railway" (illustrated), by B. Price; and "The Engineer in Egypt," by C. Collingwood.

"Lode" Factor.—There was a long discussion last week at a meeting of the Maidstone Town Council before an agreement was sanctioned with a consumer who will take a large day load from the Corporation mains for driving machinery. The agreement is for 21 years, the rate being 1d. per unit, with a provision that if the price of coal goes up the price for power shall be increased accordingly. The question, however, of this cost as compared with the average cost of production seriously harassed the minds of the Maidstone councillors. It is amusing to note that the local papers look upon the electric lighting undertaking as such a profitable one that they spell the "lode" on the same in the same way as if it was a vein of gold-bearing quartz. We are pleased to see that after the speech of the chairman of the Electricity Committee, the Council decided to sanction the agreement. They afterwards passed a resolution that Mr. Hoadley, the borough electrical engineer, should in future attend all the meetings of the Council in order to explain any technical points that may arise. This will, of course, involve considerable expenditure of time on Mr. Hoadley's part, but from the evidence before us it is clear that it will save a great deal of the councillors' time. Mr. Hoadley would have been able to dispose in a few words of the absurdity of supposing that when the number of units supplied for lighting is equal to the number supplied for power, the day "lode" is equal to the night "lode."

King William's Town.—The Borough Council have decided to municipalise the electric lighting undertaking, inaugurated by the King Electric Lighting Company in September of last year. The Council possessed power to compulsorily acquire the concern at any time up till 1907; after then they could only do so by negotiation, at any rate for a period of 25 years. At the end of 1903 the income was only £194 per month, but in August last it had risen to £453. Out of the latter sum the expenditure amounted to £333, leaving a profit of £120. The Council apparently have the right to acquire the concern at cost price, representing about £21,000. A local journal states that at the present time the business would show a profit of some £300 a month to the Council after allowing 5 per cent. for depreciation, so that there would be a considerable margin after providing for sinking fund and interest. South African finance makes rather different reading from the home level. Thus the Council estimate that they will be able to generate the quantity of electricity now consumed at 11d. per unit, though the further supply which they expect to be called upon to provide will probably cost less than half. This expansion of the business will, the Council anticipate, enable them to supply current at 1s. per unit in response to the representations for a reduced rate which are expected to follow municipalisation. We gather that the inhabitants favour municipalisation, and from the limited data before us the Council appear to have an excellent prospect of making the undertaking a substantial success.

Tramways and Light Railways Association.—A party of this association paid a visit on Friday last to the power stations of the Great Northern and City Railway and the City and South London Railway. An inspection was first made of the former, where the main engine plant consists of four Musgrave vertical cross-compound condensing engines of 1,250 i.h.p., each with standard B.T.H. type generators coupled to the engine shaft and placed between the high and low pressure cylinders. These generators are compound wound to give 575 volts at full load. Each engine is fitted with one Wheeler surface condenser to act in conjunction with same. Two auxiliary generators, driven by high-speed Davey-Paxman engines, supply power for lighting throughout the line. These generators are rated at 120 kw. each, and are compound wound to give the same voltage as the main generators, and the main switchboard is so arranged that the lighting can be run off the traction 'bus bars if necessary. The engineer and traffic manager, Mr. Brousson, accompanied the party, for whom he provided a reserved car on their journey between Moorgate-street and the power station. Subsequently the party were met at Moorgate-street by Mr. Jenkin, manager of the City and South London Railway Company, who conducted them to a special car, where Mr. McMahon, the chief engineer, with his assistants, explained everything. An observation car was provided at the end of the train, and the visitors went over the line, preparatory to inspecting the well-known generating station at Stockwell.

Chemical Action of the Cathode Rays.—Some notes on this subject appear in the *Physikalische Zeitschrift*, by Mr. Emil Bose, and an abstract of same is given in the *Journal* of the Chemical Society. The author remarks that when a very strong potassium hydroxide solution (surface = 200 square centimetres) is exposed in vacuum to the action of a cathode discharge, there are found subsequently in the gaseous phase both hydrogen and oxygen, the volume of the former being considerably more than twice that of the latter. This excess of hydrogen is 10 to 30 times as great as the amount simultaneously produced in a hydrogen voltameter under reduced pressure. The cathode rays, therefore, not only produce an electrochemical effect according to Faraday's laws, but give rise to chemical action in some other way. The most probable source of this is the kinetic energy of the cathode rays, and a computation shows that this is indeed sufficient to produce far greater chemical effects than the electricity carried with the rays, although, of course, a large proportion of the mechanical energy referred to is doubtless transformed into heat directly. That in the experiments described above such a large excess of hydrogen was obtained is due to the greater solubility of oxygen, and the electrolyte was shown in several cases to retain considerable quantities of that gas. Generally speaking, the purely chemical action of the cathode rays is electrochemical; those changes such as the coloration of alkali haloids, which have not been shown to be chemical in character or which can be reversed by the heating action of the rays, are probably dissociation effects due to the dynamic action of the rays. The dynamic action will be still greater than the chemical action in the case of the Becquerel rays.

Long-Distance Telegraphy.—A notable feat in long-distance telegraphy was consummated on Saturday by the establishment of direct automatic Wheatstone working between Liverpool and Teheran, by means of which telegrams for India and the Far East are transmitted 4,000 miles by a single operation, which constitutes by far the greatest extent of line in the world to be so worked. The Indo-European Telegraph Company constructed this route in 1869. In recent years automatic working by the Wheatstone instrument was introduced, the messages being retransmitted several times *en route*. About two years ago the

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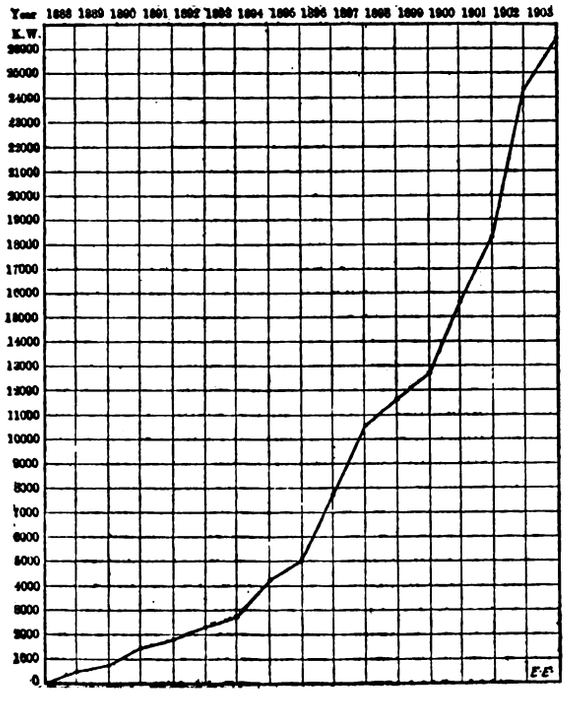
company's engineer succeeded, by perfecting delicate instruments, in communicating direct from London to Teheran and eliminating the intermediate stations. Liverpool and Manchester have now been joined up. The current required for working the whole line is of no higher strength than that usually employed, being reinforced by batteries at 12 stages. The large growth of the business of the system and the simplification of its working enabled a reduced tariff to be introduced a few months ago. Another item of news relates to "wireless," which has come to the assistance of the line between Penzance and the Scilly Isles, cable communication having been interrupted. It is stated that as the result of the adoption by the Admiralty of the latest type of Marconi apparatus for use in the Channel Fleet, the "Cæsar," flagship of Vice-Admiral Lord Charles Beresford, equipped with the Marconi system, succeeded in keeping in touch with the Marconi Company's system at Poldhu during practically the whole of the passage home this week from Gibraltar. By this means the Vice-Admiral commanding was able to transmit to the squadron news of the principal events of public interest from day to day. It is expected that the "Victorious," flagship of the second in command of the Channel Fleet, will be fitted with similar improvements to those made in the "Cæsar" wireless installation.

Crystal Palace School of Practical Engineering.—The certificates gained by the students at the Crystal Palace Company's School of Practical Engineering were distributed last Friday at a large meeting, Mr. Charles Hawksley, past-president of the Institution of Civil Engineers, in the chair. The vice-principal, Mr. Maurice Wilson, read the reports of the examiners, which were of a satisfactory character, and the list of awards in the mechanical, civil, and electrical sections of the school. The certification of honour for six certificates obtained in the school course, none lower than third in order of merit, was gained by Mr. J. M. S. Culbertson, and the Wilson premium by Mr. L. H. C. Palmer for a paper on "Railway Practice and Construction in India." The chairman, in the course of his address to the students, said too little credit was given nowadays to the work of the early engineers. They combined with engineering a taste for and a study of architecture. The practice was now very much neglected, and, as a consequence, the structures erected by engineers were too frequently needlessly ugly. The engineers were either wanting in taste themselves or they sacrificed everything to mere utility, and the result was that they disfigured the country in a way that they had no right to disfigure it. A design could be good from the point of view of utility, but it should also result in a structure which, if not handsome, was at least not offensively ugly. He had been much struck with this want of beauty in design, and he proposed, if possible, to establish a premium, in connection with the Institution of Civil Engineers, for designs which combined good taste with utility and strength. Mr. Hawksley then distributed the certificates. A vote of thanks was passed to the examiners: Mr. J. F. J. Reynolds, Mr. C. M. Barnett, and Mr. J. G. W. Aldridge, all old students of the school. The principal, Mr. J. W. Wilson, in the course of a short address, mentioned that when the Japanese Embassy visited this country in 1872 representives were sent to the Crystal Palace School for the purpose of studying their methods of work. They took voluminous notes, and it was very complimentary to know that, when the engineering college was established at Tokio, the Japanese were guided a great deal by what they had seen at the Crystal Palace School.

Telegraph Wires as Returns for Signal Circuits. In a contribution to the *Elektrotechnische Zeitschrift*, A. Prasch describes how he remedied the unsatisfactory working of the station signals on a railway line some 100m. long by making telegraph wires do duty as returns. The original trouble was not due to any inherent defects in the apparatus installed, but entirely to the varying resistance of the earth connections formerly relied upon. This variation was especially noticeable during bright frosty weather. Circumstances prevented immediate recourse being had to the induction system of working, so experiments were made, at first very cautiously, to determine the practicability of using the railway telegraph wires as returns for the station signal circuits. Contrary to expectations, no consequent disturbance could at any time be traced at the Morse telegraph instruments, although elaborate means were taken to detect same, and the two services worked admirably with the telegraph wires doing double duty. However, the practice was not persisted in after the means were forthcoming to adopt another system. Nor does the author suggest the desirability of adopting the principle in general practice. On the contrary, he points out that independent returns are always to be preferred. At the same time, there are occasions when the arrangement in question may be found useful as a temporary expedient, as, for instance, when the existing telegraph poles are already overburdened, or for economical reasons. He goes on to describe, with the aid of diagrams, the way in which the work was carried out in the particular case referred to, and gives the conditions which govern the success of any such arrangement. His conclusions are that if the estimated variation of potential in the telegraph wires, due to the connection of signal wires, is not too great, such connections may be made with impunity, especially as the influence of the telegraph wires on the signal circuits is generally a negligible quantity.

Electricity in Japan.—The accompanying diagram illustrates the growth of central-station electric lighting in



Japan, and has been compiled by the Nippon Denk Kiokwai, the Japanese national electric light association The association was founded in 1892 for the purpose of investigating and reporting on matters of importance to the electric light industry, to represent the industry before the Government, and to popularise electricity and maintain in Tokio a permanent electrical exposition. Only members of the association are allowed to exhibit their goods at the exhibition. All expense connected with the arrangement of

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exhibits for special electric lighting or for operating machinery is borne by exhibitors. A library is also maintained in the building for the benefit of members of the association. In case of applications for purchase, the authorities in charge of the building offer every facility toward bringing the purchaser in communication with the seller. The total area occupied by one exhibit is not allowed to exceed three cubic feet, and the total weight cannot be over one ton.

Direct-Driven Spinning Frames.—The electrification of cotton-spinning mills is one of the most difficult works that electrical engineers have to undertake, owing to the fact that power has to be distributed over a compact factory, and not over a considerable area. In spite of this, with carefully-designed apparatus, large savings in the coal bill can often be realised. We have recently had brought to our notice by the Alliance Electrical Company some interesting figures obtained from the operation of the mills of the Paley Brake Company, which the Alliance Company have equipped with motors for directly driving the spinning frames. The publication gives an extract of a report on this work by Mr. W. H. Cook, who, we understand, is connected with the spinning company. One difficulty of the conversion was that the speed of the spindles had to be altered at times from 6,000 revolutions to 9,000 revolutions per minute, depending on the different counts being spun. To do this work the Alliance Company designed a motor, which was direct coupled on to the spinning frame by gearing. In other cases the motor was connected to its work by means of belt gear and a countershaft. The purpose of Mr. Cook's test was to see the relative advantages of these two methods of driving. Experimenting first with the direct-coupled motor, he found that when the spindles were run at 6,200 revolutions the motor took 3·2 amperes at 200 volts, corresponding to 0·7 of a brake horse-power. The speed was then increased by stages up to 9,200 revolutions, when the motor took 4·7 amperes at the same voltage, which is equivalent to 1·1 b.h.p. From the plotted observations it was found that the power required to drive the frame increased practically directly as the speed, and not, as has been generally accepted, as the square of the speed. Tests were then made on a frame driven by belting. It was found that to run the countershaft alone ·48 e.h.p. was needed. With straps on the loose pulleys of the frame the power increased to 2·13 e.h.p., which is considerably more than was required to drive two complete frames by the direct-connected method. Mr. Cook concludes from the experiments that at least 50 per cent. of the total power in the mills in question is being wasted through belt-driving. He also speaks highly in favour of the constancy of speed obtained electrically. Figures are given in the report to show the great influence which a loose belt has on the actual spindle speed in a spinning machine. Twelve different frames, which, if the belts were in order, should run at 8,300 revolutions, were tested, and only four out of the 12 had actually got the required speed. Owing to belt slip, there were two machines with spindles running at 7,400 revolutions. With the direct-coupled motor this variation in speed, which means considerable reduction in output, can be uniformly avoided, and there are other advantages which are even more material. We trust that the information in the report will do much to convince other mill engineers of the gain from electrical driving.

The Patent Laws.—At a meeting of the Society of Arts last week, Mr. Alexander Siemens presiding, a paper by Mr. C. D. Abel on "The Patent Laws" was read. The author argued that the system of examination, with power given to the examiners to refuse the grant of a patent on the ground of alleged want of novelty, as carried out by the German and United States Patent Offices and those of many other countries, was detrimental alike to the interests of the inventor and to those of the State. It was an injustice to the inventor to oblige him to go to the expense of an appeal from the decision of a primary examiner. When the views of the examiner differed from those of the inventor, it should be the duty of the former to lay the matter before the higher authorities, and only if these authorities confirmed his decision should the inventor be called upon to argue the case further. This is provided for by the new rules of our Patent Office which come into force with the New Year. The author approved this system, assuming that an adequate examining staff is appointed, and that the most perfect system of classification of the inventions is established for enabling the work of searching to be carried out in a perfectly efficient manner, so that the inventor should not be put to unnecessary trouble in having to prove the novelty of his invention. The carrying out of such an elaborate analysis of all patents, he suggested, would entail a great increase in the examining staff, and, consequently, a very considerable increased expenditure in the Patent Office. The Government would, no doubt, object to this, but he maintained, in view of the great advantages that would be derived therefrom both by inventors and the public generally, that this necessary increased expenditure ought to be insisted upon. There had been a great deal too much false economy practised heretofore by the Government in respect of the Patent Office, for the simple reason that neither the Government nor the public had ever estimated at its true value the great debt this country owed to inventors and their inventions. He suggested that the Patent Office, instead of being, as it now was, a mere branch of a second-rate Government department, should be elevated to the position of an independent Government department directly responsible to the Cabinet and Parliament as constituting the worthy representative of one of the main sources of England's greatness and prosperity. Mr. Siemens criticised our new system on the lines indicated in his recent presidential address before the Institution of Electrical Engineers, holding that the examination ought to be made by the inventor himself, the Patent Office supplying all possible facilities. This, he implied, would obviate a false sense of security. In lighter vein, he remarked that it was easy enough to invent; the people who ought to be rewarded were those who introduced the article commercially. Our impression is that a special staff of examiners is being prepared in view of the new regulations; in fact, this was one of the reasons why the Act of 1902 was made prospective, and we trust that this new staff will attain substantially to the standard of efficiency outlined by Mr. Abel.

Electrical Practice in America.—The Sheffield Corporation authorised the general manager of their electricity supply department, Mr. S. E. Fedden, to visit the St. Louis Exhibition and certain other towns in the United States with a view to ascertaining the most up-to-date electrical appliances. He accordingly participated in the recent Transatlantic tour of the Institution of Civil Engineers, and the impressions he gained are the subject of an admirably prepared and well-illustrated report. Mr. Fedden's comparison of London and New York is interesting. New York's population is 3½ millions; London's is five millions. London's electricity is supplied by 30 authorities; New York's solely by the Edison Company, with the largest generating station in the world. More than 30,000 customers are on the books of the New York company, and the lamps, heaters, motors, etc., connected to the mains are

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equivalent to 3,068,041 16-c.p. lamps, of which there are over 1½ million incandescent lamps and nearly 21,000 arcs, the annual output according to latest returns being about 130 million units per annum. The whole system is designed on the same general principles as were adopted for the arrangement of the Neepsend works. The underlying idea may be described as one of cellular construction and strict sectionising of the plant, so that starting out with any given generating unit, it and its auxiliary apparatus portion of main cables, etc., might be isolated if desired from the general system and act as a separate and complete station. Mr. Fedden found a great deal to admire in the substantial way in which the electrical distribution of the city of New York has been laid out, no expense being spared in making it as near as possible perfect against breakdown or discontinuity of supply for any lengthened period. The system in Sheffield is laid out on very similar lines, except that as yet Sheffield has not been able to spend nearly so much money in duplicating all the mains to the different sub-stations. Mr. Fedden deals with Niagara, the electrical equipment of canals, and a number of other matters, which we may refer to in future issues, and then gives some general impressions, gained largely from the St. Louis Exhibition After alluding to the great increase in the size of generators and engines, as well as the extended employment of electric motors for the driving of all kinds of machinery, and the very large number of engineers engaged in experimenting with new forms of lamps for use on electricity circuits, all tending to decrease the cost of consumption, Mr. Fedden remarks: "Our own work has made such strides in the last few years that to-day we need fear no comparison with American methods in point of scientific development, and although in the nature of things most of our undertakings are on a smaller scale, there is undoubtedly a high average of excellence to be found in English practice, and greater consideration for the comfort and safety of the general public. Much of the work to be seen in the States is obviously designed to meet as cheaply as possible the demands of the moment." "The general tendency," proceeds Mr. Fedden, "of modern American practice in power generation and distribution is to concentrate the plant at one or two centres, and reap to the full the advantages of large units, and the highest practical limits of steam pressure, voltage, etc." Referring to the experiments carried out by the General Electric Company, Mr. Fedden says it seems most probable that a commercially successful single-phase alternating-current motor for tram and railway work will be on the general market very shortly. If this motor is successful, Mr. Fedden considers that it will pave the way to the gradual change-over of the main-line traffic to electric driving as the present steam locomotives become old and obsolete. Mr. Fedden is evidently a believer in turbines, and thinks there is plenty of room for both the Parsons and the Curtis types. The report shows throughout that Mr. Fedden made good use of his opportunities for observation.

A Three-Wire Railway in Bohemia.—At the recent Vienna convention of the International Street Railway Association Mr. Krizik, of Prague, referred to a 1,400-volt direct-current three-wire railway between Bechyne and Tabor, Bohemia, designed by him recently, of which an account appears in the *Street Railway Journal* The system is 16 miles in length, and the steepest grade is 3 5 per cent. The generating station was located near the terminus at Tabor, so as to supply light to that city and to be in proximity to a good supply of condensing water. Direct-current distribution at 750 volts was considered inadvisable owing to the heavy drop in voltage, and alternating current was rejected on account of higher first cost, lower efficiency on part loads, and lesser utility for the purposes of a combined railway and lighting plant. Owing to the small rail section used and the length of the line it was decided to instal a three-wire 1,400-volt direct-current system, with 700 volts on each side and the rails as a neutral. The power station contains three 120-h.p. compound-condensing engines, using superheated steam at 300deg. C. The engines are belted to direct-current generators, one of which supplies current for the railway only, and the others for both railway and lighting. One of these belted sets, running at 220 revolutions per minute, when

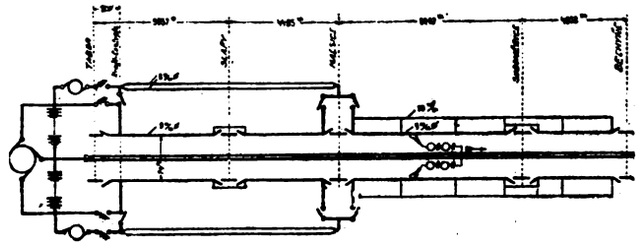
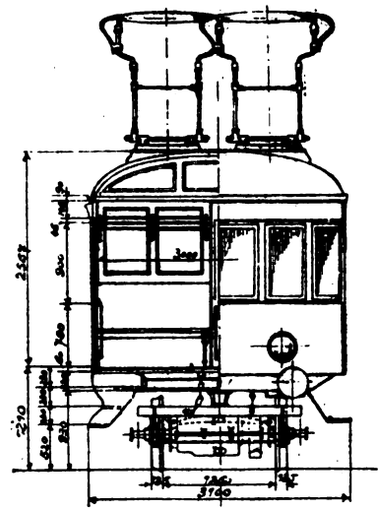


Diagram of Distribution System.

operating with the storage battery is capable of furnishing enough current to operate two 56-ton trains; at other times it is used for lighting purposes. Other sets are installed for emergencies, and two belt-driven boosters are available. The storage battery has a capacity of 123 to 171 ampere-hours for three hours loading or unloading. As half of the motor equipment operates on one side of the circuit and half on the other, the railway system is well balanced, and very little current flows through the neutral. The obvious advantage of the system over a straight line is that under no circumstances can a motor be exposed to more than 700 volts, and no difficulty has been experienced in commutator or motor installation with this pressure. Current



Cross-Section of Car Dimensions in mm.

is taken through two bow collectors. Each double-truck motorcar is furnished with four 30-h.p. 650-700-volt motors, running at 550 revolutions per minute. The commutator has 151 bars. The gear ratio is 15 : 75, and the speed attained on the level is 18 miles an hour. At starting, all motors are connected in series, and then two in parallel, but always with an earth connection between the pairs of motors. The resistance has three steps and two running points, with the motors in series and in parallel. There are also two steps for higher speeds obtained by weakening the motor fields by shunt resistances. So satisfactory are the results that a line operating at 3,000 volts and using 800-h.p. locomotives is stated to be in contemplation.

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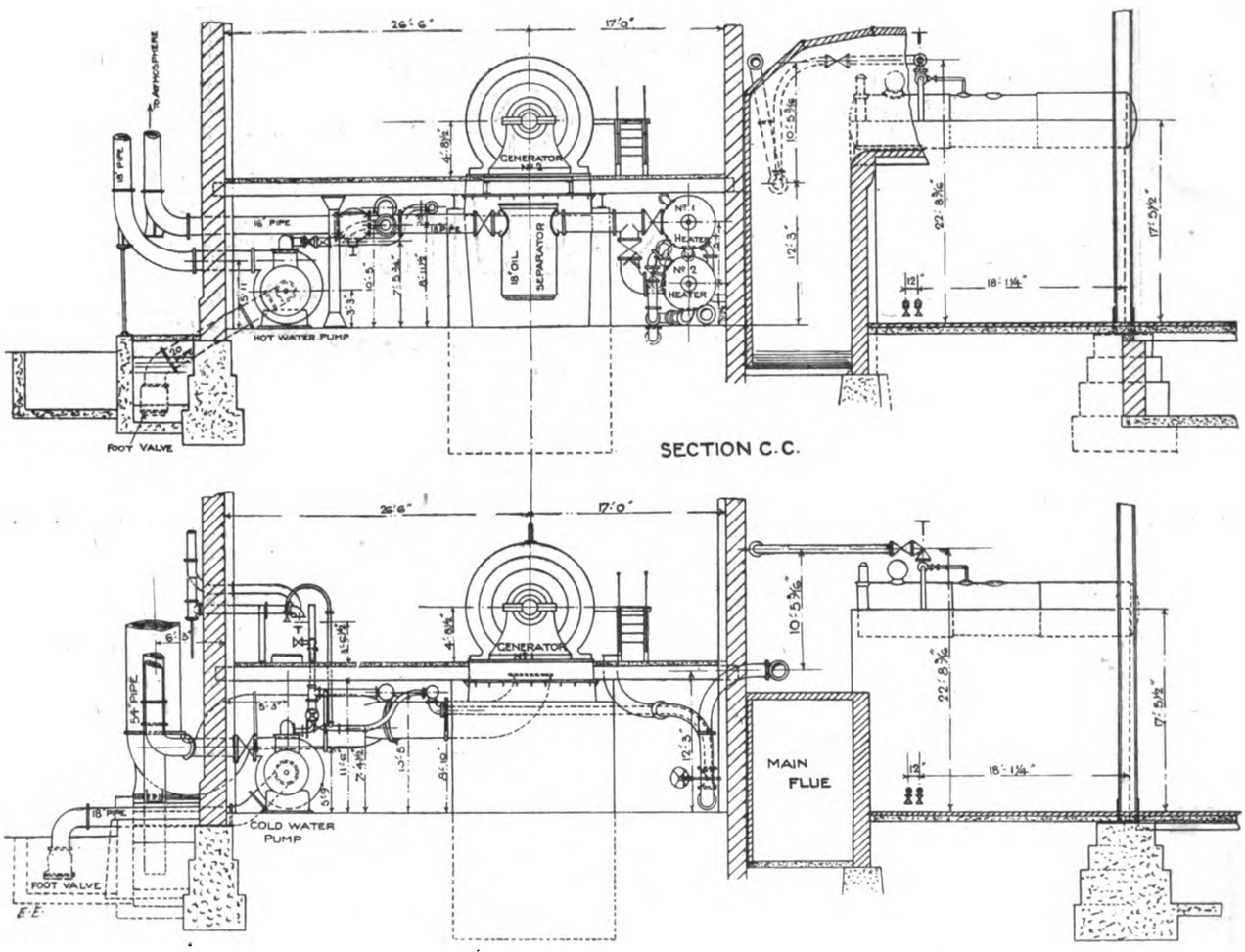
load of 184 amperes at 11,000 volts, and the guaranteed efficiency is 96 5 per cent. at full load, 95 5 per cent. at three-quarters, and 93 75 per cent. at half load. The exciting current is, as usual, led to the field coils by the aid of slip-rings. It is derived from the two exciter units, each of which consists of a Westinghouse single-acting compound engine, running at a speed of 275 revolutions per minute, direct coupled to a 100-kw., 125-volt, direct-current compound-wound generator. One such unit is sufficient to supply all the generators when fully loaded with exciting current.

Each turbine has a complete set of auxiliary plant, including an air-pump, a hot and a cold water circulating pump, a barometric condenser, and two cooling towers. The arrangement of these can be seen from the illustrations herewith. Thus, in Fig 3, which goes across two pages of our journal, we show an elevation of the station as it will be when the third set is fixed. The cross-sections of the station (Figs. 4 and 5) help to illustrate the positions of these auxiliaries, and they should be consulted with due reference to Fig. 6, which gives the general plan of the pipework for one set. Fig. 7 is an elevation of the outside wall of the engine-room, showing the barometric condensers, while Fig. 8 gives the details of the cooling towers.

Commencing our description at the point at which the steam leaves the turbines, there are two exhaust openings, owing to the fact that the turbine is of the double-flow type. The steam enters the turbine at the centre, and passes half to the right and half to the left as described above. It is then discharged downwards into two 36in. diameter pipes in the basement. These, as can be seen in Fig. 6, discharge through a breeches piece into the 54in. diameter main, which forms the uptake pipe of the condenser. The condensing plant was also made by the British Westinghouse Company at their Trafford Park works to the designs of the Alberger Condenser Company. This is a form of condenser that until recently was little known in England, but it was chosen because it is particularly adapted to maintaining the high vacuum at all loads that is such an important feature in the economical working of the steam-turbine. The condenser installed for each main generating unit is capable of dealing with 66,500lb. of steam per hour at normal full load and 110,000lb. per hour at maximum overload for a period of one hour. At normal load a vacuum of 27in. is attained, and the above overload reduces this only by 1in. Under the former condition the velocity of the steam at no point exceeds 270ft. per second, or the maximum temperature of the circulating water 85deg. F. The action of the condenser is simple. The steam rises up the vertical 54in. pipe seen in Fig. 7, and at the top passes over into the chamber to the right, where it mixes with the cold injection water. The height of the pipe which then discharges the mixture is such that a barometric vacuum is obtained. The other apparatus required for each unit are thus a cold-water circulating pump, which is



FIGS. 4 AND 5.—Cross-Sections of the Power House, showing Details of Auxiliary Plant.

of the 18in. centrifugal Gwynne type, and a 16in. centrifugal hot-water circulating pump for lifting the hot water from the hot-well and discharging it up to the cooling towers. It will be seen that by making the cold-water pump 2in larger in diameter than the hot-water, and also by making the pipe for discharging the cold water into the condenser 2in. larger than the barometric leg of the same, a seal is always secured. The steam upcast pipe is, however, arranged with an atmospheric relief valve at the top, so that in the event of any trouble with the condenser, relief to atmosphere for the condensed steam is immediately secured. There is also connected to the top of each condenser a steam-driven dry vacuum pump, which can be seen on the floor level in the illustration (Fig. 3). The engine driving this pump when working at full load develops 55 h.p. with a steam consumption of 1,375lb. per hour. By what is termed the two-stage arrangement of this pump it is enabled to effect a vacuum of 29in. in the condenser when this is shut off from the engine. The chief feature of this two-stage method, which has frequently been fully

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described in the technical Press, is that it makes it possible for the condensing plant to maintain a very high vacuum at all loads, even with a temperature of the circulating water considerably exceeding the normal.

The centrifugal circulating pumps are driven by Westinghouse high-speed compound engines, owing presumably to some variation of speed being required with variations of load, which cannot be so easily obtained with three-phase induction motors. The cooling towers in which the circulating water has its temperature reduced to about 80deg. F. were erected by Messrs. Donat and Co., and are of the Zschocke type. Our illustration (Fig. 8) shows the details of these towers, which are constructed of impregnated wood. There are two towers for each condenser, and each tower is capable of dealing with 400,000 gallons of water per hour. What is termed by the contractor one tower really consists of two independent towers as far as cooling is concerned, because they can be worked in two half sections. Water is delivered at a height 25ft. above the foundations, and the top of the tower is 75ft. The cooling is secured entirely by chimney action, there being no fans for increasing the draught. The water from these cooling towers passes out into the large reservoir lake referred to in our last issue.

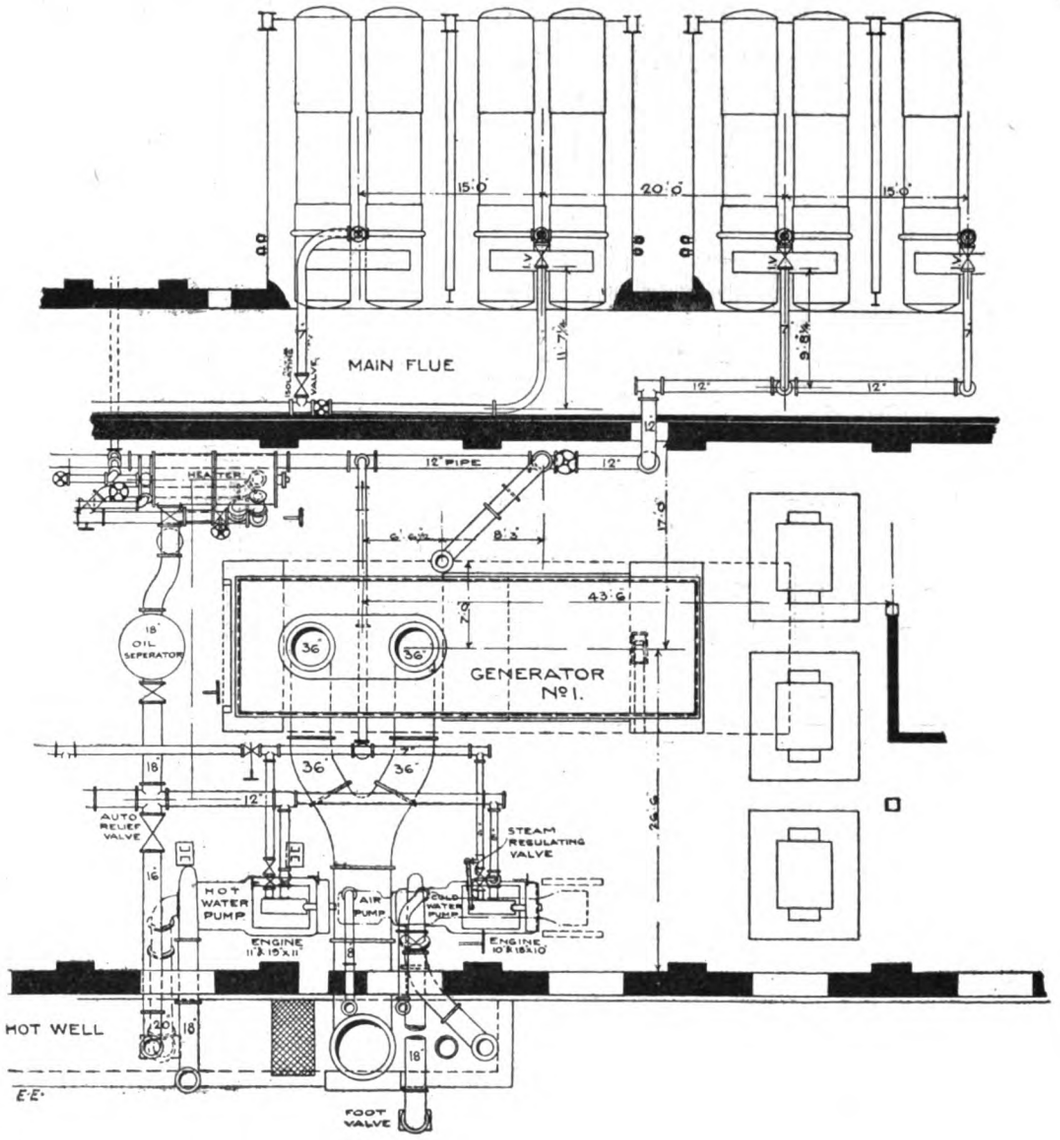

FIG. 6.—Plan of one Turbine, showing Pipe Connections.

The other auxiliary plant employed in the station consists of two surface heaters, each containing 1,000 square feet of heating surface; one Alberger surface condenser of 700 square feet cooling area for condensing the exhaust steam from the exciter engines and the 100-kw. auxiliary generating set; two Cole, Marchent, and Morley grease extractors; two tandem compound Weir steam feed pumps.

We now come to the boiler-room, which also contains many distinctive features. We only show in our fragmentary plan one small portion of the boiler-room, but the details of the boiler can be seen from the section

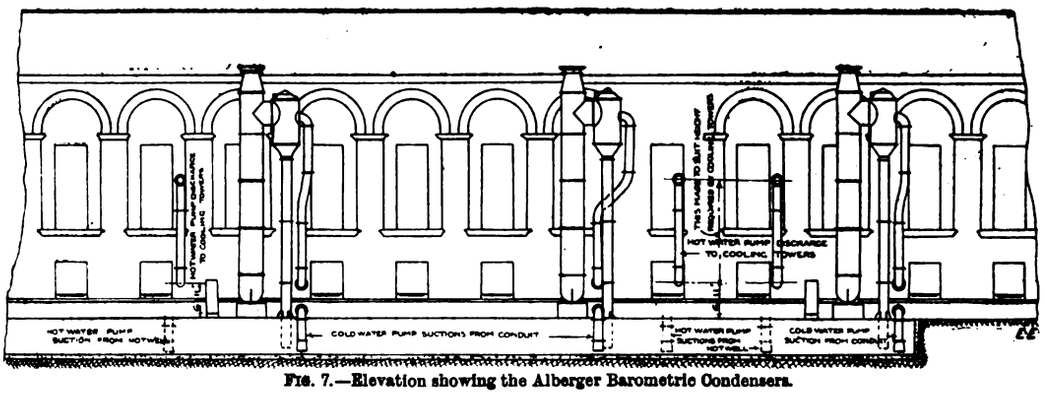

FIG. 7.—Elevation showing the Alberger Barometric Condensers.

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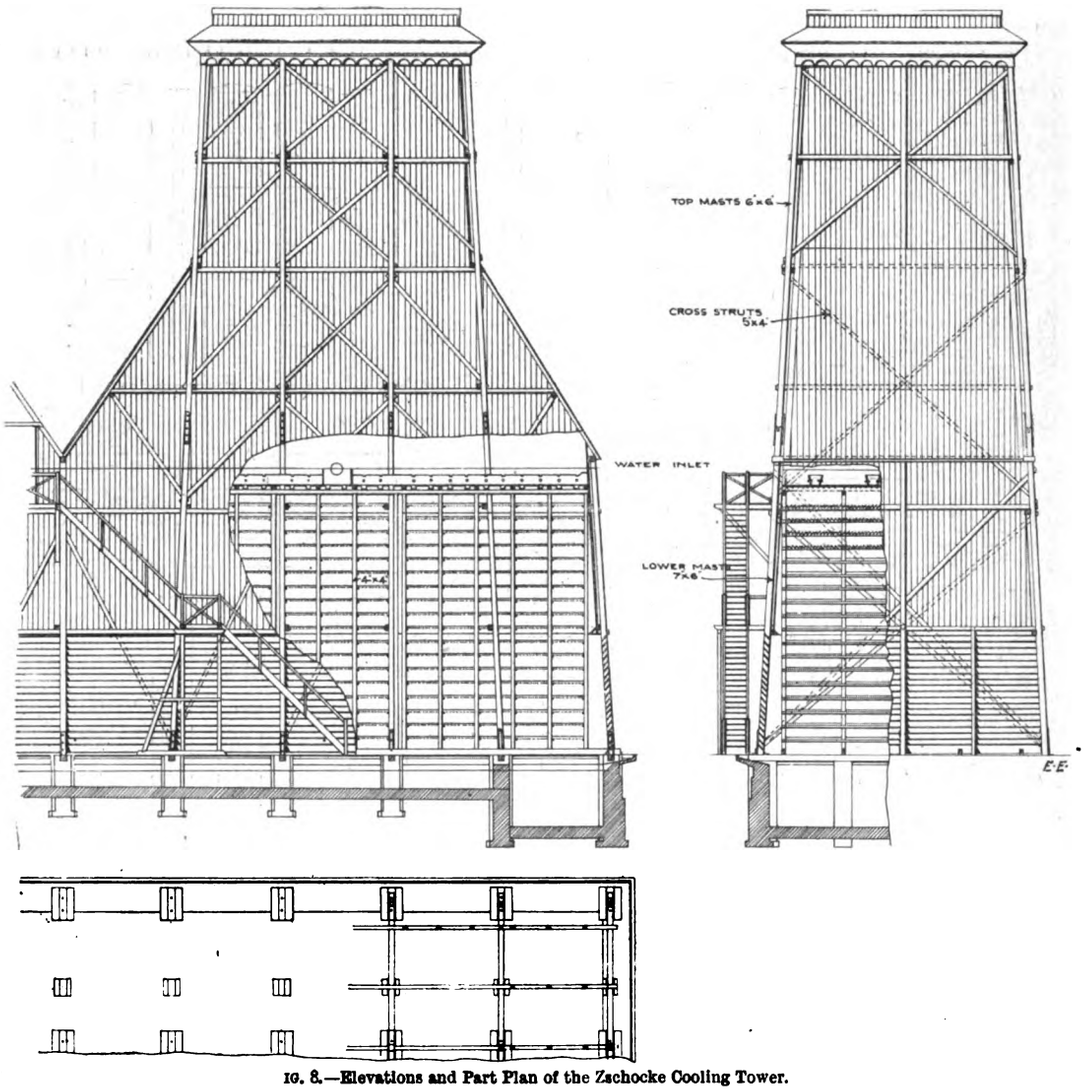
(Fig. 9) and from the photograph (Fig. 10), which shows a boiler partially set. Ten Babcock and Wilcox water-tube boilers are already installed at the above station, each of



IG. 8.—Elevations and Part Plan of the Zschocke Cooling Tower.

5,730 square feet heating surface, constructed for working at 160lb. pressure, and each evaporating 20,000lb. of water per hour. These boilers are fitted with Babcock and Wilcox

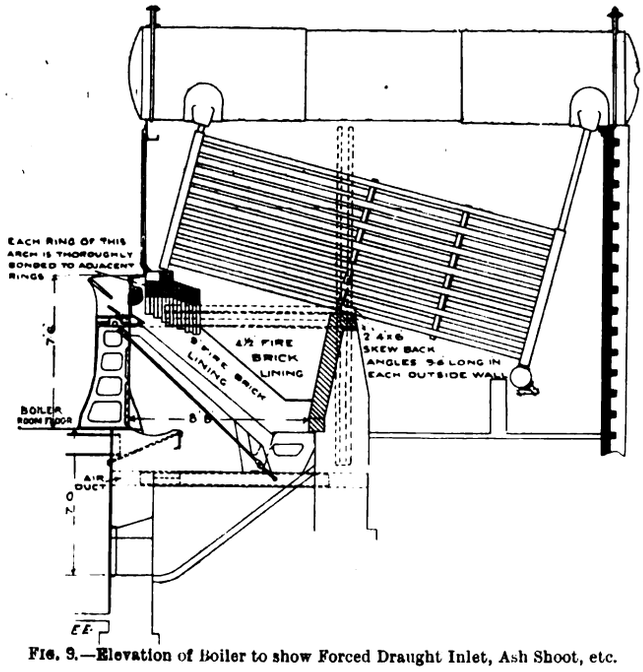


FIG. 9.—Elevation of Boiler to show Forced Draught Inlet, Ash Shoot, etc.

integral superheaters, each of 894 square feet heating surface, which impart 100deg. F. superheat to the steam. There are also on order four additional Babcock and Wilcox boilers of the same heating surface, but constructed for working at 180lb. pressure, and fitted with superheaters imparting 180deg. F. of superheat to the steam. A further description of these boilers is hardly necessary owing to the fact that they find a place in nearly all the largest electric generating stations, and are hence well known to all. It will be noted that only a moderate superheat is asked

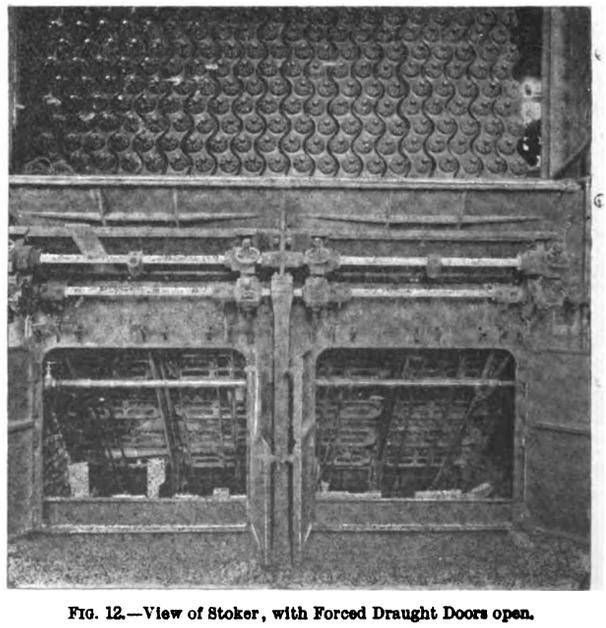


FIG. 12.—View of Stoker, with Forced Draught Doors open.

for, and that in this instance the abnormally high superheat which has given trouble in certain cases is not to be used.

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The stokers with which these boilers are equipped are of a novel type as far as this country is concerned. They are the invention of an American engineer, Mr. W. R. Roney, but they have been developed by the Westinghouse Company,

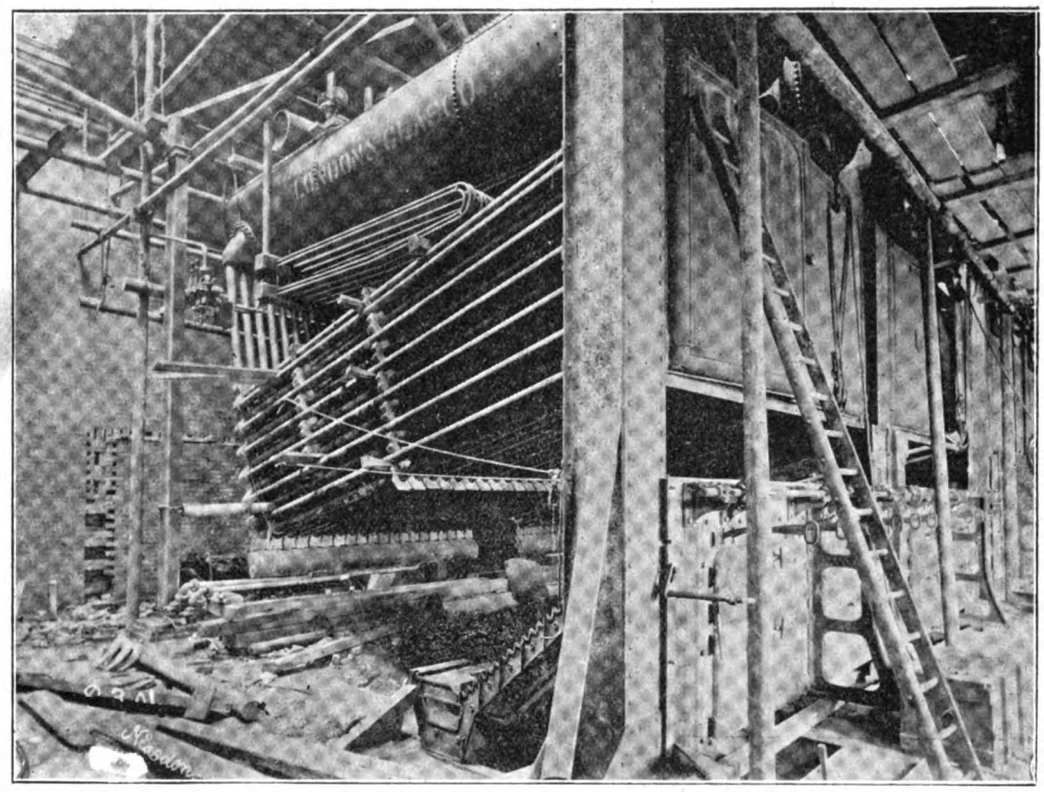

FIG. 10.—View of the Babcock-Willcox Boilers and Superheaters in course of erection.

and used with success in the States for some 10 years. To make the details clear to our readers, we reproduce in Fig. 11 a section of this stoker, while Fig. 12 is a view of the front of a boiler at Neasden. It will be seen from the illustration that the coal passes from the hopper on to a dead plate at the top of the inclined stoker. From there it is fed on to the inclined grates by the reciprocating pusher. The grate bars rock through an arc of 30deg., assuming alternately the stepped and the inclined position. The grate bars receive their motion from rocker bar and connecting rod, and these, with the pusher, are actuated by the agitator, which receives its motion through the eccentric from a shaft attached to the stoker front, under the hopper. The range of motion of the pusher is regulated by the feed wheel from no stroke to full stroke, and the amount of coal pushed into the furnace adjusted according to the demand for steam. The motion of the grate bars is similarly regulated and controlled by the position of the sheath nut and lock nuts on the connecting rod. Each grate bar is composed of two parts—a vertical

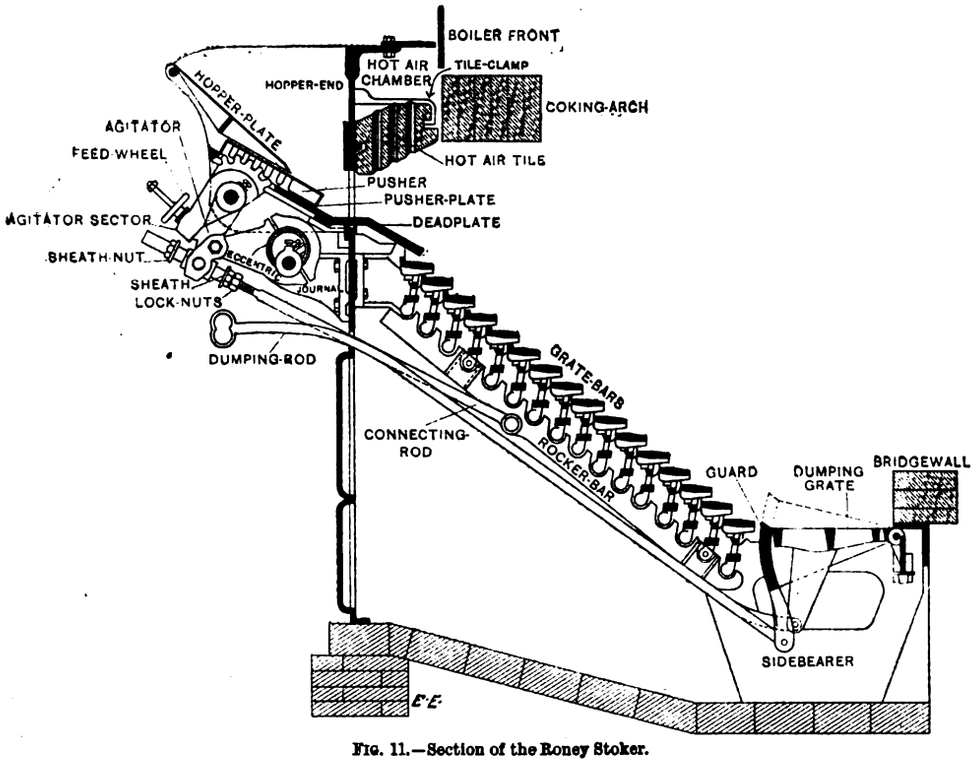

FIG. 11.—Section of the Roney Stoker.

web provided with trunnions at each end, which rest in seats in the side bearers, and a fuel plate, ribbed on its under side, which bolts to the web. These fuel plates carry the bed of burning coal, and being wearing parts, are made detachable, thus reducing cost of repairs to a minimum. The webs are perforated with longitudinal slots so placed

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that the condition of the fire can be seen at all times without opening the doors, and free access had to all parts of the grate to assist, when necessary, the removal of clinker. These slots also serve an important purpose in furnishing an abundant supply of air for combustion. The arch over the bed-plate under which the green coal is discharged is kept at a very high temperature, and aids in the combustion of any smoke formed at the point where the fuel enters the furnace, and secures the coking of the coal. It will be seen from the illustrations that these stokers as arranged at Neasden can be used with forced draught, and, if need be, induced draught can also be made use of.

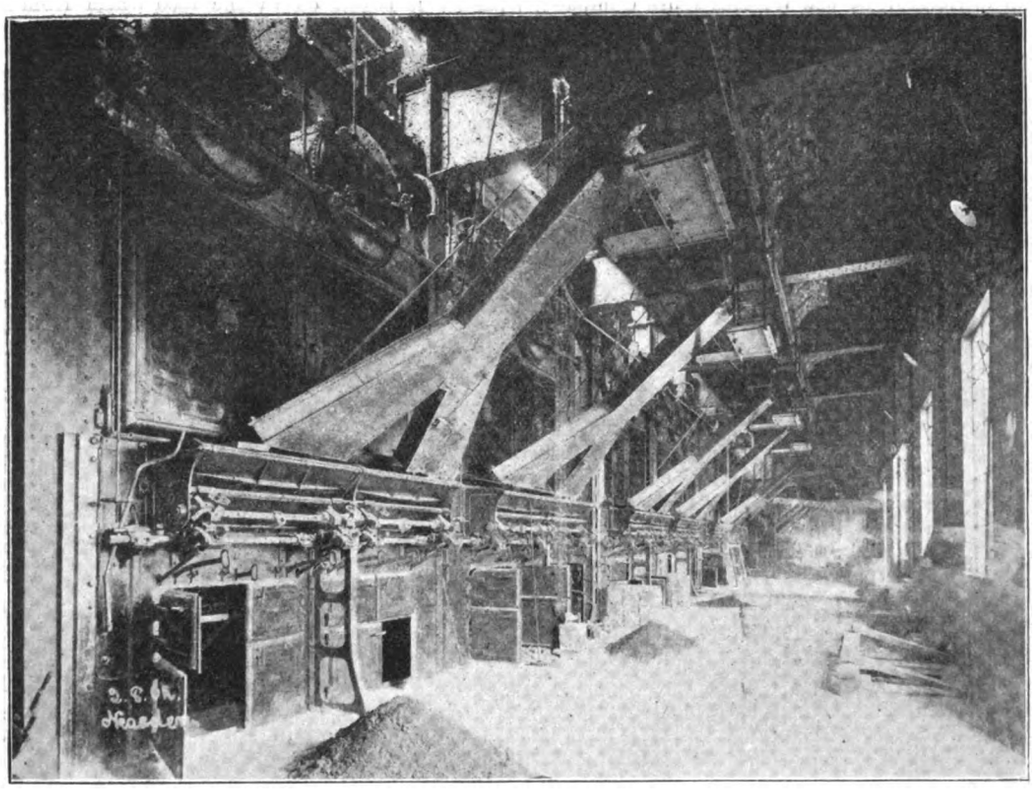
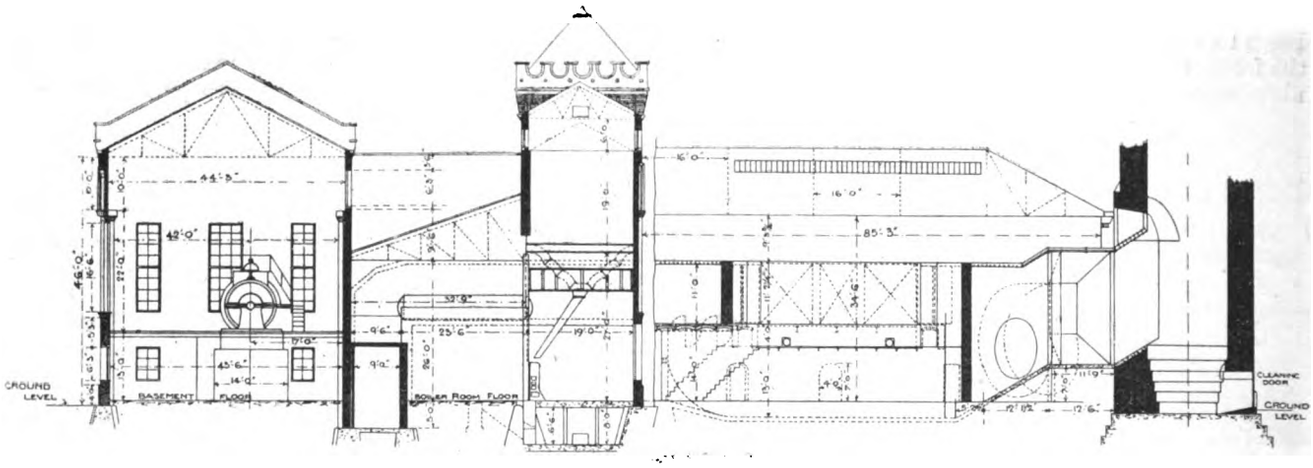


FIG. 13.—The Stoking Floor at Neasden.



CROSS SECTION

FIG, 14.—Cross-Section of the Neasden Power House.

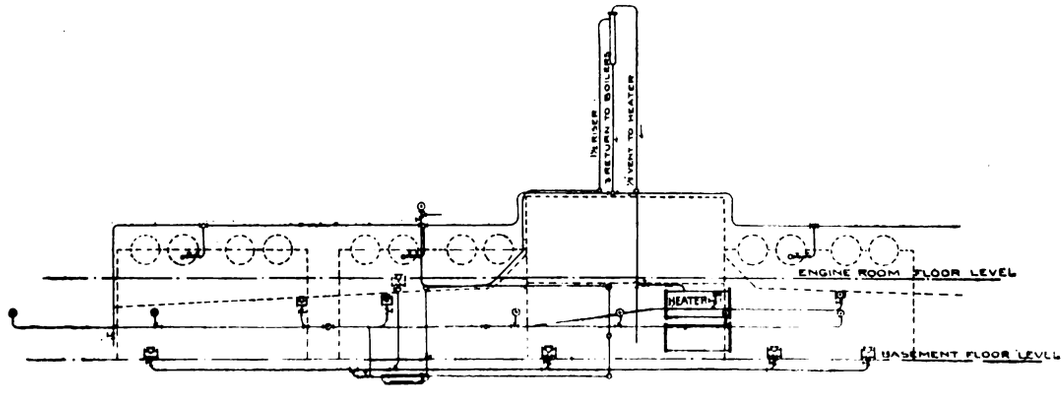


FIG. 17.—Diagram of the Pipe Connections of the Holly System.

The arrangement for discharging clinker can be readily

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seen from the illustration. It is claimed by the makers of these stokers that the form of inclined grate gives the fireman more control over his fire, as he can readily see if clinker is forming. It is also stated that with these stokers, with their liberal grate areas, boilers can be forced more readily than is the case with some other types of mechanical stokers. This feature is one which is of the utmost importance in any power-house supplying railways with suburban traffic, where a heavy rush of traffic morning and evening has to be met. The flues from these boilers pass along the side of the boiler-house wall, as seen in Fig. 4, until they are opposite the chimney shaft. The two main flues, one from each direction, then rise, as shown in Figs. 5 and 14, and pass overhead to the economisers. There are two batteries of Green's economisers now fixed, but the plans provide for four batteries being used in the future. Each battery has 1,760 tubes 10ft. long and 4in. in diameter. The by-pass flues, for use when the economisers are being repaired, pass underneath the same, as can be seen in Fig. 14. In Fig. 15 we show the neat arrangement of dampers, by means of which the change from natural to induced draught is made. This plans shows the exits from the four economiser chambers, which discharge into a triangular space in which there are inlets to two fans. The dampers, A and B, when in the position shown in the illustration, close the direct passage for the gases to the chimney, but open the path from the discharge from the fans. By this means, the change from natural to induced draught can be quickly effected after the induced-draught fans have been started up. The elevation (Fig. 16) shows in more detail one of these fans, which are driven by separate steam-engines. The chimney, which is designed to provide for the first portion of the plant now ordered, is 15ft. in diameter and 200ft. high.

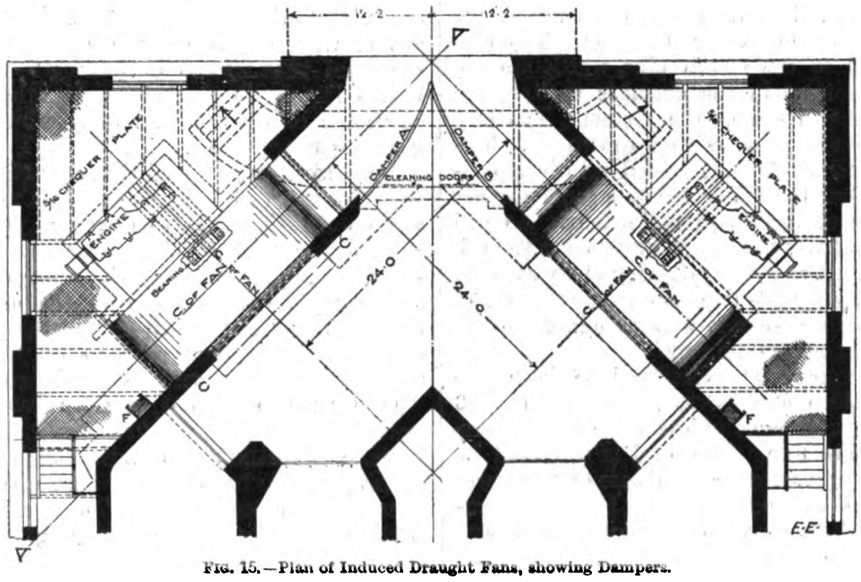

FIG. 15.—Plan of Induced Draught Fans, showing Dampers.

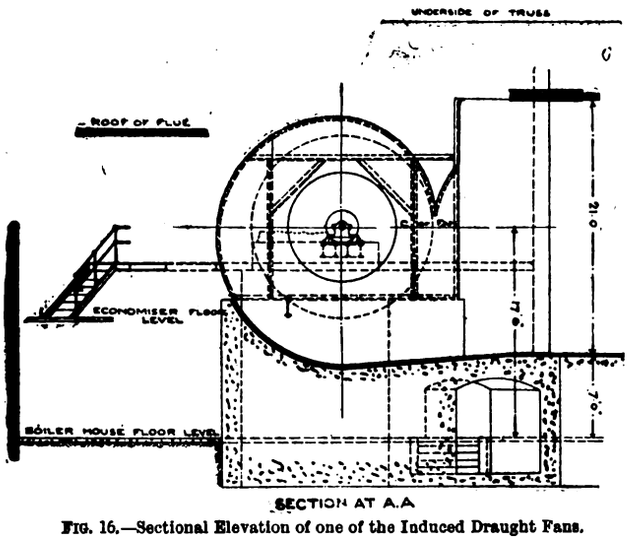

FIG. 16.—Sectional Elevation of one of the Induced Draught Fans.

Another interesting feature at Neasden is the drainage of the steam-pipes, which is effected without any steam-traps or openings to atmosphere. We show in Fig. 17 a diagrammatic elevation of the drain pipes, which are arranged on the Holly system. The usual connections for drainage are made to various points on the steam-pipes

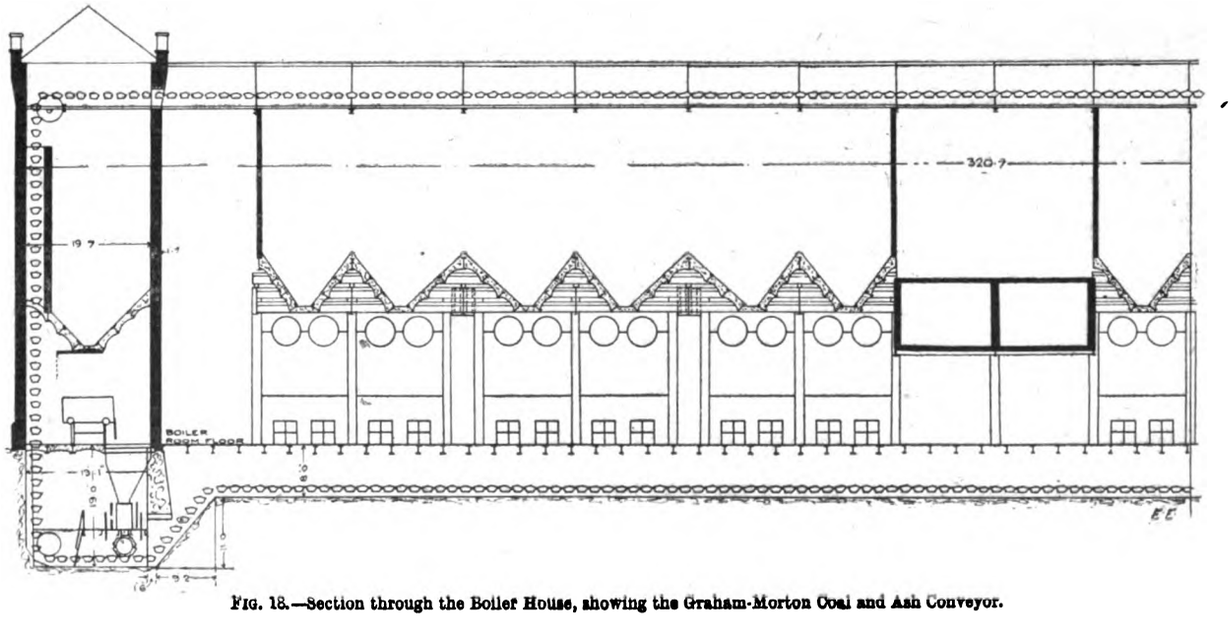

FIG. 18.—Section through the Boiler House, showing the Graham-Morton Coal and Ash Conveyor.

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in the boiler-room and engine-room. These drain pipes are all carefully lagged, and connected to a receiver at the lowest point of the system. From there an 1½in. diameter rising pipe, also carefully lagged, is led to the top of the building, where a discharge chamber is erected. The condensation in this and in the return pipe, which are not covered, causes the pressure in the chamber to be lower than that at any other point in the system. The condensed water in the drain pipes is thus drawn up. The head of condenser water in the long cooled return pipe is then enough to overcome the difference in steam pressure between the discharge chamber and the boilers. As will be gathered from the above, the whole system has the full boiler pressure on it. The device is giving every satisfaction, and it avoids any trouble due to uncertain action of steam-traps. This Holly system is also introduced to this country by the Westinghouse Company.

The coaling arrangements at Neasden have been provided by Messrs. Graham and Morton, Limited. Fig. 18 shows the general arrangement of the large bucket conveyor provided by this firm. The coal is delivered by railway trucks into a large copper at the base of the tower at the eastern end of the boiler-house. It then passes through crushers which break it to the required size and load the broken coal into the bucket conveyor, shown in the illustration. It is elevated to the top of the building and discharged into the self-trimming bunkers over the boiler-room. The coal is weighed on its way to these bunkers, and there is also a weighing machine in each shute from the bunkers to the hoppers of the mechanical stokers. When ashes have to be removed, they are dropped into the bucket conveyor as it passes to the basement and then elevated and discharged into the large bin, which is shown in the tower in Fig. 18. In this way a coal-truck, after having discharged its load into the coal-crushing hopper, can be filled up with ashes.

(To be continued.)

HIGH-TENSION SWITCHGEAR.

Mr. Leonard Andrews's paper on the above at the Manchester Section meeting of the 13th was taken as read in order that the discussion might benefit. As, however, the "few general remarks" made by the author took over an hour and a half to deliver, the discussion was shorter than expected. The point principally emphasised by the author was naturally the suitability of the reverse-current discriminating cut-out, with which Mr. Andrews is identified, for general use on switchboards where there is a possibility of a faulty generator imperilling an electricity supply system. Mr. Andrews's address was copiously illustrated by experiments upon various types of discriminating cut-outs which were fitted up on the local lighting circuit, and a full size section of a 6,600-volt switchboard of Cowans make was also displayed. Most of these experiments worked as expected, and some provided comic relief by missing their cues, which is what is to be expected at this period of the year.

Mr. WOODBRIDGE, in opening the discussion, reviewed the actual conditions under which reverse-current circuit breakers required to work, and considered that they should not be used, but that the generators should be solidly connected to the bus' bars. He pointed out that the difference between phase relation and current would alter for every ease. The switchboard attendant was the best discriminating cut-out in his opinion.

Mr. CLOTHIER thought the sample switchboard on view would be all right for the voltage if built on the scale of 6in. = 1ft., but would prefer to work it at 2,000 volts himself. He wished to know its cost per kilowatt dealt with, and stated that the Carville board cost about £2 per kilowatt. He described Mr. Andrews as the "electrical handcuff king," who made a practice of tying himself up in knots for the purpose of showing how skilfully he could extricate himself. Mr. Andrews had made a study of discriminating cut-outs for the past 12 years, and was now *au fait* on the subject, but he did not think that the run of station engineers understood much about them, and believed that Mr. Andrews had not yet met with all the obstructions that would be discovered in the path of the device. These cut-outs did not prevent shorts on the switchboard itself, and he suggested that instead of putting in expensive duplicate boards for use in case of trouble, the feeders should be connected to the machines direct through a simple plug shunting arrangement.

Mr. ORTON championed the cause of electrically-operated switchboards, and pointed out that mechanical operation had its limitations as to capacity. The paper was somewhat unfair towards electrical working, as in the list of apparatus required for this the whole of the arrangements used for the various types on the market were lumped together seemingly as one combination. He preferred the switchboard attendant to see what was going on, and not to be isolated in a separate switchboard room.

Dr. GARRARD did not consider that the right principles were applied in the cut-out recommended.

Mr. S. L. PEARCE thought that finality in reverse-current circuit breakers had not yet been reached. He preferred to couple generators direct to 'bus bars, and quoted instances of this having been done on failing generator when nothing untoward had happened.

Mr. E. W. COWAN pointed out that reverse-current circuit breakers had certainly saved machinery. He confirmed Mr. Woodbridge's mention as to the partiality of switchboard attendants for pulling out the wrong switch in an emergency.

Mr. TOPLIS preferred the three phases mechanically separated on the board to prevent a total breakdown. He concurred that the switchboard man should be in a position to see all the operations.

Mr. E. THOMAS believed that nothing at present was perfectly suitable, although good enough for most conditions to be met with. The switchboard man was the most usual reverse-current circuit breaker, but he had a very large time limit.

Mr. A. E. MCKENZIE thought that reverse-current circuit breakers would put stations in a hole sometimes, where, for instance, a generator motored owing to a Corliss valve sticking.

Mr. ANDREWS, in his reply, said that, when synchronising, the reverse-current circuit breaker should either be cut out or altered in sensitivity. He likened those engineers who would not use such cut-outs, on account of them not being able to do everything, to the man who would not use an umbrella because it did not keep the ends of his trousers dry. He compared Mr. Clothier's present admiration for bulky switchboards to Mr. Clothier's paper on the subject, which advocated compact designs. He admitted that 5,000 kw. was about the limit of a mechanical switch. He replied to Mr. Garrard's insinuations as to his lack of knowledge of the subject with the *tu quoque* argument.

A vote of thanks terminated an unusually late meeting.

ON BATTERIES WITH REVERSIBLE BOOSTERS.*

BY C. TURNBULL.

Introduction.—Some time ago I found it necessary to go into the question of having a battery and automatic reversible booster for use on the traction load at Tynemouth. The result of the investigation was the birth of the Lancashire Automatic Reversible Booster, which was brought out under the patents of Mr. McLeod and myself. This is now in considerable use, being made by the Lancashire Dynamo and Motor Company, of Manchester. In putting the machine into the various stations a number of points have come up in connection with the batteries, and to-night I wish to deal with them, in hopes that the paper may be of use to such engineers as are putting down batteries for use under similar conditions.

Price for Traction Current.—The method by which the price for traction current is fixed is one of mystery. Sometimes I think that the lowness of the rate obtained for this

* Paper read before the Newcastle Section of the Institution of Electrical Engineers.

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kind of supply is partly to be accounted for by the fact that we sell in small units. Certainly the reduction from 2d. to 1d. per unit looks a good deal less than the reduction of a year's revenue from, say, £4,000 to £2,000. At any rate, however the price is fixed, it commonly happens that, when a station engineer takes over the management of a station, he finds the glorious tramway load, from which so much is expected, resolves itself into a small output at a remarkably small price, and the problem of making it pay occupies his thoughts for many years to come. I make these remarks here, as in addition to the Greenock case, other instances are coming to light in which the trams are claiming to be supplied at the same rates, or lower, as are in force for ordinary motor load, although it is common knowledge that tram load is of an entirely different description from motor load, and should be dealt with on its own basis. The practice of debiting all stand-by plant which can be used for both lighting and traction, to lighting only, is also not to be commended.

Load Factor.—The large published load factors for traction supply in combined lighting and traction stations are frequently made use of when a low rate for traction is asked. Certainly a 40 per cent. load factor (for I think that a figure as high as this has been given) looks a lot better than the 10 per cent. for lighting. Actually these large load factors are explained by the fact that the traction load is taken as that load which is on at the moment when the highest total combined load is on the station. Seeing that the highest combined load is usually on the station in the winter months, at a time when the traction load is often lower than its normal maximum, this system frequently causes the traction to be credited with a load factor much greater than it actually earns. To take an extreme case, in a station just beginning the highest combined load might be in the summer holidays, when the trams was heavy and the lighting very low. This would give a low traction load factor and a lighting load factor of perhaps 1,000 per cent.! In a few years' time, when the station had grown, the lighting load factor might have shrunk to ordinary dimensions, while the traction load factor might come out very high. I think there is a good deal to be said for taking the respective highest loads for calculating the respective load factors. In connection with this we must also remember that while an engine may be run at nearly full load all the time on motor load, on traction load one must always provide a very large reserve of power to meet the grossly fluctuating demands which traction involves, and this does not make for economy in generating the power.

Batteries.—It has now come to be recognised that the best way to deal with a very fluctuating traction load is to put in a battery and reversible booster, and to-night I propose to deal with some of the aspects of this solution of the problem. The idea has gained currency that a booster should be designed to keep the load on the generator always at a steady value. The problem is stated thus, omitting losses in battery and booster for simplicity: The output is 2,000 units per day of 20 hours. Then 100-kw. generator with a battery and booster will just do the trick. If the maximum load be 200 kw., then the battery should be able to give 100 kw. easily for a short time, so as to meet the peak with the aid of the generator.

In some cases where the output is fairly regular from day to day, and where the maximum demand keeps within limits, this solution of the problem is quite good, and a very efficient and good working plant is obtained by adding a battery and booster to the generator. In many cases, however, this solution is of no use at all. The output varies from day to day. Likewise a large part of the day is slack, with a heavy output during certain hours only. If in addition to this we have heavy and irregular peaks at all times, then it is evident we must solve the problem in quite a different manner. Take, for instance, a case where there is already installed a plant of 200 kw.; the output varies from 1,500 to 2,500 units per day of 20 hours, and the maximum demand is 400 kw. Then if we put a battery in with an output of 200 kw. for a short time, its maximum power added to the generator's maximum will give the required maximum demanded for the feeders. But if we attempt to run the generator at constant full load all the time, it will give off 4,000 units per day, and this will provide a large surplus at all times for boiling up the battery. The difficulty can be met by putting the machine to do only half load, but in this case the combination does not give out the 400 kw. needed to meet the heavy peaks which come on at intervals. Taking everything into consideration, then, it will be found that constant load on the generators can only be got in cases where the load is similar every day, and keeps on fairly regularly throughout the day, and where the size of the generator can be fixed so as to put out the proper amount of current every day at about full load. Of course, in many cases, a good deal can be done by varying the number of hours that the generator is run, so as to provide just the number of units required to meet the load and to keep the battery properly charged.

Properties of Booster.—For a general solution of the problem the booster should have very flexible properties. It should, indeed, fulfil the following requirements:

1. When required, it should work so as to keep the load on the generator approximately steady. This will be needed when the demand for current is approximately equal to the output of the generator. In this case, however, when a very heavy demand is made on the feeders, both generator and battery current should rise to meet it, so that the utmost power of the combination will be available. If this be not arranged, it will often be found that a heavy load will blow first one circuit breaker and then the other, although the combined maximum power of the battery and generator would have sufficient to meet the demand had the booster been arranged to allow the generator output to increase along with the battery's output.

2. It should be possible to vary the apportionment of the load between the battery and generator. In a slack time the battery should do very little. Also, if the traction peak should correspond with the lighting peak, then it may be desirable to let the battery take an extra load to relieve the boilers for the time being.

3. On a slack day with occasional peaks, the battery and booster combination should be arranged to respond to the peaks only, and otherwise do practically nothing, so as not to overcharge the battery. Sometimes the booster may be cut out altogether, and the battery may then with advantage be used to float on the line to meet any occasional rush of current.

4. For periods of very light load, the booster and battery should be arranged to go on to the 'bus bars without any generator. In this case the booster should be arranged to compound up to counteract the drop of volts in the battery.

I might point out that a booster worked by the feeder currents only will not fulfil these requirements, as such a combination will tend to take the load off the generator when the battery is fully charged, while it will be sluggish and unresponsive when the battery is down at all in volts.

Size of Cells.—Given a booster with the above properties, it is not difficult to arrive at the size of the cells. Thus with an output of about 3,000 units per day of 16 hours we can do it with a generator which will do 200 kw. as ordinary full load, with, say, a 25 per cent. overload capacity to meet excessive and occasional rushes. As we can now get economical triple-expansion engines or turbines which will run economically for long hours at full load and that will give off overloads either by means of valve gear or by working as compound engines, this part of the problem is easily solved. We must then put in a battery which will be large enough to meet the maximum load of the station when running in combination with the generator. Where the hours of actual load are longer or shorter than the 16 hours mentioned above, or where there is little or no load during part of them, then the problem can be solved in a similar manner. Given, however, a booster which will work in harmony with its generator as above, the solution will not be difficult, and a good deal can be done by varying the hours of running of the generator to suit. In buying cells under maintenance, it should be arranged that the circuit breaker should be set as high as possible. This is really unobjectionable, seeing that heavy

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discharges are only momentary, and, further, the battery usually is not run down at all in working.

Type of Cells.—The actual work done by the cells when working with a reversible booster is very little. For although the curve of charge and discharge looks large enough in importance when it is examined on the recording ammeter chart, still the peaks integrate to very little. We, therefore, want a cell which will do with very heavy discharges, and also with considerable charges, but that does not necessarily have a large long hour capacity. Durability is more important than efficiency. As a matter of fact it is well known that a cell which receives charges and discharges at short intervals has an extraordinarily high efficiency, and a slight reduction in this if it gave increased durability, would not matter. I have been informed by one of our leading accumulator firms that a cell to meet those requirements can be made and maintained at about half the ordinary price if it be asked for, and I hope that such will be on the market in the near future.

Space for Additions.—It is a great advantage to have the cell boxes large enough to allow of the addition of more plates. This enables the size of the battery to be kept down, as it is easy to increase its capacity. If, however, more plates are added, then it is not desirable to simply put the new plates in parallel with the old ones. Old plates should be taken from some of the cells to make up the additional number required in the other cells, and the cells thus depleted should be made up entirely with new plates. The space at the side is useful in assisting the much-desired circulation of the acid. It also enables the cells to be inspected by an inspection lamp on an L-shaped stick. This lamp put under the plates shines upwards and shows any shorts clearly.

Space at Bottom.—The space at the bottom of the cells should be ample, about 6in. or so, so as to obviate frequent cleaning.

Number of Cells.—The possible variation of cell voltage is from 1·8 to 2·7 volts per cell, the last figure being obtained with the fortnightly overcharge, which makers recommend to be given to the cells. In ordinary working the variation is from 1·9 to 2·5 volts. Provided that the booster is arranged to prevent the current from coming back on to the generator, the number of cells may be varied considerably. I think, however, that 250 cells is a suitable number where the 'bus-bar pressure is between 500 and 550 volts. If fewer cells be used, a good deal of work is thrown upon the booster to pump the current out of them, and if more cells are installed there is a danger of the current coming back on to the generator if they be floated on the line without the booster when fully charged.

Instructions for Running the Battery.—This is a matter of great importance, and, unfortunately, battery makers usually give little assistance. It will be seen that it is necessary in working to ensure that the battery has just the right proportion of current put into it. Meters are of some assistance towards this end, but they must not be relied upon too much. It is doubtful if meters are quite accurate on the violently changing loads of a traction battery. Furthermore, it is likely that the effect of a discharge on the battery varies with the rate and also with the state of discharge that the battery is in. One hundred ampere-hours taken out of a battery just freshly charged will not need the same extra percentage to be put back that the same amount would need from a battery well run out—at least, I think not; indeed, as long as the load is of such a kind that the battery gets a charge immediately after a discharge—as happens when working with a reversible booster—then the excess percentage of charge over discharge in ampere-hours need be very little.

The advice is sometimes given that the booster should be worked so that the battery is charged every night at shutting-down time. This is impracticable without an undue amount of attention. The most practicable way that I have found is as follows: During the morning, when the generator is started up, there is usually a slack time, so that it can be arranged that the battery is mainly charging. The battery attendant should be in the battery-room now, and he should go round and see that every cell gasses up at the same time. He should watch the battery when it is gassing, and, at the same time, top up any cells with water if necessary. The water can be put in by a long glass tube, about 1½in. in diameter, with a bell mouth. This will enable the water to be put in at the bottom, and it can be stirred about and well mixed with the acid. The amount of gassing and volts per cell necessary on the daily charge should be determined by the battery makers, whose assistance should be freely requisitioned at first start up. When the cells are full up, the attendant should inform the engine-room staff, so that the booster can be regulated, so that the battery can be discharged for a time rather than charged. When a little current has been run off, the adjustment can be made so that charge and discharge are about equal or as needed. This method of working the battery needs a minimum of attention, and will be found very satisfactory in practice. Once a fortnight—if required by the makers—an extra charge can be put in, which will bring the voltage up to 2·6 or 2·7 per cell. This should be done at a quiet time, when the charge can be put in fairly steadily. The volts of each cell can then be taken on the top of the charge. The gravities of the cells can also be taken at the same time. The gravities can be relied upon to some extent to tell if the cells are getting their proper charge, but still these are affected by the addition of water to make up for evaporation. If a maintenance scheme is entered into, it should be on condition that the battery is to be worked on lines like this, and not on lighting battery lines.

Maintenance.—The question of the maintenance of batteries by makers is a thorny one. If the makers are good substantial and decent people, then there is some assurance to the owner of the battery in having a maintenance. Otherwise, it may happen that after several years of maintenance have been paid, that when repairs are needed the makers get out of their agreement by one of those curious clauses with which they fill their agreements. I mean, for instance, such a clause as that which states that the payments are to be made to the company *without demand!* It is possible to reduce the amount of the maintenance payment by stipulating for the battery to be kept up to, say, 90 per cent. of its original capacity instead of to the full capacity, and this is usually quite enough for reversible booster work. Indeed, with this proviso, the upkeep rate for a battery should be extremely low. The maintenance agreement should be settled as to terms before the order for the cells is definitely placed, as this will enable a better bargain to be struck. The user of the cells should then stipulate for six months' use of the cells before deciding whether to enter into the maintenance scheme or not. It is also desirable that the agreement should last over a long term of years—say 10—but with the user's option of terminating, say, after five years.

Water.—The question of water should be settled before the contract is placed. The makers usually stipulate for pure water only to be added to the cells, but if the town water is good, this is allowed. If this is not good, then the user is in a quandary as to how to make up the evaporation. Condensed water from a boiler is not always suitable, as it may contain boiler compounds, if such be used, or iron. Makers do not always help in the matter. Thus I know of one case where the engineer asked them to provide a distiller to provide make-up water, and they offered one, after several weeks of correspondence, for about £400! Rain-water is often too impure. I think that a simple distiller could, however, be made by using a gas jet under a boiler. The steam would go through a worm, and would be cooled by water in a tank. After the worm had gone through this tank it would go through a second tank. The boiler and the two tanks would be connected by a pipe so that the water would stand in the same level in all. This would cause the boiler to be automatically fed with hot water. A tap could run into the last tank to keep up the level, and also to provide cooling water.

Battery-Room.—It is often stated that battery-rooms should be well lighted. Actually too much light in a battery-room is bad, as it renders cell inspection difficult. The room should be rather dark, with good artificial lighting. The wiring may be done on insulators. At intervals lamps should be provided on long flexes of Lyric $^{3}/_{25}$ R.C. wire for looking into the cells from above. Hooks should be provided to hang these lamps on when not in use. I

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have found acid-resisting paint liable to chip off a concrete ceiling, but wood varnished with acid-resisting varnish has stood better. The ventilation should be good, but of a nature to prevent flies and dust from coming in too freely.

Milking Booster.—This should be run off the lighting circuit so as not to be shut off if the main circuit breaker of the traction generator is blown. It is a debatable point as to how the leads should be run for milking up the cells. In the diagram, I show them run under the grating on the floor, being supported on insulators. The flexible leads can be connected by means of screwed plug handles. A small switchboard can be fixed in one end of the room, or possibly in a small room provided for the purpose. Where the cells are on two floors the switchboard should be provided with one pair of switch fuses only, to connect either the upstairs leads or the downstairs leads on to the 'bus bars. The use of a single pair of switch fuses prevents any attempt to milk up two parts of the battery at once, as, of course, only one pair of flexible leads is kept in a room. The booster can be put in a convenient place, but the regulation of its volts can be done from the battery-room. The booster may also be arranged to provide heavy currents for meter-testing purposes. The board should have a polarised ammeter and a voltmeter with paralleling and other stops on the switchboard.

Grating.—The grating for the battery-room floor can be made of rough wood dipped into melted pitch. This makes quite a cheap and satisfactory arrangement.

Reversible Booster Switchboard.—The breakers, of the booster-motor and battery, should be on the live side, but most of the rest of the instruments on the board may be

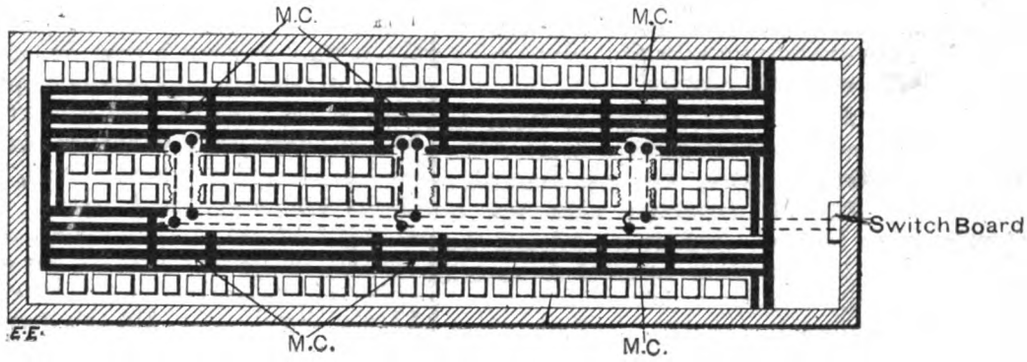

Diagram showing Arrangement of Trolley Wire Conductors for Milking-up Cells. The Grating is showing Broken Away to show the Trolley Wire which is underneath. M.C. indicates Moveable Coves by which plugs are got at.

on the earth side. The motor breaker should be arranged to shut off the battery current, if it comes out, so that the booster may not race owing to the battery current running through it. On the other hand, it is desirable to have the breakers arranged so that the blowing of the battery breaker does not stop the motor.

Meters.—Wattmeters may be used with the shunts taken off the 'bus bar, so that they virtually become ampere-hour meters. I have tried oscillating meters, which have the advantage that they do not need any pawls to stop them from running reversely. I think that mercury electrolytics or some shunted ampere-hour meters with a small drop might be used. One shunt would do for both. In this case the auto switch for putting either one or the other in circuit, according as the battery was charging or discharging, would be simply a mid-zero ammeter type of instrument, only that the pointer would have a contact on the end. This contact would swing up against one or the other of fixed contacts, and so direct the current into the right meter.

Testing of Meters.—It is not essential that the integrating meters should be absolutely correct, but it is essential that they should agree with each other, or that their differences should be known. They can easily be tested for this by simply reversing the connections of one so that they both read for charge, or discharge, for a day or two. The readings thus got will show whether the meters are agreeing.

Shunts.—The abomination of several shunts in series—one for the ammeter, one for the recorder, and one for the integrators—should be avoided. One shunt should do for the lot, or if two in series be used, then the instrument having the heaviest drop should come off the combined resistance of the two shunts. In this latter case the two shunts in series should be soldered together, so that the combined resistance could not be affected by bad contact.

Arrangement of Plant.—In some stations I think it would be a good thing to couple the booster right on to the main generator shaft, so as to save motor losses. In many cases I think it would be well to run traction and lighting dynamos in tandem on the same engine. Where a reversible booster was in use, the load on the traction generator would be steady enough to prevent flickering on the lighting boards due to variations in the engine speed. Two ideas are possible: Either the generator can be looked on as a traction generator, in which case the traction dynamo would be equal in capacity to the engine, and the lighting dynamo would be equal to the day load on the lighting board; or the lighting dynamo can be of the engine capacity and the traction one smaller. At night or on the peak loads, of course, when desired the loads could be separated out. The lighting dynamo could have the mid-wire connection through choking coils, which would obviate the running of a balancer in the daytime. Given, say, some 200 kw. on the traction and, say, 100 kw. on the lighting all day long, then the combination would provide quite a good load for a 400-kw. or 500-kw. engine. If the condensing plant were run direct off the engine shafting by chain or other gearing, we would have a very economical omnibus plant for many stations. Of course, one may say that there would be a lot of eggs in one basket in case of breakdown, but then plant does not break down now as it used to, and, of course, the ordinary stand-by plant would be necessary as it is now. The amount of current that runs to waste nowadays in running balancers and motors for various purposes is so enormous that it is worth while to do something to save it.

Conclusion.—I have written this paper at somewhat short notice, although, of course, the subject has been in my mind for a long time. Had I had more time it would have been possible to provide some diagrams, but I hope that the absence of them will not be unduly felt. Indeed, the style of the diagrams necessary to illustrate a paper of this kind is so well known that it is doubtful if they are necessary. I can only hope that the contents of the paper will be useful and interesting to all concerned in matters of this kind.

FORTHCOMING EVENTS.

Jan. 5.—A general meeting of the Röntgen Society will be held at 8.15 p.m., when Mr. C. E. S. Phillips will give a description of an automatic vacuum pump, which will be followed by an exhibition of a method by which strongly-adherent films of aluminium may be applied to glass; and "A Note on the Colouration of Glass by Radium Radiation."

Jan. 10 and 11.—At the Institution of Civil Engineers, Sir W. H. White will deliver an address, entitled "The Recent Visit to the United States and Canada."

Jan. 13.—A lecture, entitled "Theory of Electricity and Magnetism," will be delivered by Mr. J. Swinburne to the students of the Institution of Civil Engineers.

Jan. 27.—The following papers will be read at the Physical Society: "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows; "Action of Radium on the Electric Spark," by Dr. Willows and Mr. J. Peck; "The Slow Stretch in India-rubber, Glass, and Metal Wires when subjected to a Constant Pull," by Mr. J. Phillips; "Determination of Young's Modulus for Glass," by Mr. C. A. Bell; and "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

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TO CORRESPONDENTS.

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THE METRIC FALLACY.

It was with some reluctance we entered into this controversy, it is with diffidence we continue it. While the late Sir F. Bramwell, with his experience and his influence, was alive to speak, the matter was in able hands. With his death it behoves all who have thought of the subject to band together to oppose the insidious but energetic campaign of the metric advocates, and by weight of numbers, even if the influence be really lacking, to show that the arguments of the advocates are not altogether convincing. The late I. Todhunter was once out of temper at the constant iteration of men who knew not what they were talking about, and who bewailed the dearth of mathematicians in Britain, extolling to the skies the number and ability of foreign mathematicians. He said, "Look here; write down your foreign names, and I will write against each the name of a Briton who shall equal him in knowledge and ability. Make your list as long as you like." Perhaps, then, we are modest, and in losing Sir F. Bramwell may not have lost all ability or influence, but if put to the test might find firms and individuals who oppose; as able as well known, and as experienced as any who support the metric fallacy. In reply to Lord Belhaven, we can at present touch briefly only on certain points. Thus the reports of consuls need far more discussion that can now be given, but after twenty-five years of examination of them we are not surprised at anything they contain, and always want to know a good deal more than the reports give. A first and very pertinent question is, Who and what is the consul? Non-limitation to foreign trade, because "every trade calculation will be reduced to one-third of its present length." Now, how does the metric system deal with time? Surely time is a function in most trade calculations. Then navigators cannot or won't use the metric system—if any do, where are they to be found? "The French people have refused to have the 10-hour day . . . and the French navigator threw overboard his 10-hour day, his 400deg. circle, and his kilometre" (British Weights and Measures Association's pamphlet, p. 2). "We are not aware of any single country in the world, not even France, that has made the metric system its textile standard" (same pamphlet, p. 3). Two yards (shipbuilding) "one of considerable importance at Flensburg, and one at Hamburg, still use the English system of measurement for their shipwork" (Halsey and Dale, p. 41). "The millimetre has not yet driven the inch from German machine shops, and that Germany is still in the transition period" (p. 41). "*Every* trade calculation reduced, etc." Halsey's book rather controverts this idea, as, if we recollect rightly, did the late Sir F. Bramwell, and as does everybody who can use figures. Sometimes a reduction will take place by using one method, sometimes by using another, but to claim universality of reduction for any one method is an absurdity. On p. 146 of Halsey are certain calculations, and he says, "the introduction of the metric system into that school has made it possible with 245 figures to arrive at the same result that is reached with 223 figures by the elementary English formulas or with 160 figures by (English) mill methods.' On p. 205 are other examples giving results: English 15 figures, metric 27 figures; English 15, metric 23; English 16, metric 25; English 38, metric 22. The metric system does not show up very well as a reducing system for calculation. The English textile standards are six in number, the metric eight (p. 197). A French textile manufacturer says: "We are as much in the anarchy of weights and measures for the textile industry as at the time of

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the Revolution." This does not seem to prove simplicity, or even a desire in metric countries to adopt a metric system. Comment is made as to our reference to professors and students, and it is pointed out that certain eminent firms support metric reform. We agree that that is so, but to attempt to analyse the reasons why certain firms support the system would entail too much space—they are perfectly obvious in many cases. However, when a list of firms in the textile industries—that is, when Lancashire, Yorkshire, Gloucestershire, Wilts, etc.—show a leaning that way, will be time enough to claim practical men in support. The metric system in France. Casually we have referred to the textile industry—the British Weights and Measures Association calls attention also to the hat trade (p. 3), and Halsey (pp. 60-69) gives over five hundred non-metric units used in metric countries, many of these in France and French-speaking places. Is it not absurd to give a list of English variants, and claim them as showing the badness of the system, and refer to French variants as showing nothing. Halsey (pp. 28-38) deals with the persistence of old units in France, and in his introduction says: "Nowhere has the system made material progress in industry except when backed by the policeman's club. For more than a century it has been the pet of the legislator, and with the result that in France to-day its most ardent advocates are calling for more laws to compel its use by whole industries that do not, and by the testimony of these same advocates will not, use it unless compelled to do so." We have already exceeded our space, or we should have referred to the advocacy of Mr. T. Parker that the inch should be retained, but we would just like to point out that the English system of weights and measures, although possessing features which might well be modified, possess some advantages also. Take the case of the gallon: in one of Prof. Henry Robinson's books he gives a chapter on memoranda; the first is, "a gallon of water weighs 10lb." Here, then, is a decimal system, more or less, and we agree that many of the calculations involving these quantities are exceedingly simple. We are not, and never have been, against the use of decimals. We use decimals when they assist; we use vulgar fractions also when they assist.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ELECTRICAL TRADES' BENEVOLENT FUND.

SIR,—Whilst fully sympathising with the efforts of Mr. Justus Eck and his friends to promote a benevolent fund for the benefit of necessitous members of the electrical industry, may I be permitted to point out that there is already in existence a benevolent fund in connection with the Institution of Electrical Engineers for the purpose of assisting members, or the families of members, in temporary or permanent need.

Efforts are now being made to improve the position of this fund, and I shall be pleased to forward the rules to any member who may desire to have a copy.—Yours, etc.,

G. C. LLOYD,
Hon. Sec. to the Benevolent Fund of the I.E.E.

[We are sure that the treasurer will be equally pleased to send receipts for a large number of contributions to the fund.—ED., *E. E.*]

SIR,—I am obliged to you for the criticism you gave in your last issue on my letter on the above subject.

The Electrical Trades' Benevolent Institution Fund is intended to benefit all deserving persons engaged in the electrical industry who may fall in need, and is, therefore, in no sense in opposition to the benevolent fund of the Institution of Electrical Engineers, which is for the benefit only of members of that institution.

The source of revenue of the Institution of Electrical Engineers' fund is its own members; that of the electrical trades' fund will be very much larger, and should include all persons who benefit directly or indirectly from the practical applications of electricity.

Again, any funds belonging to a trade union are circumscribed both in the collecting and distributing areas. The electrical industry, now many years old, employs many thousands of individuals who cannot be assisted by either of the funds you mention. There is, therefore, ample scope for the new fund, which, supported as it is by the employers of many hundreds of hands, and pioneered by an active and industrious committee, will soon make an appeal upon lines that should command a very good reception from all classes.—Yours, etc., JUSTUS ECK.

10, Priory-road, Bedford Park, W., Dec. 18, 1904.

[We are pleased to publish further details of the above scheme, which is very wide-reaching. The principle of mutual assistance has our hearty approval, and we trust that the committee will be able to solve the many difficulties in the work before them. We are afraid that the equitable distribution of funds amongst the many grades interested will be a more difficult matter than the collection of the same. This was what led us to refer to the benevolent fund of the Institution, and to the trade and friendly societies, in our last issue as having benevolent schemes already in operation. Many of our large firms also have such funds, subscribed to regularly by the workmen and staff.—ED. *E. E.*]

QUESTIONS AND ANSWERS.

SIR,—I beg to draw your attention to a mistake in the answer to question 737, appearing in the "Supplement," Dec. 16.

The rule is given in the latter portion of the answer, when locating a fault by Murray's loop test, "the fault on the loop, A B, being nearest to that end of the bridge which gives the greatest length between its end and the test contact."

This should read, "the fault on the loop being nearer to that end of the bridge which gives the *shorter* length between its end and the test contact."

This error is in evidence both in the diagram and calculation.—Yours, etc., R. A. O'NEILL.

THE METRIC FALLACY.

SIR,—In your issue of Dec. 2 you publish an article on the "Metric Fallacy." May I be permitted to reply to some of the points contained in it?

You refer to a volume by an American author discussing this same fallacy. Is it generally known that America has so far departed from the British system of weights and measures as to adopt the metre as the fundamental standard of length, the yard being derived from such standard metre? Is this a part of the metric fallacy? You say, "the aim of the practical man is simplification of work and getting of business." That is precisely our point. That is why British consuls all over the world have for years been urging the adoption of the metric system in the interests of British trade.

When I speak of trade I do not limit the benefits of the metric system to *foreign* trade. It is quite as much, if not more, to the advantage of our home trade that the cumbrous system of weights and measures from which we suffer should be replaced by one in which every trade calculation will be reduced to one-third of its present length.

You speak of the agitation in favour of the adoption of the metric system in this country as the agitation of a few professors and students—that is, I think, a fair interpretation to be placed upon words used in your article. The accompanying list of eminent commercial and manufacturing firms who support the reform in question is probably too long for insertion here, but would amply convince your readers that if the practical men in this country are all on one side, they are certainly not on the side of our own perplexing weights and measures.

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Let me pass to your argument that the metric system is not fully adopted in France. In reply to questions put by the American Chamber of Commerce of Paris in October, 1903, on this point, the Société des Ingénieurs Civils de France stated as follows: "To-day only one system of measures exists in France, and it is absolutely incorrect to say that the old measures are still employed in this country; even their values are becoming more unknown. The popular names of the old measures, which, as stated before, designate, at the present time, metric measures, have given rise to the belief that the two systems are co-existent."

It is as absurd to say that the metric system is not wholly adopted in France to-day as it would be to maintain that English is not the universal language in this country because in outlying districts of Wales, or the Highlands, it is not always used.

Moreover, if the custom house in a metric-using country requires all invoices to be made out in the metric system, it matters very little for purposes of our export trade what weights and measures prevail in the far interior of that country.

It is obvious that if the proposal of the British Weights and Measures Association to standardise and simplify British weights and measures be carried out, the confusion and expense of change to their new simplified system would be as great as the change to the metric system, and we should be left out of harmony with metric countries, and even out of harmony with the United States—a position of "splendid isolation."

It is a common thing to hear on the part of those opposed to the adoption of the metric system that it would be a simple matter to adopt a decimal system of weights and measures based on our present measures of an inch or a pound weight. But none of those who say this have ever published a scheme, for the best of reasons that such a system would (1) be as difficult to introduce as the metric; (2) lose the advantage of the inter-correspondence possessed by the metric system in the relations of length, weights, and capacity; (3) lose the benefit of uniformity with other nations, which is one of the most important objects to be obtained by making a change. The accompanying list of customary, but illegal, weights and measures used in this country will show that the work of simplifying and standardising will be a serious matter, and should convince your readers that it will be better to make a clean sweep of them, rather than attempting a patching-up process.

As an example of the feeling in the United States, the following quotation from the report of the Secretary of the Treasury at Washington issued in June last year may be instructive: "During the year the attention of this department has been forcibly called to the growing need for international uniformity in so fundamental a necessity to trade as weights and measures. The customs congress of American republics, held at New York, strongly urged the adoption of the metric system to simplify the transaction of Government business in connection with international trade. Moreover, the National Board of Trade of the United States, the Board of Trade of Canada, and the congress of chambers of commerce of the British Empire have recently urged by strong resolutions the adoption of the metric system. The experience of 40 countries of the world has proved beyond question that the international metric system is unsurpassed for practical convenience, possessing, as it does, a terminology concise, definite, and free from ambiguity, affording a maximum facility in the countless transactions and computations of science, manufacture, and commerce."

Finally, you say that it is a question "of the Latin races against the Anglo-Saxon—once more lightness, alertness, flexibility, as against solidity and phlegmatism." May I ask under which of these heads you place the Germans?—

Yours, etc.,
BELHAVEN AND STENTON,
Vice-President of the Decimal Association.

44, Lennox-gardens, S.W., Dec. 19, 1904.

List of Eminent Firms actively supporting the Decimal Association.

Armstrong, Whitworth, and Co.
Birmingham Small-Arms Co.
Brunner, Mond, and Co.
Clayton and Shuttleworth.
Babcock and Wilcox.
British Mannesmann Tube Co.
Cleveland Bridge and Engineering Co.
Colville, David, and Sons.
Harland and Wolff.
Lancashire Explosives Co.
Mather and Platt.
North British Locomotive Co.
Ransomes, Sims, and Jefferies.
Ruston, Proctor, and Co.
Sandycroft Foundry Co.
Smith's Dock Co.
Thornycroft, John I., and Co.
Vickers, Sons, and Maxim.
Whitwell and Co.
Birch, J., and Co.
Bovril, Limited.
Broughton Copper Co.
Burroughs, Wellcombe, and Co.
Crosfield, Joseph, and Sons, Ltd.
Deloitte, Dever, Griffiths, and Co.
Fleming, Birkby, and Goodall.
Gosnell, John, and Co.
Guthrie, Edwin, and Co.
Hollins Mill Co.
Imperial Tobacco Co.
Jenson and Nicholson.
Johannesburg Cons. Investment Co.
Main, A. and J., and Co.
Pears, A. and F., Ltd.
Salt Union, Ltd.
Simpson, James, and Co.
Tapling, T., and Co.
Venesta, Ltd.
Whiteley, William, Ltd.
Central Marine Engine Works.
Fraser and Chalmers.
Jonas and Colver.
Hayser, Ellison, and Co.
N.-E. Marine Engineering Co.
Perfecta Seamless Steel Tube Co.
Rudge-Whitworth, Limited.
Salter, George, and Co.
Siemens Bros. and Co., Limited.
Swan, Hunter, and Wigham Richardson.
Tyne Iron Shipbuilding Co.
Waverley Iron and Steel Co.
Boake, Roberts, and Co.
Briggs, Thos. (Manchester), Ltd.
Egerton Burnett, Limited.
Clarke, Nicholls, and Coombs.
Debenham and Freebody.
Elliman, Sons, and Co.
Sir Douglas Fox and Partners.
Gossage, Wm., and Sons.
Harrod's Stores, Limited.
Horrockses, Crewdson, and Co.
Jaeger's Sanitary Woollen Co.
Johnson, Mattey, and Co.
Liberty and Co.
Maw, S., Son, and Sons.
Salt, Sir Titus, Bt., Sons, and Co.
Sassoon, D., and Co.
Summerscales and Son, Ltd.
United Alkali Co.
White, J. G., and Co.

List of Anomalous Customary Measures and Weights submitted to the Select Committee of 1895 by the Chairman of the Society of Inspectors of Weights and Measures.

A pot of apples, in Wolverhampton, equals 75lb.
A pot of beans and peas, in Warwickshire, equals 40lb.
A tub of potatoes, in York city, equals 20 stone—*i.e.*, 2½ cwt.
A pound of butter, in Wigan, equals 16oz. or 17oz.
A sieve of vegetables, in West Ham, equals 1 bushel.
A sieve of vegetables, in Rochester, varies 7, 8, and 9 gallons to the bushel.
A sieve of vegetables, in York city, varies 24lb. to 42lb.
A sieve of plums or black currants, in Warrington, varies 10lb. to 50lb.
A bushel of peas, in Wigan, equals 60lb.
A bushel of potatoes, in Wigan, equals 84lb.
A bushel of corn, in Hereford, equals 63lb.
A bushel of corn, in Newtown, equals 80lb.
(But the greatest absurdity is to be found in Cornwall, where it is actually supposed to contain 240lb.)
A "stone" of live meat equals 14lb.
A "stone" of dead meat equals 8lb.
A "stone" of cheese equals 16lb.
A "hobbet" of old potatoes, in Flintshire, equals 200lb.
A "hobbet" of new potatoes, in Flintshire, equals 210lb.
A "Llestr" of lime, in Carnarvonshire, equals 1 bushel.
A "punnet" of strawberries, in Greenock, varies from ¾lb. to 1lb.
(In Forfar fruit is sold by the Scotch pint, and by the "choppin." A Scotch pint equals three Imperial pints, and the "choppin" equals 1½ pints).
In Dumfriesshire the Scotch pint equals four imperial pints.
Vegetables are sold in Flintshire, in "lippins," a lippin equals ½ gallon.
A "molley" for vegetables, in Northamptonshire, varies from 12lb. to 40lb., there being large and small mollies.
A "molley" for vegetables, in Chester, equals 3½ gallons.
A peck of fruit, in Manchester, varies from 14lb. to 18lb.
A pad of potatoes, in Middlesex, equals 112lb.
A punnet of vegetables, in Middlesex, equals 1lb.
A nipper of vegetables, in Middlesex, equals 12lb.
A pack of vegetables, in Huddersfield, equals 240lb.
A hoop of vegetables, in Kendal, equals 1 Imperial gallon.
A peck of potatoes, Gloucester, equals 14lb.
A peck of potatoes, heaped, in Gloucester, equals 16lb.
A seam of straw, in Devon, equals 200lb.
A seam of hay, in Devon, equals 373lb.
A seam of dry wood, in Devon, equals 280lb.
In Northumberland they sell vegetables by the "forpet," which equals 1 gallon; by the half-forpet, which equals ½ gallon; and by the "beatment" which also equals a gallon.
A pottle of vegetables, in Buckinghamshire, equals ½ Imperial gallon.
A flat of vegetables, in Buckinghamshire, equals 1 bushel.
In Cambridge borough butter is sold by the yard; each yard is supposed to weigh a pound.
A boll of wheat, in Buteshire, equals 240lb.
A boll of barley, in Buteshire, equals 320lb.
A boll of oats, in Argyllshire, equals 6 bushels.
A bushel of corn, in Sunderland, equals 46lb.
A bushel of corn, in Shropshire, varies, 72lb. to 75lb.
A seam of green wood, in Devon, equals 336lb.
In South Wales, in place of liquor being sold in pints and half-pints, it is sold in an illegal measure called the "blue," or "sleever," which contains a third of a quart. An inspector recently informed me that in place of three measuring a quart—viz., 8 gills—that many only measure 7 gills, so their abolition would be a benefit to the poor man.

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The following is a List of the different Measures used in the Sale of Wheat, which appeared in a letter from one interested in the Corn Trade in the Daily Mail of Jan 28 1904:

Quarter of 8 imp. bushels (496lb.) country districts.
Quarter of 8 imp. bushels (504lb.) at London.
Coomb of 4 bushels at Beccles.
Load of 3 bushels at Sheffield and Doncaster.
Load of 5 quarters at Oxford and Cirencester.
Load of 5 imp. bushels at Bedford.
Boll of 3 imp. bushels at Newcastle, Carlisle, etc.
Boll of 6 imp. bushels at Berwick, Duns, and Kelso.
Boll of 4 imp. bushels throughout Scotland.
Bushel of 62lb. at Birmingham, Gloucester, and Taunton.
Bushel of 70lb. at Liverpool and Manchester.
Bushel of 75lb. at Chester, Shrewsbury, and Nantwich.
Bushel of 80lb. at Monmouth and Abergavenny.
Bushel of 65lb. at Aberystwyth.
Boll of 264lb. at Glasgow.
Boll of 240lb. at Hamilton.
Barrel of 280lb. at Dublin and Cork.
Cwt. of 112lb. at Bedford and Newry.
Cental of 100lb. at Liverpool.
Windle of 220lb. at Preston.
Hobbet of 168lb. at Denbigh.

Units in Use in the Foreign Grain and Flour Trade.

14lb.	20lb.	45lb.	60lb.	100lb.	189lb.	196lb.	210lb.	224lb.
304lb.	312lb.	320 lb.	336lb.	400lb.	480lb.	448lb.	476lb.	492lb.
496lb.	500lb.	504lb.	520lb.	532lb.	2240lb.	32lb.	34lb.	112lb.
		56lb.		1000 kilos.		Quintal.		

The correspondent who supplied this list wrote on April 21, 1904, as follows: "It is openly stated by grain traders that they would object to a *uniform* system of weights, as they would thereby lose the pull which they can get with countrymen by buying on one weight and selling on another."

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.

Mr. W. P. Adams read a paper on this subject on the 15th inst. before the Institution of Electrical Engineers.

Dealing first with the financial aspect of the matter, he emphasised the desirability of keeping the accounts of the two departments quite distinct.

Descriptions were given of all the combined stations in the country, and copious curves were presented illustrative of the conditions and progress at the various works. The author remarks that there is often a considerable difference between the value of winter and summer refuse in a given town, and also a variation in the quantity collected. It is worthy of note that these variations correspond very fairly with the fall and rise of the summer and winter output of electricity, the winter refuse generally being of the higher value.

Below is a table of the net units of electricity derived per ton of refuse burnt, taken over a year. The figure fluctuates in a large degree with the conditions. Mr. Adams mentioned the case of Hackney, which on Dec. 17 last year obtained a value of 105 8 units per ton on the peak load. This figure was obtained under ordinary working conditions, and, given a sufficiently large load (such as that obtained at Shoreditch), Mr. Adams sees no reason why 100 units per ton should not be reached throughout the day.

Name of town.		Units per ton of refuse burnt.
London —	Shoreditch	21
	,,	28·5
	Stepney	28·3
	Fulham	26·2
	Hackney	37
	Bermondsey	29·8
Provincial—	Shipley	30
	Beckenham	12·8
	Partick	29·6
	Nelson	40
	Mexborough	25·5
	Gloucester	15·3
	Grays	15·0
	,,	21·0
	St. Helens	31
	Accrington	10·6
	Bangor	15

Mr. Adams thus concludes his paper: The question of combined electricity works and dust destructors promises to assume very large proportions, and it is desirable to realise that it is only some five years since the pioneer works at Shoreditch were erected. Every town of over 10,000 inhabitants will probably in the course of a few years be provided with destructors, and if the heat value is sufficient to pay a large part of, and, perhaps, in some cases the whole, cost of destroying the refuse, the economy of combined works is a matter of high importance to ratepayers throughout the country. It is probable that many of the large existing destructors might be economically adapted for the generation of steam. Several instances have come under my notice, and I have recently been required to report in such a case. The conclusions come to are not a little interesting, and the economy of the proposed alteration for generating electricity is very considerable. It may not always happen that existing destructors are situated satisfactorily from an electrical point of view, but the transmission of the electricity generated to the electricity works or to a sub-station, is not a problem presenting any serious difficulty.

The surprising results obtained in the London undertakings which I have had the advantage of introducing to your notice this evening, may well give rise to some curiosity as to the values which will be ultimately secured in large combined works. After a study of the Fulham and Hackney curves, an average in the neighbourhood of 100 units per ton would appear to be within reach, and the heat value is certainly contained in the refuse, if only it can be fully utilised.

So long ago as 1902, Prof. George Forbes stated in a lecture before the Society of Arts that if the refuse then collected in Paddington were properly burnt and used in the most economical way, it should provide enough electricity to light one 8-c.p. lamp for two hours every night of the year per head of the population, which is the estimated amount of light demanded by the exigencies of modern civilisation. It is a great pleasure to me to take upon myself the vindication of Prof. Forbes as a prophet, for by the exercise of a small amount of scientific license I am able to demonstrate that in at least two metropolitan boroughs this result will certainly be achieved within a few years. A 30-watt carbon lamp burning two hours per night throughout the year would absorb 22 units. A Nernst lamp giving the same light would burn, say, 11 units. The population of Fulham is 150,000, thus 1,650,000 units would be required; the ultimate value is estimated at 1,870,000 units. The population of Hackney is 230,000, the units required would amount to 2,530,000 units; the ultimate value of the Hackney refuse as estimated by Mr. Robinson is 2,436,000.

I will ask you to bear with me while I make a modest little calculation on my own responsibility. The annual collection of refuse in London amounts to approximately 1¼ million tons. Taking so low an average as 40 units per ton as its potential capacity for generating electricity, no less a sum than £200,000 per annum—taking the average coal cost of all the London undertakings—is being tipped on dust heaps, resolved into vapour, and deliberately barged out to sea at heavy cost.

Conclusions—As I am addressing engineers, I need summarise my conclusions but briefly.

1. The remarkable figures obtained in some undertakings, as demonstrated in the series of curves I have had the privilege of laying before you, are evidence that great advances have been made in the problem of utilising waste heat from burning refuse in destructors since the pioneer works were started.

2. That these results still leave room for substantial improvement (*a*) by closer attention to the details of construction of furnaces and flues, and the general arrangement of the plant; (*b*) by improving the methods of handling and burning the refuse; (*c*) by careful utilisation of the steam generated, and the adoption of an economical form of blast.

3. That given suitable conditions, there is without doubt a substantial gain to be effected by the combination of electricity and destructor works; but owing to the variation in the calorific value of refuse in different localities, and to other special local considerations, every proposed case of combination needs to be considered on its merits by persons qualified to make an independent and intelligent enquiry.

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4. That the various and in some cases crude methods in vogue of adjusting accounts between the two works need to be systematised, and that it is highly desirable that the results obtained be separated and recorded with accuracy, so as to give, so far as possible, a true record of the financial position of both works.

[The figures given in the paragraph immediately preceding the "Conclusions," are as amended by the author on the reading of the paper, and not as originally printed, the revised numbers embodying substantial increases.]

The following is a synopsis of the discussion:

Mr. Highfield, late of the St. Helens works, stated that the load factor at his station was extremely high, so the refuse had had a chance of giving the best results. Taken over a year, they had obtained 36 units per ton of refuse. He pointed out that the units yielded by the refuse started rather badly in the morning, which he attributed to the varying quality of the refuse throughout the day. As a rule he found that the last load of the day to come in was of very moderate value and decidedly odoriferous. The dust destructor was not a nice neighbour, and the only way to prevent dust, etc., leaking through and affecting the electrical machinery was to erect an enormous wall. He did not think it fair to take the coal consumption on light load and make that the basis for calculating the value of refuse burnt at peak time. He thought the calculations of the author, based on the prophecy of Dr. Geo. Forbes, referred to in the above abstract, were over-sanguine, as witness Montreal, where the figures were quite out of proportion to those mentioned above.

Mr. Newton Russell congratulated the author upon his paper, which must have involved a great amount of work. In regard to the statement that at Shoreditch "dampers are provided between the destructor and boiler furnaces to cut off the former when not in use," the great heat had caused the dampers to burn out in a very few weeks, and the construction of the cells would not allow of their being replaced, so that the operations had been carried out under disadvantageous circumstances. In reference to the author's tables, Mr. Russell pointed out that the value of the refuse does not altogether depend upon its calorific value, but has to be coupled with the efficiency of the electrical generating plant. For instance, at Fulham he understood that it required 50lb. to 60lb. of steam to generate one unit of electricity, while at Hackney (one of the most modern stations) it only required 27lb. to 31lb. Mr. Russell thought the author had scarcely given sufficient consideration to the extra land required when dust destructor works were added to the plant. This extra land in London districts represented a heavy figure. He quite approved of the author's views in regard to separate accounts for the two departments, though this was not quite practicable in the case of Shoreditch, because the steam was used for other purposes as well as for generating electricity. Mr. Russell stated that as the result of experiments he had conducted he was convinced that the maximum heat was not obtained from the refuse by the present practice, and that it could be burned down to a considerably lower point; in fact, he had found it melt itself and run out like slack in an iron furnace.

Mr. L. L. Robinson advocated very low prices for power, so as to encourage a large day load in preference to putting in a big battery. He concurred with the author in regard to separate accounts, of which a special point was made at Hackney. The lax method of keeping accounts greatly impaired the value of the author's comparative tables. The coal bill at Hackney was lower than at any other of the works dealt with, this being attributable to triple-expansion engines, superheat, condensers, automatic stokers, and electrically-driven auxiliaries. He dissented from the author's statement that a refuse destructor means a saving of labour to the electricity works. This had certainly not been the experience at Hackney. The author was too sanguine about the disposal of clinker, which was becoming a greater glut in the market than ever. He deprecated on hygienic grounds the author's suggestion that money should be made by letting people pick over the refuse. Considerable trouble arose in the electricity works from the dust creeping into the engine-house, etc. He was not much in favour of running the refuse to the last ounce; he would rather keep "a little in hand." The author had treated the Hackney works unfairly by giving the costs per ton destroyed an undue load of capital charges.

NEW YORK CENTRAL TRIALS.

For the purpose of experimenting with their electric locomotives, the New York Central Railroad Company and the General Electric Company are equipping a six-mile track from Schenectady to Hoffmans for testing purposes. Power is supplied from the generating station at Schenectady at 11,000 volts, which is transformed down to 460 volts at the Wyatts sub-station, five miles distant, the conditions corresponding as nearly as possible with those to be met in actual practice. As the track is not yet finished no complete tests have been made, but some preliminary runs have been carried out for the electric traction commission of the company. The two first diagrams give speed, current input, and voltage at the locomotive, all on a time basis, with an eight-car train weighing 336 tons and a four-car train weighing 170 tons, both exclusive of locomotive. The total weight of train, including locomotive and passengers, was 431 tons, and 265 tons for the eight-car and four-car trains respectively. Two sets of starting tests are illustrated (Fig. 3),

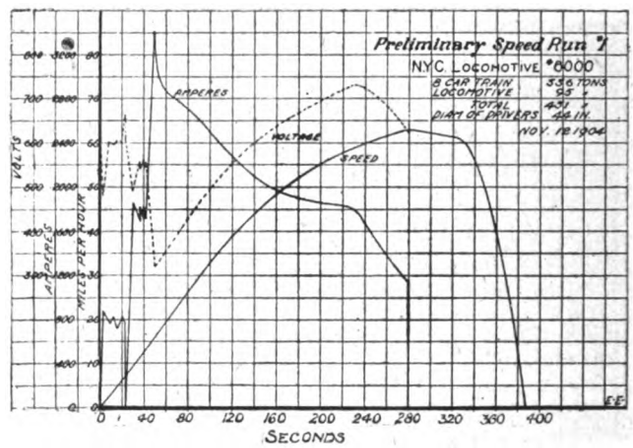

FIG 1.

showing the more rapid rate of acceleration possible with the higher maintained voltage available near the sub-station. The speeds reached were 63 miles per hour with an eight-car train and 72 miles per hour with a four-car train—the maxima obtainable on the length of track available. It

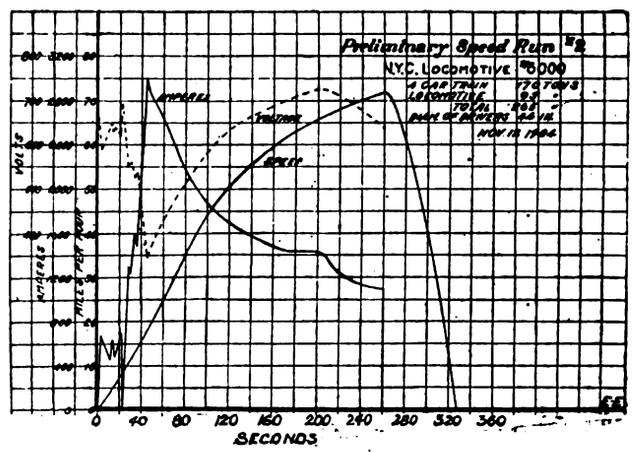

FIG. 2.

will be noted that the trains were still accelerating at these speeds, but the length of track so far equipped did not permit attaining higher speeds. The New York Central locomotives are not designed for abnormally high speeds at intervals, but rather to obtain a high average

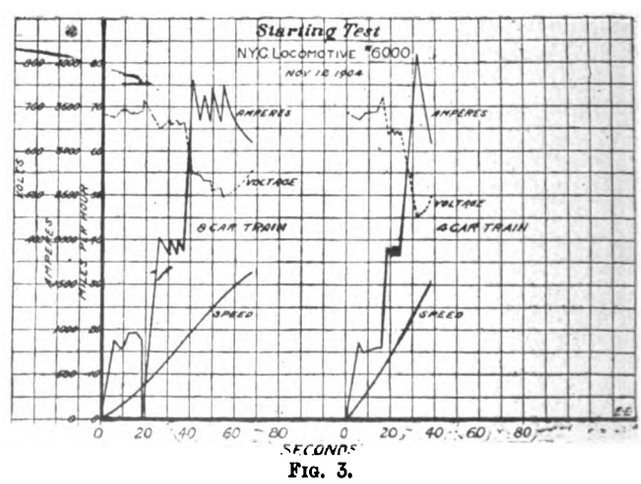

FIG. 3.

schedule, due to their ability to accelerate more rapidly than is possible with the present steam locomotives. In the starting tests a speed of 30 miles per hour was reached in 60 seconds with an eight-car train weighing, including the locomotive, 431 tons, corresponding to an

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acceleration of one-half mile per hour per second. During certain periods of the acceleration the increase in speed amounted to 0·6 mile per hour per second, calling for a tractive effort of approximately 27,000lb. developed at the rim of the locomotive drivers. This value was somewhat exceeded with the four-car train, where a momentary input of 4,200 amperes developed a tractive effort of 31,000lb. at the drivers, with a coefficient of traction of 22 5 per cent. of weight on drivers. The average rate of acceleration with the four-car train, weighing, including the locomotive, 265 tons, was 30 miles in 37½ seconds, or 0·8 mile per hour per second, calling for an average tractive effort of 22,000lb. The maximum input recorded, 4,200 amperes at 460 volts, or 1,935 kw., gives an output of the motors of 2,200 h.p. available at the wheel. With 4,200 amperes and a maintained potential of 600 volts there would have been an input to the locomotive of 2,520 kw., corresponding to 2,870 h p. output of the motors. This output is secured without in any way exceeding the safe commutation limit of the motors and with a coefficient of traction of only 22·5 per cent. of the weight upon the drivers, thus placing this electric locomotive in advance of any steam locomotive yet built. No service capacity temperature runs have been made as yet, and the preliminary tests have not

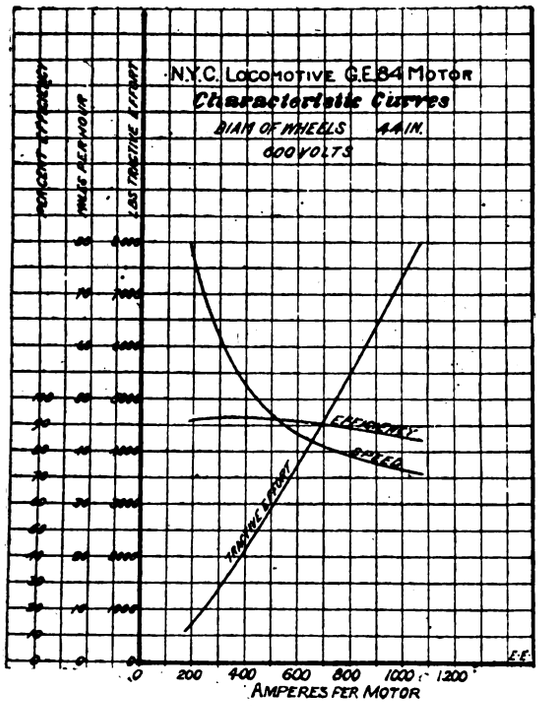

FIG. 4.

shown any appreciable warming up of the motors sufficiently to take thermometer readings. Throughout both the starting and running tests the electric locomotive shows its remarkable steadiness in running, a distinct contrast in this respect to the steam locomotive, especially should the latter be forced to perform the work here shown to be accomplished by the electric locomotive. The elimination of gear and bearing losses permits of a very high efficiency of the locomotive. Reference to the motor characteristics (Fig. 4) shows a maximum efficiency of approximately 93 per cent., this value being some 4 per cent. better than possible with motors of the geared type. This gain is especially noticeable at high speeds, the efficiency curve remaining above 90 per cent. even at the free running speed of the locomotive alone.

STEAM-PIPES.

BY F. H. DAVIES.

The steady increase in steam pressures that has taken place during the last few decades has naturally altered ideas and practice in steam-pipe work to a considerable extent, and has resulted, among other things, in investigations of the behaviour of steam under various conditions of restriction and flow, and in recognition of the importance of sundry details of pipework that formerly were deemed of small consequence.

The economic and other laws that govern the efficient conduction of steam are, of course, well known, being on the whole very similar to those that apply to fluids. Of these, one of the most important from the point of view of design is that relating to the maximum permissible velocity of flow of steam in pipes, which has been laid down by different authorities as varying from 6,000ft. to 8,000ft. per minute. Experience, however, shows that such hard-and-fast statements cannot be accepted as finite, and that, with all due regard to economy, under certain conditions these amounts may be safely exceeded, as under other conditions they must not be approached. The percentage of allowable drop, diameter of pipe, and pressure of steam all have a bearing upon this question; and as the two latter, at any rate, vary very considerably in steam installations, it is obvious that any attempt to specify a finite and all-round figure must be futile. The lower the pressure of steam, the greater is the permissible velocity of flow with a given percentage of loss of pressure per unit of length, the reason, of course, being that reduced pressure results in reduced friction against the pipe. The figures in Table A are the mean of those deduced by various authorities from the behaviour of fluids in pipes, and show the approximate maximum velocity of steam at various absolute pressures in pipes of sundry diameters with a loss of 1lb. pressure per 100ft. of length—a useful and convenient figure upon which to base a comparison, and a usual one in practice.

TABLE A.

Absolute pres., lbs. per sq. in.	Velocity of steam in feet per minute.							
2	12,000	17,500	24,000	29,000	34,000	38,000	42,000	61,000
20	4,000	6,000	8,000	10,000	12,000	13,000	14,000	17,000
150	1,600	2,300	3,100	4,000	4,700	5,400	5,800	6,500
200	1,400	2,000	2,600	3,200	3,800	4,200	4,500	5,000
Diam. of pipe..	1in.	2in.	4in.	6in.	8in.	10in.	12in.	18in.

The question of the diameter of steam and exhaust pipes for different horse-powers is one that has received a great deal of attention, and the general consensus of opinion appears to be that in the case of the former it is preferable for the pipe to be too small than too large, upon the score that the larger the pipe the greater its cost and that of its covering, and the amount of loss occasioned by condensation. The only argument for pipes of ample proportions is that the fall of pressure in them is negligible; but this cannot stand against the above disadvantages, besides which the pressure drop due to friction must not be entirely regarded as a loss, as the steam is to a certain extent superheated thereby, always a desirability even in a small degree. Exhaust pipes, upon the other hand, it is most important should be of ample dimensions, as back pressure, that will naturally decrease with the size, is a great source of lost energy acting under most favourable conditions for itself—namely, during the full length of the stroke, and on the engine piston of largest area. The increased cost with diameter of exhaust piping is not a matter of much consequence, and, at any rate, will be paid for over again in the saving effected by reduced back pressure.

A loss in steam-mains that is little appreciated is that which arises when several engines fed from one main pipe take their steam at the same instant of time. The result of such an event, which must be of frequent occurrence, is a momentary very large flow of steam in the pipe far beyond that which it was designed for, and a consequent drop of pressure by friction in excess of anything that would be tolerated in the usual way. The duration of the loss is, of course, very small, but seeing that it must recur with great frequency under ordinary conditions, it is one that is worth considering. A steam receiver placed at each engine, or perhaps at intervals in the main pipe, has long been advocated as a means of reducing this extra friction. Such an arrangement by providing a local reserve of steam that may be drawn upon in like cases to the above, not only helps to stop injurious vibration, but also saves much of the friction loss, and, as has been

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proved, allows a smaller diameter of pipe to be used, thus compensating to a great extent for the extra condensation losses in the receiver. For best results it has been stated that the latter should have a capacity approximately of 50 times that of its engine's high pressure cylinder up to the point of cut off—an ample allowance, but apparently one that has been justified by the results obtained in practice. The usual system of installing separators at each engine is a step in the right direction, as these, besides performing their duty as steam driers, also act as small reservoirs, and tend to equalise the flow of steam in the pipe, although from the latter point of view they might be enlarged with advantage.

The question of the most suitable material for the construction of steam-pipes is one that in its time has given rise to much discussion, happily now terminated in the general admission that steel is far and away the best and safest metal for all-round purposes. Advocacy of copper has been based upon the fact that it is ductile and tough, and that it will to a great extent compensate for expansion within itself. It was adopted in marine work because its ductility allows it to bend freely with the straining of the ship without risk of fracture. These are in themselves undoubted advantages, but, on the other hand, copper pipes possess so many inherent defects, varying with the manner in which they are constructed, that their use with high-pressure steam is only advisable in most exceptional cases. The earliest copper pipes were built up of thin sheeting with a longitudinal brazed seam, the flanges also being brazed on. This method, however, introduces a very serious weakness, serious chiefly because it is one that takes time to come out. It has been found that though new brazed pipes will stand their hydraulic test perfectly and give every indication of reliability, the effect of heat and vibration is very deleterious to the brazing in time, depreciating it to such an extent that rupture along the seam may be anticipated ultimately almost with certainty. The solder used for this work consists of copper and zinc in approximately equal proportions, and as long as these proportions remain unaltered, the brazing may be regarded as sound and equal in strength to the pipe. It is found, however, that under the influence of high temperature and chemical action in time the greater part of the zinc disappears, only a little remaining in the shape of an oxide, with the consequence that the joint then depends solely for its holding upon a very cellular and brittle structure of copper, which is quite unsuitable for the purpose. This has been proved by chemical analysis of old brazing, and amply demonstrates that grave risks are incurred by the use of such piping. Up to diameters of 8in. or so it is now usual practice to make copper pipes seamless either electrically or by solid drawing. This certainly represents a considerable advance over the old method above referred to, but there are still salient objections that cannot be overlooked. As stated, the chief argument in favour of copper pipe is that its ductility allows the pipe itself to take up expansion and contraction, but this very quality is also greatly its undoing, since the repeated bending and straining that the pipe is subjected to in the processes hardens the metal very considerably by the flanges, with the result that it becomes brittle and loses the ductility that was the excuse for its adoption. When it has reached this stage, external vibration, such as may be occasioned by racing or water-hammer, is apt to result in radial cracking by the flanges, and that most fatal of all disasters—a burst steam-pipe.

From the various methods of reinforcement of copper pipes in use it is evident that those responsible for their installation are by no means over-confident as to their ability to stand severe strains when under the influence of high-pressure steam. A brazed copper pipe always gives out at the seam, and no matter how small the original opening may be, it will extend with increasing rapidity until it reaches the flanges each way. In order to confine such rips within less dangerous limits, various methods of reinforcement have been adopted; steel bands have been shrunk on or fixed in two halves by cotters at short intervals, varying with the size of the pipe and steam pressure; but it has been found that these, unless very closely spaced, actually weaken the pipe instead of strengthening it, and, in addition, they add considerably to radiation losses by increasing the surface. Another method is that in which a spiral copper band is wound round the pipe and brazed to it in order to equalise the strain, the ends being attached to the flanges by special means. The wire-wound pipe, such as is used in the navy, seems, however, the best of the bunch, as it is undoubtedly stronger, and being more closely applied cannot allow a burst to spread any distance. As a rule, two or more independent wires are used, so that in the event of one breaking, the other will still hold the pipe together. The wire is of copper or delta metal, wound on at a tension of 1½ tons per square inch, and is alone capable of withstanding the maximum pressure independently of the strength of the pipe.

While such methods may be effective, they cannot be deemed truly satisfactory in every sense, for besides adding largely to the prime cost and increasing the radiating surface, they are not always reliable, as experience has proved. Whatever excuse there may be for the use of copper pipes—reinforced or otherwise—at sea, there is none for them on land; and seeing that legally a steam-pipe now comes under the same heading as a boiler, and that engineers and managers are held responsible for any injury to life or limb that may occur through negligence in their upkeep, there is every advantage to be gained and nothing to lose by the complete abolition of copper pipe for high pressure or, perhaps, any steam work. However much opinion may differ with regard to this, there is unanimous agreement—in this country at least—that cast iron should be rigidly excluded from high-pressure pipework: 100lb. per square inch is the maximum pressure it should be used at, and even this is not desirable. The many bad accidents that have occurred with cast-iron elbows and T-pieces, owing to their brittleness and low elastic limit, have demonstrated the utter unsuitability of this metal for anything but low-pressure pipework, with the consequence that, copper being excluded by its expense and unreliability, engineers have turned to wrought iron and steel as the most suitable materials for use in connection with modern high pressures. Such pipes are usually either solid-drawn or lap-welded, sometimes in the latter case being strengthened by a reinforcement piece running longitudinally along the seam. Solid-drawn pipes are preferable, but welding makes a thoroughly sound job, and in ordinary cases does not need the above reinforcement strip, which introduces the possibility of leakage at the rivets. For 150lb. pressure, ¼in. is the usual thickness, and the hydraulic test generally specified is 350lb. per square inch

Steel and iron pipes having a lower coefficient of expansion than copper, require special expansion bends or joints where the range is of any length. In the interests of draining the first are best placed horizontally, and should be as thin as is compatible with safety in order to facilitate bending. Where expansion joints are used, it is essential that the pipes should be thoroughly anchored, and the joint, therefore, forced to take up variations in length. If this is not done, it is quite possible that the special piece moving hard on its gland may throw the work on the flange joints, and so cause the leakage and strains that it was installed to prevent. The adjustment of these joints is a delicate matter, and forms the chief objection to their use, it being difficult to hit the point where leakage at the stuffing box is reduced to a minimum and free movement is not interfered with. A bunch of small pipes in parallel inserted at intervals in the main range has been effectively used for taking up expansion, but the increased number of joints that this system necessitates is a drawback, besides the difficulty in covering. On the whole, the horizontally placed bend has given the greatest satisfaction, being, if properly designed, certain in its action and perfectly safe.

The flange of mild-steel and malleable iron pipes are made of the same materials stamped out of the solid, and are usually provided with strengthening collars. Up to 6in. diameter it is general practice to fix them on the pipe when hot by means of a fine thread, expanding, caulking, and brazing being used as additional safeguards. Over this diameter they are generally riveted, holes being drilled radially to the centre of the pipe after the flange is in position, the burrs removed, and the rivets driven by hydraulic pressure. The best practice always provides for an

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accurately faced strip for jointing purposes, standing out $\frac{1}{16}$in. or $\frac{1}{8}$in. from the flange, and level with the end of the pipe. With screwed flanges, especially if the thread employed is coarse, there is always a possibility of leakage between the flange and the pipe, and the best way to obviate this is to make the joint upon the end of the pipe as well as on the flange, and not wholly on the latter. With small pipes it is not as important or as easy a matter to do this, and consequently accurate facing all over of the flange is the method employed, but with larger diameters the pulling up so distorts the flanges as to render the greater part of their surfaces useless for the prevention of leakage, which has to be guarded against by the narrower joint nearer the pipe where the strains do not take effect.

With well-erected pipes and good facing strips a soft copper ring makes an excellent joint, but is rather difficult to fix accurately in position. The corrugated brass ring smeared with mastic cement is easy to apply, and makes an equally good joint, and its use may be said to be almost universal for both high and low pressure work. Owing to the distortion that takes place in flanges by the pulling up of the bolts, it is most necessary that the bolt circle should be as small as possible; putting aside the enhanced difficulties of jointing, the more a flange is distorted the greater is the risk of its giving out. With a small bolt circle—that is, one that only just allows room for the bolt-heads and nuts—the leverage of the power that tends to pull the flange out of its plane is reduced, while at the same time the pressure on the jointing material is exactly the same; thus a small circle represents the best possible conditions obtainable. British and American standard practice in flanges is contrasted in Table B.

TABLE B.

Bore. In.	British. Dia. of flange. In.	British. Dia. of bolt circle. In.	British. No. of bolts.	British. Size of bolts. In.	American. Dia. of flange. In.	American. Dia. of bolt circle. In.	American. No. of bolts.	American. Size of bolts. In.
2	7	5½	6	⅝	6½	5	4	⅝
2½	7½	6	6	⅝	7½	5⅞	4	¾
3	8¼	6¾	6	¾	8¼	6½	8	⅝
3½	9	7¼	6	¾	9	7¼	8	⅝
4	10	8¼	8	¾	10	7⅞	8	¾
5	11	9	8	¾	11	9¼	8	¾
6	12	10	8	¾	12½	10⅝	12	¾
7	14	11¾	12	¾	14	11¾	12	⅞
8	14	12¼	12	¾	15	13	12	⅞
9	15	13¼	12	¾	16	14	12	⅞
10	17	14¾	12	⅞	17½	15¼	16	⅞
12	19½	17¼	12	⅞	20	17¾	16	⅞

It will be noticed that in American practice the number of bolts employed is always a multiple of four, whereas in England the six-bolted flange is a very popular one in medium sizes. The English bolt circle is smaller in large pipes than the American, but the reverse in small sizes, and the diameter of the bolts varies in much the same way.

TELEPHONE RATES AND GOVERNMENT PURCHASE.

The following is a statement on the above subject prepared by Mr. A. R. Bennett, dated December, and addressed somewhat widely—*i.e.*, "to local authorities, chambers of commerce, trade associations, and others interested in the provision of a good and cheap telephone service":

The following is a statement, compiled from published rate lists and advertisements, of the National Telephone Company's tariffs in towns where competition exists or has existed. The most noteworthy points are the £5 per annum exclusive line, with unlimited number of calls, for private houses at Hull, and the suppression of the £10 and £8 10s. unlimited rates at Portsmouth and Swansea. Where corporation competing exchanges exist their tariffs are also given.

Many of the tariffs have been in operation for years—that at Sheffield for about 12 years, and those at Glasgow, Tunbridge Wells, and Portsmouth for from two to three years—and they are still vigorously pushed. They cannot, therefore, be taken as experimental rates, but rather as representing what are remunerative rates to the company, and what British cities and towns can be telephoned for. There is danger that the Post Office in carrying out the contemplated purchase of the telephones may pay such a price as to make any cheapening of telephony in the United Kingdom impracticable, thereby placing British manufacturers and traders permanently at a disadvantage as compared with their competitors in foreign countries, where cheap telephone rates prevail. They are already so in respect to telephone trunk-line rates, as those charged by the British Post Office have no parallel elsewhere in Europe. Foreigners are also free from the terminal charges which the National Telephone Company is permitted to impose on trunk messages exchanged between its subscribers and those of the Post Office and corporations.

At different times the Corporations of Hull and Eastbourne have negotiated for the purchase of the company's system in their respective areas, but both found that the price demanded for the old plant was about three times the cost of an entirely new exchange. Purchase on such terms was out of the question, as it would have precluded the possibility of giving their burgesses lower rates. It is unlikely that the company will sell to the Post Office except on some such favourable terms: it can scarcely ask its shareholders to write off a proportion of their holdings, and as many have bought into the company at 106-8 for the purpose of making a profit out of the anticipated sale, it is improbable that they would agree even if asked. Consequently, there is a likelihood of the Post Office recommending Parliament to buy at a price that would burden the public with high rates in perpetuity. It is true that a select committee has been promised, but no terms of reference have been mentioned, and it is by no means certain that it is intended that the committee shall take evidence and sift matters to the bottom.

It therefore behoves local authorities, chambers of commerce, trade associations, and kindred bodies throughout the kingdom to take concerted action to impress upon the Government that any purchase of the telephones would be useless unless it could be arranged beforehand to ensure that the low rates proved to be practical by the corporations and by the company itself, as demonstrated by its published tariffs, can be made universally applicable. It would be suicidal to agree to a price without ascertaining definitely what scale of rates that price would render practicable. The Post Office makes a recurring loss on the telephone business which it at present conducts. The Treasury after a purchase would certainly insist on rates that would produce a profit on the purchase price, and so, unless foresight be exercised, telephone users may have their rates raised instead of reduced. Further, if no purchase takes place, it should be made a condition of any prolongation of the company's license which may be granted in any part of the kingdom, that the reduced rates now in force at Glasgow, Hull, etc., be brought into immediate use universally and permanently.

A secondary point for consideration and investigation is why the company's telephone charges differ so materially in different places. Why should it charge so much lower in Glasgow than in Huddersfield, in Hull than in Edinburgh, in Portsmouth and Brighton than in Southampton and Ramsgate, and in Swansea than in Cardiff?

It is remarkable that no distance limit is imposed on any of the rates, low as they are, except at Sheffield and Tunbridge Wells. This is another inequality between competitive and non-competitive towns which calls for redress.

Wherever there is competition, too, the company reorganises its system, modernises its apparatus, and spares no expense to meet its subscribers' wishes. It opens public telephone call offices everywhere. In Glasgow it now has over 1,000 such offices, whereas before the competition there were only some dozen or so.

It should be understood that the corporation tariffs are remunerative. In no cases are corporation exchanges being run at a loss, while they continue to grow in spite of all opposition.

A. R. BENNETT.

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Particulars of Telephone Charges.

Glasgow Telephone Area (Population, 1,000,000).

National Telephone Company.

1. Exclusive Line.—Unlimited use, £10 a year first connection. Second connection, £8. 10s. a year.
2. Two-Party Line.—Unlimited use, £6 a year.
3. Exclusive Line.—Measured service, £5 a year, 600 calls. Excess calls 1d. each, or 300 for £1.
4. Four-Party Line.—Unlimited use, £4 a year.
5. Ten-Party Line.—No installation charge, subscriber to guarantee 2d. a day (payment for two calls). Extra calls, 1d. each.
6. Omnibus Line.—25s. a year for 600 outward calls. Excess calls, ½d. each.
7. Special Exclusive Line for private houses, £5 for 1,500 calls. Excess calls, 1d. each.
8. Extension Station in the same building as the main station.—On a message rate line, 15s. a year. On a flat rate line, £1 a year. Special terms to large users. All inward calls are free.

Corporation.

Exclusive Line.—Unlimited use, £5. 5s. per annum.
Toll Service.—Exclusive line £3. 10s. per annum and 1d. for each outward call.
Two-Party Line.—Unlimited use, £4. 4s. per annum.
Four-Party Line.—Unlimited use, £3. 3s. per annum.
All inward calls are free.

Hull Telephone Area (Population, 300,000).

National Telephone Company.

Exclusive Line.—Unlimited service, first connection, £10 per annum. Second connection, £8. 10s. per annum.
Private houses, £5 per annum. Exclusive line, unlimited service.
Rates for large users:
10 or more exchange lines, £7 per line per annum.
15 or more exchange lines, £5. 10s. per line per annum.
Line to be used for trunk-line connections only, £5 per annum.
Exclusive Line.—Measured service:

600	messages,	£5 per annum.
1,100	,,	£6 ,,
1,600	,,	£7 ,,
2,100	,,	£8 ,,
2,600	,,	£9 ,,

Extra messages, 1d. each.
Message rate service, £3 per annum and 1d. per message.
Two-Party Line.—No installation charge, subscriber to guarantee 4d. per day (payment for four messages). Extra messages, 1d. each, or Unlimited service. £5 per annum.
Four-Party Line.—Unlimited service, £4 per annum.
Ten-Party Line.—No installation charge, subscriber to guarantee 2d. per day (payment for two messages). Extra messages, 1d. each.
Omnibus Line.—25s. per annum for 600 messages. Extra messages, ½d. each.
Extension Lines.—Extension station in the same building as the main station. On a message rate line, 15s. a year. On a flat rate line, £1 a year.
All inward calls on all services are free.

Corporation.

Exclusive Line.—Unlimited use:
For business premises, £6. 6s. per annum.
For business premises (second connection), £5. 15s. per annum.
For private houses, £5 per annum.
Toll Service.—Exclusive line, £3 per annum and 1d. per outward call.
All inward calls are free.

Portsmouth Telephone Area (Population, 250,000).

National Telephone Company.

No mention is made of any £10 or £8. 10s. unlimited rate.
1. Exclusive Line.—Measured service:

£5	0	0	a year providing	1,800	messages.
£5	10	0	,, ,,	2,500	,,
£6	0	0	,, ,,	3,000	,,
£7	0	0	,, ,,	3,500	,,
£8	0	0	,, ,,	4,200	,,
£9	0	0	,, ,,	5,000	,,

Extra messages, ½d. each.
2. Exclusive Line.—Message rate, £3. 10s. a year, and ½d. a message.
3. Two-Party Line.—Unlimited use, £3 a year.
4. Ten-Party Line.—No rental. Subscriber to guarantee to originate on an average 1d. call a day.

Corporation.

Exclusive Line.—Unlimited use, £5. 17s. 6d. per annum.
Exclusive Line.—Unlimited use, second connection, £5. 5s. per annum.
Exclusive Line.—Toll tariffs:
1. £3 10 0 per annum, with ½d. for each outward call.
2. £2 10 0 per annum, with 1d. for each outward call.
3. £5 0 0 per annum to cover 1,800 outward calls. Extra calls, ½d. each.

All inward calls are free.

Tunbridge Wells Telephone Area (Population, 70,000).

National Telephone Company.

Exclusive Line.—Unlimited service, £6 per annum.
Message Rate.—£3. 10s. per annum, and 1d. per outward call. Subscribers to guarantee a minimum payment of 30s. per annum, and to deposit that amount as security.
Ten-Party Line.—No annual payment. Outward calls, 1d. each. Subscriber to guarantee a minimum of 2d. per day. Money collected in slot machine.
Two-Party Line.—Same as ten-party line, but subscriber must guaran a minimum of 4d. per day.
All inward calls are free.

Foregoing rates for exclusive lines apply to one mile from the exchange only, and in the case of party lines to 220 yards from a main circuit.

The low rates in the Tunbridge Wells area were brought about by the establishment of a municipal telephone exchange, which, after being in successful operation and paying its way for a few months, was sold to the National Telephone Company. While the Corporation obtained several thousand pounds more than their exchange had cost, and secured permanent and substantial reductions on the tariffs which had prevailed prior to competition, it is obvious from an inspection of the present National Telephone Company charges that the Tunbridge Wells people are far worse off, both as regards tariffs and restrictions, than those of Glasgow, Portsmouth, Brighton, and the other places which have kept their own exchanges.

Brighton Telephone Area (Population, 185,000).

National Telephone Company.

Exclusive Line.—Unlimited service, first connection, £10 per annum. Second and additional connections, £8. 10s. per annum.
Exclusive Line.—Limited service, £3. 10s. per annum, plus ½d. per call.
Exclusive Line.—Measured service:

£5	0	0	per annum with	1,600	free calls.
£5	10	0	,, ,,	2,500	,,
£6	0	0	,, ,,	3,000	,,
£7	0	0	,, ,,	3,500	,,
£8	0	0	,, ,,	4,200	,,
£9	0	0	,, ,,	5,000	,,

Additional calls, ½d. each.
Two-Party Line.—£3 per annum, with unlimited service.
Ten-Party Line.—No installation charge. Subscriber to guarantee 1d. per day (payment for one local call).
Omnibus Line.—25s. per annum for 600 calls. Extra calls, ½d. each.
All inward calls are free.

Corporation.

Exclusive Line.—Unlimited use. £5. 10s. per annum.
Exclusive Line.—Toll service, £3. 10s. per annum, with 1d. for each outward call.
Party Lines:
Two-party, unlimited use, £4. 4s. per annum.
Four-party ,, ,, £3 ,,
All inward calls are free.

Swansea Telephone Area (Population, 150,000).

National Telephone Company.

No mention is made of any £10 or £8. 10s. unlimited rate.
Exclusive Line.—Measured service:

1,800	messages	£5	0	0 a year.
2,500	,,	5	10	0 ,,
3,000	,,	6	0	0 ,,
3,500	,,	7	0	0 ,,

½d. for each additional outward message.
Exclusive Line.—Message rate, £3. 10s. a year, and ½d. per message.
Two-Party Line.—Unlimited use, £3 a year.
Ten-Party Line.—Subscribers to guarantee 1d. per day (payment for one message). Extra messages, 1d. each.
Omnibus Line.—600 messages, £1. 5s. a year. Extra messages, ½d. each.
All inward calls are free.

Corporation.

Exclusive Line.—Unlimited use, £5 per annum.
Exclusive Line—Toll tariff, £3 per annum, with 1d. for each outward call.
All inward calls are free.

Sheffield, City and Suburbs (Population, 427,000).

National Telephone Company.

Business premises within 1½ miles of an exchange, £8 per annum.
Business premises within two miles of an exchange, £10 per annum.
Private houses not exceeding two miles from an exchange, £7 per annum.

The low charges in Sheffield were brought about by the threatened competition of the New Telephone Company in 1892. A committee of Sheffield citizens was formed to arrange for such competition, to avoid which the National Telephone Company agreed to introduce and permanently maintain the tariff as noted.

Guernsey (Population, 40,300).

National Telephone Company.

The company has no exchanges in Guernsey. In order to start one it asked £10 per line per annum, with extras for distances beyond one mile; when the local authority threatened to undertake the telephoning of the island themselves the £10 was reduced to £8. When it became apparent that the local authority were in earnest this £8 was further reduced to £6, with other concessions thrown in, but the States declined to be turned from their purpose, although the last offer would probably have been accepted had it been made in the first instance.

States (Local Authority).

The States established their exchange in 1898, and it is now scoor ingly in its seventh year of working. The following are the tariffs, which yield a satisfactory profit. All lines are direct to the exchange and exclusive.
1. £5 per annum to cover 4,000 outward calls; additional calls, five for 1d.
2. £2. 10s. per annum and ½d. for each outward call up to 1,520; additional calls, five for 1d.

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3. £1. 10s. per annum and 1d. for each outward call up to 1,000; additional calls, five for 1d.
All inward calls are free.

TRADE NOTICES AND NOVELTIES.

Electrical Apparatus.

Several fine examples of switchboard work are illustrated in the latest catalogue issued by Messrs. Dorman and Smith, Ordsal Electrical Works, Salford, Manchester, besides some up-to-date specialities shown now for the first time. Liquid controllers are listed for reversing series or compound wound crane motors, etc., and also non-reversible controllers for starting motors in the ordinary way. We illustrate herewith (Fig. 1) one of the non-reversing pattern. The principal feature

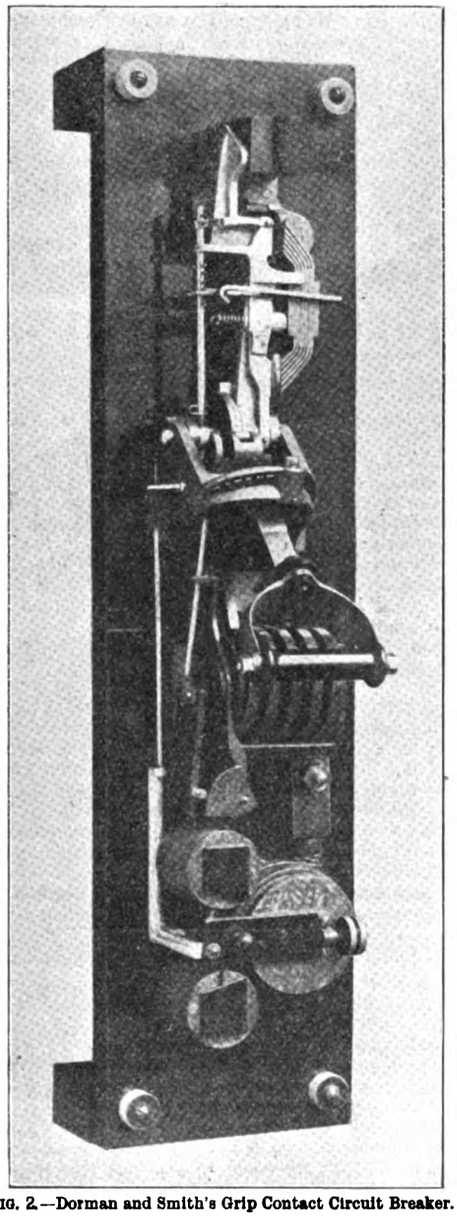

FIG. 2.—Dorman and Smith's Grip Contact Circuit Breaker.

carried out in this liquid motor starter is the provision of ample area of plate and an efficient short-circuiting switch for when the plate is fully immersed. Moreover, great care has been taken to secure perfect insulation, the chief cause of trouble met with in using this class of apparatus being thus eliminated. Our next illustration (Fig. 2) shows one of the firm's patent "grip-contact" circuit breakers. This is a combined overload and reverse-current circuit breaker for direct current. The edgewise construction and very substantial design of the controlling gear will be noted. Messrs. Dorman and Smith have always made the controlling device of their circuit breakers with a large reserve of power. This they claim is the principal reason why these breakers are so free from the defects of failure to act. Fig. 3 shows the firm's double-pole "Baffle" type of house service fuse. The fuse contacts are disconnected when the lid is opened, and the fuse can thus be replaced while the contacts are depolarised. The fuse itself passes over a baffle plate provided with an asbestos pad which effectually prevents arcing between the terminals when the fuse blows. The live terminal, which is the lower one shown in the illustration, is quite cut off from the fuse itself. These fuses are made with self-contained ceiling boxes, or with sepa-

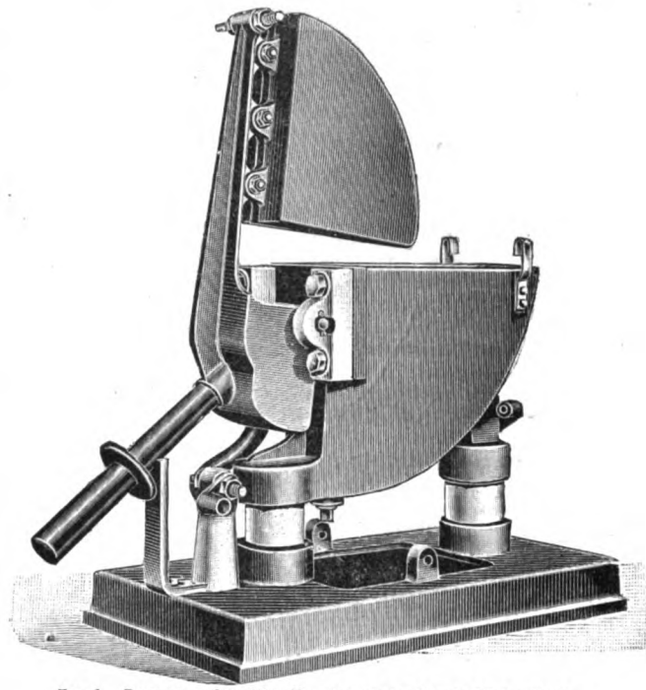

FIG. 1.—Dorman and Smith's Non-Reversible Liquid Motor Starter.

rate ceiling boxes as required. Altogether, their design seems admirable. From the large range of fittings listed in the latter portion of the catalogue we select one of the mill fittings (Fig. 4) as an example. These fittings have been designed

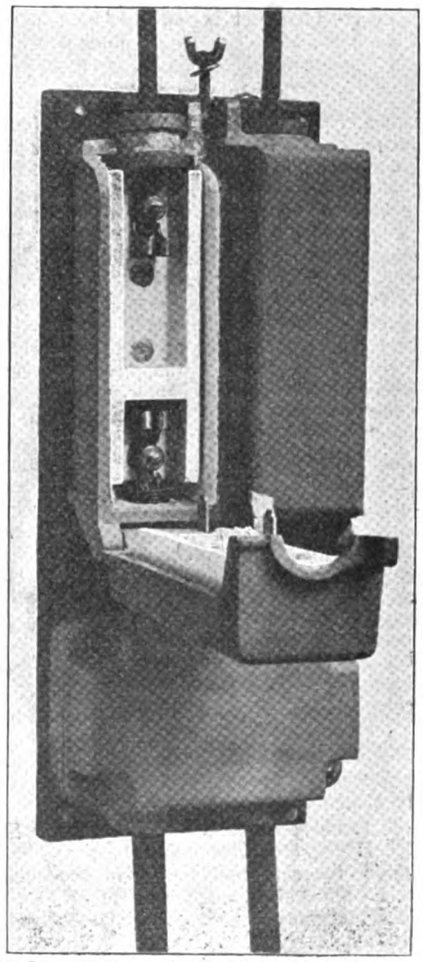

FIG. 3.—Dorman and Smith's Double-Pole Baffle Fuse.

to be interchangeable with the patent conduit wiring ceiling roses, the same jointing box being used for either a ceiling rose or one of the mill fittings as may be required. The jointing boxes are constructed for any make of conduit, and for one, two, three, or four ways.

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Among the further contents we notice improved chopper switches and various replacement fuses, which can be supplied either mounted or unmounted for the use of switchboard makers; improved ceiling plate and other accessories for nexpensive pipe wiring; iron-cased switch and fuse gear, and

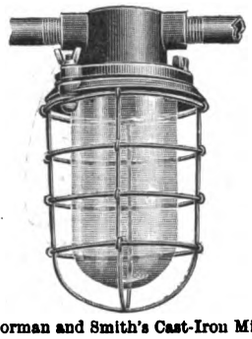
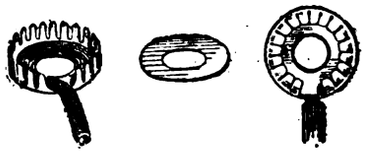


FIG. 4.—Dorman and Smith's Cast-Iron Mill Fitting.

a new small-size porcelain tumbler switch. Incidentally, it may be mentioned that improved facilities for production and increased output have enabled Messrs. Dorman and Smith to make substantial reductions in their prices, while at the same time maintaining the high quality of their manufactures.

Terminals.

Messrs. Ross, Courtney, and Co., Limited, Ashbrook-road, Upper Holloway, London, N., have sent us a sample box of their new patent terminals for small wires. The accompanying illustration shows the principle involved. The end of the



wire is looped into the terminal, a washer laid on the top, and the serrated edges of the terminal then pressed down with the fingers. Thus a good contact is made without destroying the flexibility of the wire, while the use of pliers or other tools for the job is unnecessary.

Catalogues, etc.

MOTORS FOR INTERMITTENT SERVICE.—The Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., have sent us a copy of their list No. 20, in two sections, A and B, dealing with continuous-current series-wound motors designed for intermittent service and for driving machines which only start under load, and which frequently require a reversal of their motions. The cases of these motors are divided horizontally in line with the shaft. The lower half is provided with cast-iron feet, and carries the oil-wells for ring lubrication, also the terminal block. Thus, by unbolting the top half of the motor case, it becomes possible to make a convenient and close inspection of the inner parts of the motor. Some useful advice on the selection of motors for various purposes is included in Section A of the list under notice, while Section B is composed for the most part of tabulated data.

SIEMENS ELECTRIC APPLIANCES.—From Siemens Electric Appliances, Limited, 61-62, Watling-street, London, E.C., we have two leaflets, the first of which deals with the firm's traction lamps, especially made for series burning, and the second with their economical turn-down lamps.

POLYPHASE GENERATORS. — Messrs. Mather and Platt, Limited, of Salford Ironworks, Manchester, and Queen Anne's-chambers, Westminster, S.W., have recently published a second edition of their list of standard generators for two-phase or three-phase currents. These generators are of the revolving-field type, and range in output from 75 to 1,500 kilovolt-amperes. Their design is based upon the considerable experience in the construction of alternating-current machines generally which Messrs. Mather and Platt, Limited, have had, and the careful study of requirements. For further particulars we must refer the reader to the list in question.

ELECTRIC MINING.—Messrs. John Davis and Son, of All Saints' Works, Derby, and Camomile-street-chambers, London, E.C., favoured us recently with a copy of the latest edition of their Section B catalogue, entitled electric mining. This publication deals largely with coal-cutting machines and other plant used in mines. Colliery fittings, mining bells, telephones, etc., are also listed.

AUTOMATIC BATTERY SWITCHES.—A leaflet which we have received from Ernest F. May, Limited, Greenland-place, Camden Town, London, N.W., describes the firm's automatic battery switch, type No. 67. This switch automatically closes the circuit when the E.M.F. of the dynamo exceeds that of the cells, and opens it in the event of the charging volts falling below the battery volts. It is enclosed in a neat enamelled cast-iron case, with a hinged front fitted with a glass panel, so that the action of the swich may be observed, being suitable for mounting on a main switchboard or fitting in a battery-room. Five sizes are listed, ranging in capacity from 30 to 150 amperes.

ACCESSORIES. — From the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., we have several new leaflets dealing respectively with high-voltage lamp-holders and adaptors; tumbler switches and wood blocks; Royal switches of different patterns, including change-over switches, switches in watertight cast-iron cases, and single-pole pear switches; H.V. wall sockets and plugs; ceiling roses and fuseboards. The same firm also send us a pamphlet describing their "Ideal" candle fitting.

Calendars, etc.

CALVERT'S MECHANICS' ALMANACK AND WORKSHOP COMPANION.—Forty-second year of publication. Wm. Calvert, Gordon-street, Old Trafford, Manchester.

UNITED STATES METALLIC PACKING COMPANY, LIMITED, Soho Works, Bradford.—An artistic bas-relief calendar.

WILLING'S PRESS GUIDE, 125, Strand, W.C., and 162, Piccadilly, W.—The thirty-second annual issue of this handy "Press Guide" is quite up to the excellent standard of its predecessors.

RHODES ELECTRIC MANUFACTURING COMPANY, LIMITED, 70 and 71, Bishopsgate-street Within, London, E.C.—A fantastic Christmas card.

LEGAL INTELLIGENCE.

THE CITY AND SOUTH LONDON RAILWAY COMPANY v. THE RECTOR AND CHURCHWARDENS OF THE UNITED PARISHES OF ST. MARY WOOLNOTH AND ST. MARY WOOLCHURCH HAW AND THE ECCLESIASTICAL COMMISSIONERS FOR ENGLAND.

This case came before the House of Lords on an appeal from an order of the Court of Appeal dated March 27, 1903, affirming an order made by Mr. Justice Wright on May 14, 1902, made upon an award stated in the form of a special case for the opinion of the Court by Robert Vigers, the arbitrator appointed therein. The question was the amount of purchase money or compensation payable by the appellants for certain land adjoining and annexed to the Church of St. Mary Woolnoth, and for an easement or right of using the subsoil, crypt, and foundations of the church which had been taken by the appellants.

The case was fully argued by counsel.

The **Lord Chancellor**, in moving that the appeal should be dismissed, said that the company had not paid for the value of the site, but had only been called upon to pay for that which they had actually obtained. The extra expenditure below the foundations of the church had been deducted from the sum which they had been called upon to pay. If in the future the church should be removed, there was no reason why the respondents should not be compensated for what was their own property. The Court of Appeal had dealt with the questions involved with perfect accuracy.

Lord Macnaghten, Lord Robertson, and **Lord Lindley** concurred.

THE DEPTFORD AND GREENWICH TRAMWAYS.

In the King's Bench Division on Wednesday, Mr. Justice Bray delivered judgment in the case of the London, Deptford, and Greenwich Tramways Company and the London County Council. The Council having given notice to acquire the London, Deptford, and Greenwich tramways, Mr. H. G. Harris was appointed referee by the Board of Trade to decide the value of the undertaking. During the arbitration a contention was raised by the company that the present value of the tramways was enhanced by reason of the company being freed from liability to contribute to the widening of some of the streets in which the tramways were laid. The referee held that the contention of the company was unfounded. The widenings had not, in fact, been made.

His Lordship said that to him it was a startling proposition that the Council should have to pay as part of the purchase money for an expenditure which had never been incurred. Admittedly, the claim was a novel one, and there was no authority to support it. He had come to the conclusion that the referee was right when he expressed the opinion that the contention of the company was wholly unfounded. The company's contention could not prevail, and therefore it was entitled to only £91,363. 7s. 6d., and not to the additional £22,773. 6s. 8d.

PERSONAL.

The partnership between Mr. Vincent S. Allpress, M.I.C.E., consulting electrical and mechanical engineer, and Mr. W. H. Massey has been dissolved by mutual consent. Mr. Allpress will continue to practice at 25, Queen Anne's-gate, Westminster.

Mr. H. H. Heayberd, late of Messrs. R. W. Blackwell and Co., has been appointed outside equipment assistant at the tramway power station, Osborne-street, Hull.

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COMPANIES' MEETINGS AND REPORTS

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The ordinary general meeting was held at the office, Cannon-street, Major Leonard Darwin presiding. Particulars of the account appeared in our last issue.

The **Chairman** stated that the present price of raw material was very high; raw indiarubber was about 30 per cent. higher than the highest ever reached before, and twice the price at which it had been sold at a fairly recent date. About 10 days ago the trade agreed to advance selling prices, but the increase would not suffice if the price of the raw material should not show a considerable reduction in the current year. The development of a new line of business was progressing, and the inevitable attendant expenses, though diminishing, were still very heavy, and had made serious inroads into such reserves as were applicable to this purpose, and also on the year's revenue. Increased vigilance and great prudence were necessary on the directors' part owing to the ever-increasing, though only too often ephemeral, competition to which the Company's productions were subjected. Local taxation was another point which industrial undertakings should always have in view. Their rating in West Ham, where the Silvertown works were situated, had reached 10s. 2d. in the £. As a rate of about this amount had been charged for some years, he believed that the establishment of their works in the district brought a contribution of no less than between £45,000 and £55,000 per annum to the Corporation. The Board were of opinion that in present circumstances it was unwise to ask the shareholders to sanction the payment of a larger dividend than 5 per cent. for the year.

The resolution adopting the report, which recommended a dividend of 5 per cent., was carried.

SOUTH STAFFORDSHIRE TRAMWAYS.

The fourteenth ordinary general meeting of this Company was held at Winchester House, Mr. W. Somers L. Schuster, the chairman, presiding.

The **Chairman** stated that the Company had been in conflict with various bodies, but he was glad to say they had come to a settlement with the lessee company. The offer made by the lessee company in a circular of July 1, 1904, had been accepted by proprietors holding £77,405 ordinary stock and £58,240 preferred capital, which represented a very considerable majority. The lessee company was now very much the largest shareholder in the old concern, and it was just as much in their interest as in that of the other shareholders to do all that was possible with the Company. The lessee company's nominees were people who thoroughly understood the tramways business from every point of view; there was no body which controlled more tramways in the United Kingdom than the British Electric Traction Company. They had a total of £1,590 available for distribution, and out of this it was proposed to devote to dividends a sum of £1,583, which left the very small sum of £7 to carry forward. This meant a dividend of 2s. 10d. for the year 1903, and one of 1s. 4d. for the half-year ending June 30 last. In regard to the various negotiations which they had had with the local authorities, the completion of the sale of that part of their undertaking in the borough of Wednesbury still remained in abeyance; the sale to the Handsworth Urban District Council of the lines and depôt in Handsworth had been completed at the price mentioned last year; while negotiations were still pending with the Corporation of Dudley regarding the purchase by them of that part of the undertaking in that borough. All these negotiations would be greatly helped by the lessee company holding such a large proportion of the shares, for all interests would be in harmony, and it would practically be a dual control.

The report was adopted.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING.

The annual meeting of this Company was held at Winchester House, Lord Arthur Butler presiding.

In moving the adoption of the report, the **Chairman** stated that the total receipts showed an increase of £2 943 when compared with the previous year's account. The increased traffic had been largely due to the improved weather during the summer season. The total mileage run showed an increase of 48,967, and the number of passengers an increase of 226,490. To pay the debenture interest, dividend on preference shares, interest on loan, income tax, etc., an additional sum of £2,454 was required, and this had been taken from the unappropriated balance at the credit of last year's revenue account. **Mr. H. Brown** seconded the adoption of the report, which was approved.

MANX ELECTRIC RAILWAY.

The report for the year ended Sept. 30, 1904, to be submitted at the meeting on the 3rd prox., states that gross receipts amounted to £30,818, and expenditure to £17,279, leaving a net profit of £13 538. To this must be added balance brought forward from last year, £3,266. After paying the preference share dividend there remains to be carried forward £780. During the year a large amount has been spent out of revenue in raising and ballasting the Douglas and Laxey track and also the Snaefell Mountain track, and the whole line has been kept in a good state of repair. Upon capital account there has been expended during the year £20,414 in the completion of the new generating plant and equipment, on rolling-stock, the erection of car-sheds, goods-sheds, and other works. The sum of £1,000 has, in addition, been set aside out of revenue towards a renewal fund.

NEW COMPANIES REGISTERED.

Dorchester and District Electric Supply Company, Limited.—Capital, £1,000. Objects: to construct, lay down, establish, and maintain cables, wires, lines, accumulators, lamps, and works, and to carry on the business of electricians, electrical and general engineers, suppliers of electric light and power, tramway proprietors, etc., in Dorchester or elsewhere. Registered office: 11, Carteret-street, Queen Anne's-gate, Westminster.

Marlborough Electric Supply Company, Limited.—Capital, £1,000. Objects: to carry on the business of suppliers of electric light and power, electrical engineers, electricians, contractors, tramway and railway proprietors, etc., and to enter into an agreement with the Bristol Trust, Limited, whereby the said trust undertakes, in consideration of £250, to pay the costs of formation and registration and certain preliminary expenses.

Automatic Electric Company, Limited.—Capital, £1,000. Objects: to carry on the business of suppliers of light, heat, and power, carriers of passengers and goods, manufacturers of telephones, telegraphs, phonographs, dynamos, accumulators, lamps, and all apparatus used in connection with the generation, accumulation, distribution, supply, and employment of electricity, etc. No initial public issue. D. L. Chalmers is the first managing director. Registered office: 12, St. John's-lane, Liverpool.

Kramos, Limited.—Mr. H. V. Kramer has formed a new company under the style of Kramos, Limited, Bath, with the object of taking over the entire business of the late Bath Manufacturing Company, Limited, for the manufacture of Kramos controllers, resistance pieces, high-speed electrical drills, etc.

Liens Registered.

City of Buenos Ayres Tramways Company (1904), Limited, London, E.C.—Trust deed registered Dec. 8, for £174,000 4 per cent. debenture stock. Trustees: J. Heaton, 1, Great Winchester-street, E.C.; S. Rostron, of Beddington; and E. H. Woods, 110, Cannon-street, E.C. Secured on an annuity for 80 years of £71,060, reducible to £70,660, the sum of £11,500 to be invested, and the interest thereon and all accumulations thereon referred to in the trust deed as the redemption fund, and on the undertaking, assets, and property, present and future.

Liverpool Electric Cable Company, Limited.—Debenture registered Dec. 12, for a sum not exceeding £6,000. Holder: Liverpool Rubber Company, Limited. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being.

APPOINTMENTS VACANT.

Electrical Engineer, Hanley Corporation. Salary £300, rising to £350 by annual increments of £10. Applications to Town Clerk by Jan. 10. See advertisement.

Improver, Perth Corporation electricity works. Wages, 12s. per week. Applications to John Lambert, burgh electrical engineer. See advertisement.

Foreman Instrument Maker, small shop in the North of England. See advertisement.

Electrician for electrical department. Apply, by letter, to Thomas Broadbent and Sons, Limited, Central Ironworks, Huddersfield. See advertisement.

Publicity Department Manager, electricity works, Croydon. Salary, £150 per annum. Applications by Dec. 27 to Borough Electrical Engineer.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Spain.—Particulars of tramway concessions appear in another column.

Guirgia (Roumania)—Tenders are required for the electric lighting of the town. Particulars from the town's secretary. Tenders by Jan. 28, 1905.

Neath.—The Corporation invite tenders for the supply and delivery of electric wattmeters. Specification on application to the Town Clerk. Tenders by Dec. 28.

Caen (France).—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Rochdale.—The Corporation invite tenders for high-tension three-phase switchgear and extensions to the low-tension continuous-current switchboards. Tenders to Mr. Wm. Henry Hickson, town clerk, by 27th inst.

Sunderland.—The Corporation invite tenders for the supply of one wooden cooling tower capable of cooling the circulating water for a surface condenser dealing with 30,000lb. of steam per hour. Tenders by Dec. 30.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

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Port Elizabeth.—Messrs. Davis and Soper, 54, St. Mary-axe, E.C., agents of the Municipal Corporation of Port Elizabeth, South Africa, invite tenders for various works in connection with the Corporation electricity supply undertaking Tenders by Jan. 16, 1905.

Pudsey.—The Corporation invite tenders for underground electric mains, switchboard, etc. Specifications, etc., may be obtained on application to Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders to the Town Clerk by Jan. 20.

Erith.—The Urban District Council invite tenders for overhead line equipment, poles, etc.; underground feeder cables, boxes, etc.; rotary converters, transformers, and motor-booster; and main high and low tension switchboards, cable connections, etc. Tenders by Jan. 9. See advertisement.

Johannesburg.—The Municipal Council invite tenders for two 35-ton electric overhead travelling cranes and transformer pillars and switchgear. Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and received by them not later than Dec. 27.

Spain.—The *Gaceta de Madrid* of Dec. 6 notifies an application by the Compañia General de Tranvias for the concession of an electric tramway from Sans to Coll-Blanch. One month from the date of the publication of this notice is allowed in which other proposals on more favourable terms, duly guaranteed, may be made. The *Gaceta* may be seen at the Commercial Intelligence Branch of the Board of Trade.

Hull.—The Public Libraries Committee invite tenders for the necessary electric light installation and fittings required at the Carnegie Library, West Park, Anlaby-road. Specifications may be obtained at the office of Mr. Joseph H. Hirst, city architect, Town Hall, Hull. Tenders are to be addressed to the Chairman of the Libraries Committee, and delivered at the Town Clerk's Office, Hull, before 10 a.m. on Jan. 2.

Valladolid.—Tenders are required for the public lighting by means of electricity of the city of Valladolid. Fifteen hundred incandescent lamps of 17 c.p. will be required. The concession will terminate on Dec. 31, 1911. The annual payment to the concessionnaire will be about £965. A deposit of £48 is required to qualify any tender. The adjudication will take place at 11 a.m. on Dec. 26, at the Casa Consistorial, Valladolid.

South London Electric Supply Corporation.—The Directors invite tenders for the construction, supply, and erection at their works at Bengeworth-road, Loughborough Junction, S.E., of one 750-kw. steam alternator with pipe connections and sundry ironwork. Sealed tenders must be forwarded to the secretary of the company, Mr. H. H. Boyer, Bengeworth-road, Loughborough Junction, S.E., before noon on Jan. 16. See advertisement.

Perth (Australia).—Tenders are invited by the Duputy-Postmaster-General for the supply of the following telephone material; 19½ miles 26-pair lead-covered cable, dry core, to standard specification No. 7; 5,000 paper sleeves, 3in. long by $\frac{1}{16}$in. diameter; 350 yards paper strips, 2in. wide. Conditions, etc., may be obtained at the General Post Offices at Perth, Adelaide, Melbourne, Sydney, Brisbane, and Hobart. Tenders by Dec. 28.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

Bromsgrove (Worcs.).—The Visiting Committee invite tenders for the supply and erection at their new lunatic asylum of the following plant: (Section A) engines, dynamos, booster, and steam services; (B) storage battery and accessories; (C) main switchboard, ring main, feeders, distribution boards, wiring, lamps, and accessories. Specification, etc., may be obtained from Mr. Robert J. Oliver, clerk of the Visiting Committee, Shirehall, Worcester, on payment of £5 for each section of the work as above, which will be returned on receipt of a bona fide tender.

London, W.—The Great Western Railway Company invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, etc.: (Specification No. 8) steel conductor rails, cast-iron and steel ramps and fastenings; (9) porcelain insulating supports and their fastenings for conductor rails; (10) copper bonds, insulated cable connections, cable terminals, bonding presses, and accessories for connecting up conductor rails. Tenders, addressed to the Secretary, Great Western Railway, Paddington Station, W., will be received on or before Jan. 3.

Madrid.—Tenders are invited for the public lighting by means of electricity of the town of Villanueva y Geltru for a term of 10 years. Twenty-four arc lamps of 500 c.p. and 239 incandescent lamps of 20 c.p. will be required. The concessionnaire will be allowed to supply private individuals without payment of a municipal tax subject to his supplying, free of charge, the Casa Consistorial with 75 kw. per month. He will be required to maintain a duplicate set of machinery in order to avoid the possibility of the town being left in darkness through a breakdown. The annual payment (upset price) to the concessionnaire will be 23 145 pesetas (about £678). The adjudication will take place on Dec. 24. A deposit of £68 is required to qualify any tender.

Porto (Portugal).—The Town Council opens a competition, which will close on March 15, at 3 p.m. precisely, for the concession of the exclusive right of the working of tramways for collective transports of passengers, luggage, and goods in all the municipal public ways, present and future, which favour that service, or in a special way within the limits of the town of Porto, according to the conditions approved in the meeting of Dec. 1 of the present year. The bases to which the eighth condition refers, the Herman Lourenzo Feuerheerd's request, and the rates, with the minima of the journeys, and the maxima of the prices of the passages, are published to the town hall's office for those who want to examine the conditions of the competition. The conditions of the competition are published to the Portuguese Consulate in London.

Madrid.—The *Gaceta de Madrid* of Nov. 9 publishes a notice inviting tenders for the construction and working for 60 years of an electric tramway between Azcoitia and Zumaya (Province of Guipúzcoa), in accordance with certain conditions set out in the *Gaceta*. An application for this concession has already been received from Don Dionisio Sorseta Garcia, who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on the reduction of the tariff fixed for the conveyance of passengers, etc.; in the event of equal terms being offered, it will turn on a reduction of the period of concession. Adjudication of tenders will take place before the Director-General of Public Works, Madrid, on Jan. 10. A deposit of 16,297 pesetas (about £475) is required to qualify any tender

RESULTS OF TENDERS.

Yarmouth.—The Town Council have accepted the tender of the Callender Cable Company, at £259. 4s., for cables to carry the current to Gorleston.

Insulating Compound.—Messrs. Watson and Co., 119, Victoria-street, Westminster, London, have again secured the contract for the supply of insulating compound for the National Telephone Company.

Worcestershire.—It is reported that the important order for the electric lighting of the new Birmingham University buildings at Selly Oak has been placed with Lea, Son, and Co., Pengwerne Works, Shrewsbury.

London County Council.—The Fire Brigade Committee have recommended for acceptance the tender of Ward Bros. for wiring and supplying fittings for an electric light installation at the new Isle of Dogs station for £140.

Mansfield and District Light Railways.—Messrs. J. G. White and Co., 22A, College-hill, Cannon-street, London, E.C., have secured the contract for the above, Messrs. Bramwell and Harris being the consulting engineers. The value of this contract is £48,000.

Llandudno.—The Urban District Council have accepted the tender of the Hart Accumulator Company, Marshgate-lane, Stratford, London, E., for replacing the storage battery at their electricity works with 256 standard lighting-type cells having a capacity of 450 ampere-hours.

Admiralty Contract.—The Lancashire Dynamo and Motor Company have received an order from the Admiralty for the whole of the electrical equipment for Malta Dockyard, including boilers, engines, dynamos, motor-generators, and motors, in accordance with the specification of Messrs. Preece and Cardew.

Sunderland.—The Corporation have accepted the tender of the General Electric Company, Witton, Birmingham, for the supply of two 300-kw. three-phase generators, 5,500 volts, to be coupled to existing Belliss engines, and two 300-kw. synchronous three-phase motors, 5,000 volts, to be coupled to existing multipolar Silvertown dynamos.

Monte Video Tramways.—This contract, obtained by J. G. White and Co., 22A, College-hill, Cannon-street, London, E.C., as noted in our last issue, consists of 51 miles of permanent way with the accompanying overhead construction. There are 100 cars. The power station will contain generating sets to the extent of 2,000 kw. The value of this contract exceeds £400,000.

Wandsworth.—The Borough Council have received the following tenders for the installation of electric lighting at the Council House:

W. H. McKone and Co. (accepted)	£281	14	0
J. Wilson	295	0	0
Lee and Warran	303	10	0
G. Candler and Sons	313	0	0
E. Probert and Co.	315	15	0
Bromley and Batstone	323	12	6
W. Wallace and Co., Limited	326	0	9
Holmes and Cooper	333	10	0
J. E Spagnoletti and Co.	355	0	0
Jackson Bros.	359	8	0
Salisbury Electrical Engineering Company	370	0	0
Hemingway and Pritt	379	6	0
Hooper, Neary, and Co.	388	9	0
May, Calder, and Co.	390	19	0
A. White and Co.	400	0	0
Ward Bros.	418	0	0
Strode and Co.	425	0	0
W. J. Fryer and Co.	431	8	0
Wright, Methuen, and Co.	433	17	0
D. Hulett and Co., Limited	447	11	0
Grundy and Coombe	460	0	0
Alliance Electrical Company, Limited	495	5	0
Tamplin and Makovski, Limited	500	0	0
W. S. Murrin	504	0	0
F. J. Coleby and Co.	525	0	0
Davidson Bros.	540	0	0
F. Hayes	550	0	0

Huddersfield.—The passenger receipts for November were £5,018, or £241 more than in November, 1903. An agreement has been entered into with Messrs. J. H. Sykes and Co., woollen cloth manufacturers, Gosport Mills, Outlane, to convey coal to their mill from the Hillhouse railway sidings at 1s. 9d. per ton, the Corporation to extend the line at Outlane, and the firm to lay the line from the extension into their premises, and to make the agreement for seven years.

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BUSINESS NOTES.

TRACTION.

Dover.—The Corporation are hastening the preliminary steps in connection with the tramways extensions.

Bury.—The Bill providing for, *inter alia*, the extension of the tramways has been approved by the Corporation.

Taunton.—The Corporation have decided to call upon the company to repair the track, which is stated to be in a deplorable condition.

Rhondda.—The Urban District Council have deposited their Bill by which they seek, *inter alia*, an extension of time for the construction of tramways.

British Electric Traction Co.—The directors have declared an interim on the ordinary shares at the rate of 6 per cent. per annum for the half-year to Sept. 30.

Geneva Tramways Co.—The traffic receipts for the month of November amounted to £6,734. 7s., being an increase of £578. 16s. over the coresponding period of last year.

Poole.—At the meeting of the Corporation a memorial was presented asking for the construction of a line from the existing system of the Bournemouth Corporation to Sandbanks and the district.

Sheffield.—The wages of the tramcar conductors, which are slightly lower than those paid in other cities of the same size, are to be increased. This involves an increased cost per annum of £1,306. 10s.

South Shields.—The Town Council have decided that the work of laying the tramlines shall be commenced at the earliest possible date. Contracts for carrying out the work are to be advertised. The Council have decided to erect a commodious car-shed.

New York Underground.—It is reported that, in consequence of the success of the new system, application will be made for a charter authorising an additional line, so as to provide a link between the east and west sides of the city and to complete the circle.

Salford.—Another 1½ miles of tramways have been added to the Corporation system by the opening of the route from the junction of Leicester-road and Bury Old-road to Heaton Park Station. The track is now being laid for a further extension of the route to St. Margaret's Church.

Dunfermline.—The tramway company have completed a survey of the routes over which they proposed to construct lines, and a conference with the District Committee is to be held early in the new year to arrange details previous to the application for sanction to the scheme.

Wellingborough.—This and the Raunds Council have received a communication from the British Electric Traction Company in regard to the company's revised tramway schemes for the district, and also concerning a large lighting project. The matter is under the consideration of the councils.

Spain.—The Public Works Department has received applications for concessions for the following proposed electric tramways: (1) for the town of Vigo, D. Alvaro Lopez Mora; (2) for Madrid, Madrid Electric Traction Company; (3) for Madrid, Soc. Colonia Sanatorio de la Playa de la Malvarossa; (4) for Cadiz, D. Ubaldo Fuester Birlayn.

Dundee.—The financial position for the first half of the current year has turned out to be very satisfactory. The estimated expenditure for the six months was £13,550, while the actual outlay amounted to £120 less. With regard to the revenue, the estimate for the same period was £22,083. 10s., and the actual income was £23,165. 4s., or £1,081. 14s. better than was anticipated.

Southampton.—A motion was extensively discussed at last week's meeting of the Corporation for the appointment of a general manager of the tramways. Finally, the following amendment was carried: "It having been stated that the Tramways Committee will bring up a report as to the appointment of a manager, the consideration of the matter be postponed to the next Council meeting."

Chesterfield.—On Tuesday Major Pringle, on behalf of the Board of Trade, inspected the new electric tramway system constructed for the Chesterfield Corporation by the British Insulated and Helsby Cables, Limited, at a cost approaching £60,000. The inspector was accompanied by Mr. A. P. Trotter, the electrical adviser to the Board of Trade. The inspection was satisfactory, and the cars commenced to run on the Brampton line in the afternoon.

The Paris Metropolitan Railway.—The Eighth Correctional Tribunal has delivered judgment in the case of the disaster which occurred at the Couronnes Station of the Paris Metropolitan Railway in August, 1903. The guard of the train and the stationmaster were each sentenced to a month's imprisonment under the First Offenders Act, with 2,000fr. damages, while the motorman was ordered to pay a fine of 3,000fr., and another guard one of 2,000fr. The railway company is declared to be liable with regard to the claims arising out of the case.

Hindley.—The Council have confirmed a resolution that the Council grant a lease of the Market-street and Wigan-road length of tramways to the South Lancashire Tramways Company on the terms contained in the agreement scheduled to the South Lancashire Tramways Act, 1903, permission to be granted to the South Lancashire Tramway Company to sub-lease the Wigan-road length to the Wigan Corporation on such terms as the Hindley Council approve of, and subject to all statutory and other obligations and agreements existing between the Hindley Urban District Council and the South Lancashire Tramways Company.

North London Electric Tramways.—Sir Colin Monorieff sat in the Westminster Guildhall as arbitrator for the purpose of determining a claim brought by the Hornsey Borough Council against the Middlesex County Council for the recovery of a sum of £2,000. It was stated that in connection with the construction of the electric tramways in North London the County Council required the Borough Council to carry out certain alterations to a number of manholes to sewers. The plan proposed by the County Council was regarded by the Borough Council as a dangerous one, both to the sewermen and the traffic generally, and accordingly the Borough Council carried out the work itself, and now sought repayment of the cost from the Council. After hearing expert evidence the arbitrator reserved his award.

North-Eastern Railway.—A report was brought up before the Tynemouth Council recommending that strong representations should be made to Sir George Gibb and each director of the North-Eastern Railway Company as to the state of things at present existing on the electric system being a source of great danger to the travelling public; that the carriage accommodation was totally inadequate to the needs of the district; and that the withdrawal of the first-class carriages on stopping trains was causing great inconvenience and annoyance to manufacturers and residents of the borough, who had for many years travelled first-class, and that, if steps were not taken to remedy these matters, the Council would be compelled to appeal to the Railway Commissioners and the Board of Trade. The report was adopted and a deputation appointed.

Glasgow.—The Parliamentary Bills Committee of the District Committee of Upper Renfrewshire have been considering the orders of the Glasgow Corporation and the Paisley District Tramway Company to make extensions of their tramway systems in the district. The Glasgow Corporation propose to lay a line from Thornliebank to Barrhead, a distance of three miles, while the latter authority seeks power to lay lines from Glenfield-road, Paisley, to Barrhead, a distance of two miles, and from the boundary of the burgh of Johnstone to Kilbarchan, a distance of one mile. Provision is made for the lines being single, with passing places. The Parliamentary Bills Committee have decided to insist that the lines be double throughout, and they also recommend the District Committee to oppose the orders, so that opportunity may be given for discussing the objections.

Brighton.—The Corporation have adopted the minutes of the Tramways Committee, which read as follows: "A letter was read from the clerk to the Steyning (East) Rural Council with reference to the setting back of the footpath in a portion of Dyke-road, stating that his Council would agree to specified terms. One of these stipulations was to the effect that the Corporation were not to be called on to carry out the work for two years. These terms were approved. The tramways manager was authorised in future to take off any cars that he considered were unnecessary, but requested to report at the following meeting of the committee as to any cars that he may have so taken off. The committee further recommended that the service on the North-road route be altered from an eight minutes' service to a five minutes' service, and that the matter be considered in a month's time."

Rushden.—At the meeting of the Council it was reported that a communication had been received from the British Electric Traction Company stating that they were applying for parliamentary powers to extend the tramways to Stanwick and Raunds, but to give up the line to Irthlingborough, and part of the projected line in Rushden. They were also applying for power to supply electricity in bulk, and were working in conjunction with the Northants Electric Supply Company. They asked the Council to support their scheme. Several members were of opinion that they should oppose the tramway company's scheme for supplying electricity unless they carried out the whole of the scheme previously approved of by the Council. Mr. Ballard said that if either party got a provisional order, it would put the Council out of court as an authority. Ultimately it was decided that the company's scheme in its present form should be opposed, but that if the whole scheme was carried out the Council might be disposed to favourably consider the question of electric supply.

Walsall.—The following particulars refer to the working of the tramways during the past two months: Four weeks ending Oct. 27, 1904—number of passengers, 341,180; receipts, £1,892. 14s.; car miles run, 46,650; receipts per car mile run, 9·73d. Five weeks ending Dec. 3, 1904—number of passengers, 400,754; receipts, £2,215. 4s. 6d.; car miles run, 57,558; receipts per car mile run, 9·23d. Wages paid (including repair of permanent way)—for four weeks ending Oct. 27, 1904, £629. 1s. 11d.; for five weeks ending Dec. 1, 1904, £771. 13s. 7d. The committee have approved the suggestions contained in the manager's report for effecting a saving of mileage in the running of the early morning cars on the Bloxwich, Pleck, and Birmingham-road routes. The Board of Trade have been asked to renew for an indefinite period their order sanctioning the use of electrical power on the lines purchased from the South Staffordshire Tramways Company, which order expires on Feb. 9, 1905. Mr. A. P. Trotter, electrical adviser to the Board of Trade, has inspected the overhead equipment.

Belfast.—We have already noted the contract awarded to Messrs. J. G. White and Co. This is divided into five sections, and supplies some interesting particulars as to the form of construction. Section 1—permanent way: 28½ miles double track, two miles single track, and six miles of double track, repairing and bonding only; the rails are British standard Nos. 4 and 40; the concrete bed is 7in. thick; the special work amounts to £25,000; the paving is granite setts. Section 2—37 miles overhead construction, mostly span wire; the trolley wire is 4/0 S.W.G. Section 3—cables, comprising feeders, telephone and test cables for the above, the cables to be laid on the solid system in earthenware troughs, filled in with bitumen; the dielectric is vulcanised bitumen. Section 4—comprises engines, dynamos, switchboard three-phase condensing plant, etc.; there are three steam dynamos, direct-current, of 1,000 kw. each, at 180 revolutions per minute; there are two 250-kw. three-phase motor-generators, two 125-kw. three-phase motor-generators; there is also a 25-ton crane. Section 5—boiler-house, containing superheaters

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mechanical stokers, condensers, coal and ash conveying plant, and the usual piping; there are four boilers, working at a pressure of 170lb.

Watford.—At the meeting of the Urban District Council the following recommendations were submitted in regard to the route of the suggested tramways: (1) from the termination of the Bushey light railway opposite Hayden-road to the junction of St. Albans-road with the High-street; (2) from the High-street, running down Queen-street and terminating at St. Albans-road; (3) from the High-street at its junction with Market-street, running along Market-street to Cassio-road, turning up Cassio-road in a north-westerly direction to Whippendell-road, and terminating at the junction of the new Whippendell-road extension with Rickmansworth main road; (4) from High-street at its junction with St. Albans-road, running the whole length of St. Albans-road within the urban district, and terminating at the boundary of Bushey Mill-lane. The committee also recommended that certain street widenings should be carried out, and that the tramway be paved with jarrah wood block paving throughout the entire route. After some discussion the report was adopted, with the following variations: that the portion of the proposed tramway from the junction of Market-place with Market-street to the junction of St Albans-road with Langley-road be omitted or deferred; that if this section was subsequently carried out specified street widenings should be effected; and that the rails should be laid in the most approved method in order to secure silence.

Greenock.—The following minute from the Electricity Committee was passed at the meeting of the Corporation: "The sub-committee on tramways reported that they had met on Oct. 14 and had considered a further letter from the tramway company, in which the company stated that, while they were prepared to increase their guaranteed annual consumption, they were not prepared to admit that there was any provision in the lease for such increase being paid for at the maximum rate of 1½d. per unit. The company further expressed the desire to meet the engineer in order to discuss the matter with a view to arriving at a settlement. It was agreed to authorise the engineer to meet the directors of the company for this purpose, and report to a future meeting. The engineer now stated that, as authorised, he had met the directors of the company in London and discussed the question of maximum demand in connection with the supply of energy to the tramways. As a result of the negotiations, the company, while not admitting they were liable to pay at an increased rate for the additional guaranteed consumption, were prepared to temporarily increase their guarantee from 500,000 to 600,000 units per annum, and to pay for the additional 100,000 at 1½d. per unit, this arrangement to take effect as from Aug. 1 last, and to remain in force until the next term for the revision of rates. The company have confirmed this offer.

London County Council.—The agenda for Tuesday's meeting of the Council contained an adjourned report of the Finance Committee with reference to capital votes of £21,500, £104,000, £154 000 £26,100, and £14 400 for street improvements in connection with tramways. The report of Mr. J. Allen Baker, chairman of the Highways Committee, upon the New York Rapid Transit Subway is to be printed. The Highways Committee ask that expenditure on capital account not exceeding £3,250 be sanctioned in connection with the construction of a temporary end screen for the first portion of the Greenwich generating station. The committee also recommend that advertisements be allowed on the top facia panels, in addition to the ordinary spaces, on the top covered cars. They also recommend that technical assistants employed temporarily in the tramways department be paid at rates not exceeding £5 a week. The committee further recommend that plans be prepared for the line between the Archway Tavern and the county boundary at Highgate Archway on the overhead principle, so that they may be submitted for the approval of the Board of Trade without delay. Pending the reconstruction of the Council's northern system this line will probably be worked by the Middlesex County Council in connection with their system of light railways. The receipts from April 1 to the 10th inst totalled £464,619, against £363,732 last year. The Chairman of the Highways Committee stated that the committee were now endeavouring to get the Commissioner of Police to approve a lower built car with a covered top, so that they could be used on the Tooting lines. Mr. John Burns, M.P., asked the chairman if the committee would consider the question of proposing to the railway companies the reconstruction of the Clapham and Tooting railway bridges, so that the cars could pass underneath, the Council and the companies bearing the cost between them. The Chairman said the question was one which the Highways Committee would be glad to consider. The petition presented to the City Corporation by Alderman Sir John Bell against tramways along the Embankment was referred to committee. A resolution was read from the precinct of St. Ann, Blackfriars, approving of the proposal of the County Council provided that the suggestion for widening the north-western corner of Blackfriars Bridge was carried out. This communication was also referred to the Streets Committee. Mr. Fortescue's motion, of which we have already given particulars, was adopted after considerable discussion. Finally, the Streets Committee presented a report on a conference which had taken place between its members and the representatives of the Highways Committee of the County Council. It was stated that the consideration of the matter had been adjourned until the first meeting in the New Year in the hope that by that time the report of the Royal Commission on London Traffic would be in the hands of the Corporation.

The Metropolitan Railway.—Heads of an agreement have been arranged between this company and the Great Central Company, and will be scheduled to their joint Bill for next session. The following are the chief features: The Metropolitan Company to grant a lease for 999 years of the line from Canfield-place to Harrow South Junction at an annual rental of £22,000. The Metropolitan Company to have running powers between Harrow South Junction and a junction to be provided by the Great Central Company at a point north of the Great Central Company's proposed new junction with their Northolt line for passenger goods and mineral trains at mileage rates with an allowance of 33⅓ per cent. for running expenses, with the usual facilities for dealing with empty stock. The present station at Willesden Green to be enlarged at joint expense of the two companies, and exchange platforms constructed. The Great Central Company not to convey traffic locally to or from any point between Marylebone and Harrow South Junction. The Metropolitan Company to have a through crossing at Wembley Park, providing for access to their yard and property on the south-west side of the line as at present. The Metropolitan Company to lease their railway from Harrow South Junction to Verney Junction with the Chesham branch, including stations, works, sidings, wharves, approaches, lands, and conveniences, except properties to which the Surplus Lands Committee have a beneficial interest, to a Metropolitan and Great Central Joint Committee for 999 years at a yearly rental of £44,000, and the Joint Committee shall assume the interest and obligations of the Metropolitan in respect of the Brill Tramway; but if and when the same shall become vested in the two companies that portion of it lying to the west of the Princes Risborough and Grendon Underwood line of the Great Central Company shall, if the Great Central so request, be transferred to such parties as they may indicate at a price fairly proportionate to the cost of the whole. The Great Central Company to put upon the joint line a minimum amount of through traffic of £45,500 a year gross. Any deficiency during the first two years in any one of such years to be made up in the next following year. The joint lines to be managed by the Metropolitan Company's officers for the first five years under the direction of the Joint Committee, and subsequently in periods of five years alternately by each company unless otherwise agreed. Each company to be allowed 33⅓ per cent. of the mileage receipts in their own trains for running expenses. Accounts to be made up half-yearly—June and December. Any deficiency arising on the working of the joint lines to be borne in equal proportion by the two companies, and any profit up to and including £5,500 per annum to be received by the Metropolitan Company, and the balance of profit thereafter to be divided equally between the two companies. If in any year the Metropolitan Company's mileage proportion of receipts between Baker-street and Harrow South Junction accruing from passenger train traffic to and from Baker-street and the stations on the Inner Circle Railway, with the joint-line stations north of and inclusive of Harrow, fall below the ascertained receipts for the year 1904 (after allowing for any reduction of rates and fares, if the future receipts are thereby reduced below the 1904 figures), by reason of the diversion of any of such traffic to or from Marylebone, the Great Central Company to pay the Metropolitan Company 66⅔ per cent. of the mileage proportion accruing to the railway between Marylebone and Harrow South Junction in respect of such diverted traffic up to the amount of such ascertained receipts. When the traffic referred to in the last paragraph exceeds the 1904 figures, the balance, after deducting running expenses at 33⅓ per cent. to each company, to be divided half-yearly for the first five years in the proportion three-fifths to Metropolitan and two-fifths to Great Central, and thereafter in equal proportions. The fares and rates from Marylebone to Harrow and stations north thereof on the joint line not to be less than those charged from Baker-street (Metropolitan). The out-of-pocket cost of the Metropolitan Company in connection with the arbitration proceedings to be paid by the Great Central Company. This agreement to come into operation upon the opening of the Great Central and Great Western joint lines for passenger traffic through (*via* Northolt) to Marylebone.

LIGHTING AND GENERAL.

Maidstone.—The Electricity and Light Railways Committee have re-elected Councillor Vaughan chairman.

Ormskirk.—The Guardians have decided that a loan of £4,000 be obtained for the electric light installation.

"Engineering Diary."—We refer to a notice relating to free copies of this periodical appearing in another column.

Eccles.—On Sunday the organ at the parish church was driven for the first time by electricity supplied from the Council's cables.

Dorking.—The last report of the Finance Committee shows that o the £20,000 borrowed for the electric lighting undertaking, £19,705 has already been expended.

Electricity Exhibition.—Particulars of the electrical exhibition to be held at the Queen's-road Baths, Bayswater, from March 27 to April 8, 1905, appear in another column.

Oldham.—An enquiry was held on Wednesday into an application of the Town Council for sanction to borrow £48,114 required for the electricity undertaking. Attention being called to an item of £565, the cost of photographs, souvenirs, etc., the enquiry was adjourned indefinitely in order that details might be obtained.

Edmonton.—The District Council met specially for the third time on Friday last to consider the offers of the North Metropolitan Electric Power Supply Company, Foote and Milne, Limited, National Electric Construction Company, and the Electrical Engineering Company. A motion was before the Council when it adjourned on the last occasion that the offer of the North Metropolitan Company should be accepted, to which an amendment had been proposed that the Council should themselves take steps to supply the compulsory area. After further discussion the amendment was defeated. A further amendment was then proposed that the Council should agree to lease its powers to the North Metropolitan Company, subject to terms to be agreed upon by the Council. It was stated that the company had previously offered better terms than it now proposed, and it was with the object of getting a more favourable offer that the amendment was moved. This amendment was then adopted.

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Grimsby.—Sanction has been received to borrow £3,000 for the extension of mains and the purchase of meters in connection with the electricity works for the next 12 months.

Newmarket.—The question of further alterations in the Grainger market will come early in January before a special meeting, which will also consider the introduction of electric or other lighting.

Luton.—The financial position of the town's electricity undertaking was discussed at the last meeting of the Town Council. A resolution to establish a depreciation fund was, after discussion, defeated.

Woolwich.—The Borough Council have resolved to apply to the London County Council for permission to borrow two sums of £7,500 each for the extension of electricity mains to Eltham and Shooter's Hill.

Penny-in-the-Slot Meters.—Penny-in-the-slot meters for electric light have been distributed by the Birkenhead Corporation Electricity Committee, and about 25 houses and small shops have them now in active working.

Leeds Hospitals.—The Corporation Hospitals' Committee have decided to accept the tender of the Magneta Company, of Winchester House, London, for the supply of their electric time system to the Seacroft Hospital.

Port Glasgow.—The Town Council are considering a scheme and report by Messrs. D. and A. Home Morton, consulting engineers, Glasgow, for the electric lighting of the burgh, in conjunction with the destructor plant already installed.

Rushden.—The Urban District Council are considering a communication from Messrs. Leadbitter and Harvey, of Newcastle-on-Tyne, to an application by Mr. Harvey, of Richmond, for consent to a provisional order for the supply of electricity in Rushden, Higham, and Irthlingborough.

London County Council.—On Tuesday it was agreed to lend the St. Pancras Borough Council £7,515 for electric light installation. The Council have decided to allow the Woolwich Borough Council eight years for the repayment of their £1,000 loan for wiring consumers' premises for electric lighting.

Carmarthen.—Under the joint Bill of the South Wales Electrical Power Distribution Company and the Carmarthenshire Electric Power Company, power is sought to transfer and vest in the South Wales Electrical Power Distribution Company the undertaking of the Carmarthenshire Electric Power Company, and for other purposes.

Hipperholme.—The Rural District Council have sealed the memorial for an electric lighting provisional order, and have decided that in case the Board of Trade gave leave to restrict the compulsory area to a smaller district than that originally advertised, the seal of the Council be affixed to a memorial for similar powers in such restricted area.

St. Albans.—The Rural District Council have consented to the application of the St. Albans and District Electric Supply Company for an electric lighting provisional order in respect to the rural district of St. Albans. It appears that the city authorities have granted the company powers, but they cannot get a site within the city; consequently, must go outside.

Southern Indian Railway.—During the past year, says *Indian Engineering*, the station buildings and yards at Tanjore and Trichinopoly Stations on the South Indian Railway, as well as the general offices at Trichinopoly Junction, have been provided with electric lights, and the public rooms at both stations, as well as the rooms of the officers in the general offices, have been provided with electric fans in lieu of punkahs.

Watford.—The number of electric light consumers connected to date is 370. The Windsor-road sub-station has now been put into service. The building of the Market-street and Wiggenhall-road sub-stations has been completed. A new type of arc lamp is being fixed to the three columns in the Market-place and at the public library at an estimated cost of £25. The engineer in his last report stated that since the first arc lamp had been erected at Messrs. Ward, Jones, and Co., eight weeks ago, 11 other arc lamps had been fixed in the town.

London Gazette.—A receiving order has been made out on creditors' petition in the estate of Edward Sumner, electrical engineer, 140, Dale-street, Liverpool. Frederick Seymour Salaman, 1, Oxford-court, Cannon-street, E.C., has been appointed trustee in the estate of William Henry Lloyd Watson and George Huntingdon, electricians, 83, Battersea-rise, London. Henry Edward Abbott, 5, Fenwick-street, Liverpool, has been released as liquidator in the estate of the Electrical Regulating and Lighting Syndicate, Limited, Liverpool.

Ebbw Vale.—At the Council meeting on Tuesday, the draft agreement was submitted between the Council and the Ebbw Vale Company with reference to a supply of electricity for lighting purposes, which had been approved by Mr. Wilson, electrical engineer to the Council. The various clauses were approved, with the exception of one providing that the delivery of energy should be given at one spot instead of three, as desired. It was decided to negotiate for the amendment of the agreement to the effect that delivery be arranged for at three centres.

Montrose.—The directors of the North of Scotland Electric Light and Power Company, Limited, last week threw their works open for inspection. The following few figures are available, showing the progress made by the undertaking: July, 1901, supply commenced; December, 1901, 2,000 equivalent 8-c.p. lamps connected; December, 1902, 6,422 equivalent 8-c.p. lamps connected; December, 1903, 11,670 equivalent 8-c.p. lamps connected; Nov. 30, 1904, 14,880 equivalent 8-c.p. lamps connected. These figures include motors to the extent of over 150 h.p.

Gravesend.—Councillor Enfield has been appointed chairman of the Electric Committee for the ensuing year. Mains are to be laid at a cost of £165 to supply Messrs. Russell's Brewery, Limited, with current to work certain fans they propose installing. The electrical engineer, in a recent report, states that in a local case in which a nuisance was alleged to exist by reason of noise from machinery, it had been satisfactorily established that as far as the electric motors were concerned there was no cause for complaint, such motors being entirely free from both noise and vibration.

Bexhill.—The electrical engineer has been authorised to arrange an electrical exhibition in the borough, and a sub-committee, consisting of the chairman, Alderman Young, and Councillors Longman and Paton, formed to supervise and report upon the necessary arrangements. The committee's last report stated that they had received four applications for the supply of electricity since the previous meeting, representing a total of 124 8-c.p. lamps. The total number of lamps connected to Dec. 12 was stated to be 23 572, and the total number of consumers connected to the same date 476.

Battersea.—At the last meeting of the Borough Council, the Lighting Committee stated that the electrical engineer had reported that the model prepayment electricity meter submitted by the British Thomson-Houston Company, Limited, as per their offer reported to the Council in October, had been thoroughly tested, and had proved to be satisfactory. Arrangements were consequently being made for the whole of the meters on the Latchmere Estate to be replaced with meters as per model meter, and for the supply of the necessary meters required both for the town hall and Latchmere estates.

Electrical Testing.—The Westminster Electrical Testing Laboratory are now, we are informed, carrying out a complete series of tests on 12 of the principal makes of incandescent lamps. The lamps have been purchased in the open market, and they are being run for 800 hours, and are being tested for candle-power and current consumption at start, and after 100, 200, 400, 600, and 800 hours' running. All lamps are being run together on the same circuit, and are being tested against the same standards. The test, therefore, will be perfectly fair. The results of the measurements obtained will be fully tabulated and averages will be worked out.

Aberdeen Telephones.—At the last joint meeting of the Finance and Streets and Roads Committees of the Town Council the terms of the draft agreement with the National Telephone Company were considered. It deals with the improvement of the telephone service in the city, part of the scheme being the laying of underground wires. The meeting, after a long discussion, agreed to practically accept terms similar to those contained in the agreement between the Edinburgh Corporation and the National Telephone Company. The National Telephone Company, it is reported, are prepared to spend £50,000 upon improving the service in the city.

Walsall.—Mr. Alderman William Brownhill has been appointed chairman and Mr. Alderman Noake vice-chairman of the Electricity Committee for the ensuing year. The total number of consumers supplied on Nov. 30 last was 380. During the past month the total units generated at the station was 156,417. The total output from the main generators was 151,417 units. The total units from the transformers was 119,472 (estimated). The total units registered on the meters was 111,403. The machinery was run for 684 hours. The wages paid amounted £133. The question of extending the electric mains in Lyswys-street and Mellish-road is under consideration.

Bermondsey.—The terms of the agreement proposed to be entered into between the Council and the Surrey Commercial Dock Company for the supply of electric power and lighting have been settled by the Council as follows: for power, 2d. per unit up to 10,000 units, 1½d. per unit for each unit in excess of 10,000 up to 20,000, 1½d. per unit for each unit in excess of 20,000 up to 50,000, and beyond 50,000 a charge of 1½d. per unit be effected; that for lighting, 3½d. per unit be charged up to 30,000 units, any excess to be charged at 2d. per unit. There is to be a condition that a minimum of 30,000 units be used for both power and lighting, and that the agreement be made for not less than three years.

Hampstead.—At the last meeting of the Borough Council the General Purposes Committee reported that they had had before them a letter, dated Dec. 1, from the Electric Power Development Company, Limited, of Connaught-mansions, Victoria-street, enclosing a notice inserted in the *London Gazette* of their intention to apply to Parliament during the ensuing session for power to supply electric energy in bulk in the London district; and they recommended that the application of the Electric Power Development Company, Limited, and any other applications of a like nature by other bodies or persons, be referred to this committee, with power to consult with the Lighting Committee and with other local authorities interested; and that they be authorised to take such steps as may be necessary to oppose the Bill or Bills before Parliament. The report was adopted.

Willesden.—In his report for the year ended March 31, 1904, the engineer and surveyor, Mr. O. Claude Robson, M.I.C.E., says: "An important alteration in the public lighting of the district has been effected since my last report, by the installation of electric light and the substitution of 140 electric arc lamps for the gas lamps in some of the principal thoroughfares. A number of the arc lamps are kept burning until midnight; two 32-c.p. incandescent lights on brackets being used on others for the remainder of the night. The cost for each of these lights is £25. 10s. and £19 per annum respectively. Six incandescent electric lights in Willesden-lane and Salusbury-road are also fixed by the electricity department for experimental purposes. The removal of gas lamp columns, as mainly necessitated by the fixing of electric light standards, has involved an outlay of £130. 14s. 8d., representing the shifting of 289 lamps. A large number of these have been removed to store, and will be utilised where new lamps are required. The contracts for the erection of the main electricity works in Taylors-lane, and the sub-station in Salusbury-road, have been finally settled, the ultimate cost of each of these works having been as follows—viz.: Main generating station, Taylors-lane—building, £23,869. 15s. 8d.; entrance gates and walls to Selwyn-avenue, £93.

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9s. 1d.; sidings, £1,534. 5s. 6d.; coal bunkers, £313. 3s. 7d.; cooling tanks, £846. 2s. 8d.; erection of machinery, £167. 14s. 8d.; lighting, £331. 16s.; telephones, £24. 6s. 6d.; various items certified by electrical engineer, £246. 0s. 4d.; sundries, £22?. 7s. 5d.; chimney shaft, main station, £5,614. 16s. 11d.—total, £33 768. 18s. 4d. Sub-station, Salusbury-road—building, £10,452. 14s. 2d.; lighting, £286. 5s. 4d.; telephones, £19. 19s. 8d.; tiling, £96. 4s. 10d; heating, £40. 18s. 6d.; entrance gates, £74. 8s. 6d.; sprinkler fire-extinguishing apparatus, £129. 0s. 8d.; various items certified by electrical engineer, £28. 18s. 3d.; sundries, £377. 2s. 5d.—total, £11,505. 12s. 4d. Total of both stations, £45,274. 10s. 8d. This shows a saving of £6.830 upon my estimate for these works as submitted in September, 1901. A reduction of £1,323 has also been made upon the tenders received, which amounted to £46,597. The main station in Taylors-lane was sold to the North Metropolitan Electric Power Supply Company by agreement with the Council, the sub-station and offices only in Salusbury-road now being retained by the Council."

Kensington.—The Council have consented to applications of the Kensington and Knightsbridge Electric Lighting Company, Limited, to erect a Bastian mercury vapour lamp in Kensington Court. The company will fix the lamp, and provide a meter at their own cost for the purpose of measuring the current taken, and they undertake to charge the Council for the lighting at the present rate paid for gas and renewals. A proposal of the Gaslight and Coke Company to substitute high-pressure incandescent gas lighting for the present electric arc lamps in Kensington High-street and Kensington-road has been declined as far as that road is concerned. The Council have been in communication with the Postmaster-General, calling his attention to the objection entertained by the Council to the laying of underground telegraphic lines across streets, and have received a reply pointing out that it is no part of his policy to connect single houses on one side of the street by laying underground lines from the main cables on the other side of the street, and that whilst in a few isolated cases it has been found to be more convenient and economical to tap the cables in the middle of a street rather than at one end of it, it does not necessarily follow that the number of crossings are increased thereby, as the crossing in the middle of the street may obviate the necessity for a crossing at the end; the Postmaster-General, therefore, asks that the Council will now grant consent to crossings in Argyll-road and Sydney-place (applications 400 and 401) which have previously been refused. The committee in their last report report recommend that the Postmaster-General be informed that this Council adhere to the view they have already expressed, that the crossing of streets by underground telegraphic lines should be obviated as far as practicable by the laying of such lines along the sides of the streets, and that they cannot see their way to grant the two applications referred to. Applications received from the Post Office for permission to lay pipes for telephone wires, etc., in accordance with plans submitted, in Ladbroke-grove, Cornwall-gardens, Hanover-terrace, and Kensington-square have been agreed to, as well as a notice from the Brompton and Kensington Electricity Supply Company relative to a proposed extension of their mains, etc., in Cathcart-road. The Kensington and Knightsbridge Electric Lighting Company have also obtained permission to establish a testing station in the town hall building, and to fix the necessary apparatus therein.

PROVISIONAL PATENTS, 1904.

DEC. 12.

27013. An electric automatic stopping device applicable to knitting and other textile fabric machines. Isaac Hardy Parsons and Henry Randall Waddington, 2, Laurel-road, Leicester.

27028. Improvements in flexible continuous covering for ploughway of electric conduit system and apparatus on cars for manipulating the said covering. Thomas Thornton Dewhirst and Benjamin Biggs, 189, High-street, Lewisham, London.

27033. Improvements in electromagnetic releasing mechanism for electric switches and cut-outs. Charles Mark Dorman, Reginal Arthur Smith, and Herbert George Baggs, Ordsal Electrical Works, Salford.

27060. Improvements in controlling devices for electric motors Burnett Clifton Kenyon, 18, Southampton-buildings, Chancery-lane, London.

27082. Improvements in or connected with electrical counting apparatus, more especially applicable for use in connection with ships' logs. Dolland and Co. and Tyson Crawford, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

27083. Improvements in the control of electric motors and in apparatus therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27084. Improvements in controlling mechanisms for self-propelled vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27095. Improvements in electric telephony. Charles Adams Randall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

27096. An improvement in electrical signalling apparatus particularly applicable to fire-alarms. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Act.-Ges., Germany.) (Complete specification.)

27100. Improvements in and relating to electric motor apparatus. Mavor and Coulson, Limited, and Henry Alexander Mavor, 46, Lincoln's-inn-fields, London.

DEC. 13.

27114. Improvements in and relating to operating gear for moving the points on electric and other tramways. Alfred Charles Virgin, 24, Kingsley-road, Cotham, Bristol. (Complete specification.)

27115. Improvements in reverse current circuit breakers and indicators for alternating currents. Leonard Andrews, 38, Deansgate, Manchester.

27135. Improvements in hangers or ears for overhead electric trolley wires. Henry Heap, James Bailey, Thomas Brierley, Robert Billington, Abraham Richardson, James Haydock, and Thomas Smith Jones, 6, Bank-street, Manchester.

27168. An improvement in the method of automatically regulating the voltage in electric light and power circuits with varying loads. Max James Eccles Tilney, 8, Astwood-road, South Kensington, London.

27185. Improvements relating to electric conductors. Frederick Wilhelm Sorg, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

27199. Improved method of accelerating the excitation of electrical machines. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

27201. Improvements in connection with electrostatic watt-meters and watt-hour meters. Ernest Wilson, 322, High Holborn, London.

27209. An improved system of electrical distribution for railways and method of operating same. Josef Henrik Hallberg, 18, Buckingham-street, Strand, London. (Complete specification.)

27211. Improvements in protection of electric distribution systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

DEC. 14.

27217. Improvements in and relating to telegraphic transmitters and receivers. Joseph Esser, 51, Hohenzollern-ring, Cologne, Germany. (Date applied for under Patents Act, 1901, May 2, 1904, being date of application in Germany.) (Complete specification.)

27246. Improvements in electrical measuring instruments. Siemens Bros. and Co., Limited, and Ernest Akehurst Holmes, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

27260. Improvements in apparatus for electrode deposition. Alfred Jerome Betteridge, 77, Colmore-row, Birmingham.

27285. Improvements in emergency brakes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27286. Improvements in emergency valves for fluid pressure systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27287. Improvements in brakes for hoists and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27297. Improvements in and relating to means for lighting and extinguishing gas lamps by electricity. Giorgio Giorgi, 4, South-street, Finsbury, London. (Complete specification.)

DEC. 15.

27310. Improvements connected with electric glow lamps. Charles Edmund Abell, 11, Burlington-chambers, New-street, Birmingham.

27317. Improved means of reflection in connection with electric and other lights. Thomas David Jackson, 6, Finkle-street, Stockton-on-Tees.

27343. Improvements in electrical switches. George Eason, 52, Queen Victoria-street, London. (Complete specification.)

27352. Improvements in electric controlling apparatus. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company, United States.)

27399. Improvements in electricity meters. William Hamilton and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

27400. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27401. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27402. Improvements in maximum-demand electric indicators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. The General Electric Company, United States.)

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27403. Improvements in maximum-current indicating devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

27404. Improvements in metal-working machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 5, 1905.

1903.

27069. Arc lamps. Cotis.

27199. Electric arc lamps. Lewis.

27316. Arrangements for prepayment or automatic supply of electricity. Warden-Stevens.

27330. Electric telephone systems. Fairweather. (Stromberg Carlson Telephone Manufacturing Company.)

27399. Means for separating and supporting accumulator plates. Leitner.

27783. Storage batteries or electrical accumulators. Romanoff (London) Syndicate, Limited. (de Romanoff.)

28063. Telephone transmitters. Fairweather. (Kellog Switchboard and Supply Company.)

28059. Earth indicating apparatus for trolley standards and other parts of electric traction systems. British Thomson-Houston Company, Limited, and Cubitt.

28183. Electrically-actuated musical instruments. Dickson.

1904.

869. Relays for recording, retransmitting, and controlling currents of electricity and apparatus therefor. Johnston.

2930. Electrometers of the induction type. Lewis.

2948. Wattmeters. Duddell.

3216. Fuse box for electric cables. W. T. Henley's Telegraph Works Company, Limited, and Nichols.

3236. Tremblers for electrical circuits. Wilson and Wilson and Pilcher, Limited.

3243. Electric arc lamps. Mensing.

3261. Valves for fluid-pressure brake systems. British Thomson-Houston Company, Limited. (General Electric Company.)

3431. Telephones. Kingsbury. (Western Electric Company.)

3492. Method of fixing the covers to electrical switches and other articles. Tucker.

3547. Electric switches. Kingsland.

3588. Controlling alternating-current motors. British Thomson-Houston Company, Limited. (General Electric Company.)

3589. Alternating-current electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

3590. Means for controlling electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

3603. Electric controlling apparatus for electric circuits. Leitner and Lucas.

3643. Electric light baths and the like radiant therapeutic appliances. Scott.

3665. Electric motor controllers. British Thomson-Houston Company, Limited. (General Electric Company.)

6218. Automatic suspension device for the suspension of electric arc lamps and other objects. Imray. (Deutsche Waffen und Munitions Fabriken.)

8657. Printing telegraph receivers. White.

10691. Electrically-operated typewriters and telegraphs. Roussel and King.

19234. Rail joint and electrical rail bond. Webber. (Date applied for under International Convention, Sept. 16, 1903.)

19341. Bearings for motors, dynamos, and other machines. Haynes.

19422. Regulating mechanism for arc lamps. Haddan. (Allgemeine Beleuchtungs und Heizindustrie Act.-Ges.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅞-1
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	–	15/32-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	5¼-5⅜
—— 5 per cent. Cum. Pref., 1-100,000	5	–	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	–	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000	5	–	2⅜-2½
—— 4 per cent. Mortgage Debenture Stock	100	–	88-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731 ..	2	–	⅞-⅞
—— Non. Cum., 5 per cent. Pref.	2	–	1⅛-1⅛
—— 4½ per cent. 1st Debenture Stock	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	68-72
Callender's Cable, Debentures	100	–	104-106
—— Ordinary	5	–	9¼ 10
—— 5 per cent. Pref.	5	–	5-5¼ xd
Crompton and Co.	5	–	1⅝ 1¾
—— 5 per cent. Debentures	100	–	93 98
Edison and Swan United, "A" Shares, 1-99,261	5	–	⅜-½
—— "A" Shares, 01-017,139	5	–	1-1⅛
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78 83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1⅛-1¼
—— 7 per cent. Cumulative Pref.	2	–	2¼-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref. ..	10	–	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10¼-10⅜
—— 4½ per cent. Preference	5	–	5¼-5⅜
—— 4½ per cent. Debentures	100	–	110-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	15¼-16¼
—— 4 per cent. Debentures	100	–	99-103
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	38-40
—— 5 per cent. Bonds	100	–	103-105
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	12-13
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¼-10
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock. Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 ..	5	–	7¼ 8¼
—— Nos. 20,001-30,000	5	–	7-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	104-107
Charing Cross and Strand, Nos. 1-70,000	5	–	8¼-8⅜
—— 70,001-80,000	5	..	8-8¼
—— 4½ per cent. Cum. Pref.	5	–	5 9/16 5 13/16
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4 15/16-5 1/16
—— 40,001-80,000	5	..	4 15/16-5 1/16
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)..	100	–	101-103 xd
Chelsea Electricity Supply	5	–	6¼-6⅜
—— 4½ per cent. Debentures	100	–	108-111
City of London, Ordinary	10	–	10⅜-11¼
—— 6 per cent. Cumulative Pref.	10	–	13¼-14
—— 5 per cent. Debenture Stock	100	–	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) ..	100	–	103-105
County of London Electric Supply, Ordinary	10	–	9 9¼
—— 6 per cent. Cum. Pref.	10	–	12-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	101-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000..	5	–	6¼ 6⅜
—— 6 per cent. Cum. Pref.	5	–	6-6¼
—— 4½ per cent. First Mort. Deb.	100	–	107-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2⅛
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000.....	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	102-105
Havana Electricity, Limited, 1-15,000	10	–	9¼-10⅛
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7⅛ 8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	100-102
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	9/16-11/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5		12¼-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10¼
London Electric, Ordinary	5	–	2 1/16-2 5/16
—— 6 per cent. Pref.	5	–	5 9/16 5 13/16
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100	–	95 97 xd
Metropolitan Ordinary	10	–	16¾-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb..	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	–	14¼-15
—— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) ..	100		101-103
Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510.....	5	–	6¼-6⅜
—— 4 per cent. Debenture Stock	100	–	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000..	5	–	2⅜-2½
—— 4 per cent. Debenture Stock	100	–	83-87
South London, Ordinary		–	4¼ 4⅜
South Metropolitan Electric Light and Power Co., Ord...	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1⅛-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	–	107-110
—— Ditto, June, 1904		–	
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	13½-14¼
—— 7 per cent. Pref.	5	–	8¼-9
—— 3½ per cent. Deb.	100	–	99 101
Urban Electric Supply Co., Ordinary, 8-50,007	5	–	4 15/16-5 1/16
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	4 15/16-5 1/16
Westminster, Ordinary	5	–	12⅜ 13¼
—— 5 per cent. Cum. Pref., 110,101-138,261	5	–	6¼-6⅜
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5 7/16-5 9/16
—— Ord.	5	..	7⅜-7½
—— Permanent 6 per cent. Debenture Stock, 1888 ..	100	–	143-146
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	106-107
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	10¼-11
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9¼-10
—— 5 per cent. Deb., Red., 1-600	100	–	98-101
—— 4½ per cent. Red. Deb. Stock	100	–	93-97
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..	1	..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13¾-13⅞
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000.....	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103
—— Ord Pref.	100	–	100-103
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	–	102-104 p c
—— 4½ per cent. Vancouver Power Deb.	100	–	98-101
British Electric Traction Ord. 1-300,000 & 60,001-80,000	10	–	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10 13/16-11 1/16
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	–	95-97

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Name.	Amount paid.		Last price.
	£		£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	..	3¾-3⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5½-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5½-5⅝
—— 5 per cent. Deb. Stock, Red.	100	–	106-108
—— Prov. Certs., all paid	100	–	103 106
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	..	96-99
Calcutta Tramways, Limited, 1-102,268	5	..	7⅛-8⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	–	1 7/16 1 9 16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4⅞ 5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	–	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100		101-104
Cork Electric Tramways and Lighting Co. Ordinary	10		9½-10
—— 5 per cent. Cum. Pref.	10	–	11-12
—— 4 per cent. Debentures	100	–	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	94-97
Imperial Tramways Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14⅛
—— 4½ per cent. Deb Stock	100		108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5		3¼-4
—— 4 per cent. Debenture Stock	100	–	90-93
Kidderminster and District Lighting and Traction, Pref.	5	–	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	10⅜-10⅞
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	103 105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	..	103-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	..	⅞ 7/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	..	103-105
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	..	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	–	¼-1¼

Name.	Amount paid.		Last price
	£		£
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	12½
—— 5 per cent. Cum. Pref.	10	–	9⅜-9⅝
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk.	100	–	103-106
Potteries Electric Traction, Ordinary 20,001-40,000	10	–	8-8½
—— 5 per cent. Cum. Pref., 1-20,000	10	–	8¼-8¾
—— 4½ per cent. Debenture Stock	100	–	99-102
South Lancashire Electric Traction and Power Company			
—— £250,000 Ordinary	1		1
—— £101,132 5 per cent. Preference	1		1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	–	100 p.c.

Electric Railways.—

Central London, Ordinary	100	–	90 92
—— 4 per cent. Pref.	100	–	101-103
—— ,, ,, deferred	100	–	84-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	108 110
City and South London, Consolidated Ordinary	100	–	45¼ 46¼
—— 4 per cent. Debenture Stock	100	–	104-107
—— 5 per cent. Pref. Stock '91	100	–	122-125
—— ,, ,, ,, '96	100	–	117-120
—— ,, ,, ,, '01	100	–	116-119
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10⅛
—— Ordinary, 1-50,000	10	–	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	–	97-98
Waterloo and City, Ordinary	100	–	88-90

Telephones.—

National Telephone, Preferred	100	–	108½-109½
—— Deferred Stock	100	–	101-102
—— 6 per cent. Cum. First Pref.	10	–	13-14
—— 6 per cent. Cum. Second Pref.	10	–	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5 5/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100	–	98 99
—— 4 per cent. Deb. Stock, Red.	100	–	103½-105½
—— 4 per cent. Prov. Cert.	–	..	67⅛-68⅛
Oriental Telephone and Electric Company	1	–	1-1⅛
—— 6 per cent. Cum. Pref.	1	..	1⅛-1⅛

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 17	1,063	1,076	– 13	+ 5,714*h*	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 17	170	162	+ 8	+ 497	8	8	,, 15	14,160	3,201,586	336,049	1·03	10·11	1,770	5·04
Barking Corporation	,, 17	62	39	+ 23	+ 70	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 18	984	998	– 14	– 533	23·53	23½	March 31	56,073	11,327,332	1,319,701	1·158	9·98	2,383*b*	6·1
Birmingham Corporation	,, 17	314	—	—	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 17	5,488	5,015	+ 473	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 16	765	723	+ 42	+ 3,363	24	23	,, 25	43,374	7,742,692	951,484	—	10·94	—	4·99
Blackpool Corporation	,, 15	261	255	+ 6	+ 5,940	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 17	153	153	—	—	16½	16½	Dec. 31	32,021	2,253,984	600,757	3·34	12·75	2,001	7·05
Bolton Corporation	,, 11	1,626	1,660	– 34	+ 483	38	38	March 31	94,161	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 14	793	805	– 12	+ 2,023	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 17	3,729	3,366	+ 363	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 18	758	751	+ 7	+ 3,287*h*	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 16	4,505	4,425	+ 81	—	51½	51½	Dec. 31*g*	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 17	987	769	+ 218	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 11	295	291	+ 4	—	8¼	—	March 31*j*	11,574	2,556,134	282,378	1·08	9·84	1,570	7·57
Cardiff Corporation	,, 3	1,816	1,700	+ 116	+ 1,653	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 17	170	163	+ 7	+ 217	—	—	Dec. 31*g*	9,987	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 17	7,182	7,254	– 72	– 255*h*	6	6	,, 31	362,471	44,933,938	1,292,674*a*	1·87	64·87	58,229	35·60
City & South London Railway	,, 18	2,960	3,070	– 110	– 2 416*h*	6¼	6⅜	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Colchester Corporation	,, 14	156	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 17	375	388	– 13	—	—	—	,, 31*g*	26,657	6,355,323	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 9	206	96	+ 10	+ 78	7·23	7·23	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 17	180	169	+ 11	—	4½	4½	,, 31	11,255	2,871,332	280,901	0·91	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 16	90	81	+ 9	— *h*	7	6½	Dec. 31*g*	6,234	888,905	107,164	3·88	14·09	932	7·39
Dublin U. T., electric cars	,, 16	3,647	3,641	+ 6	} —	47	46	,, 31*g*	134,648	—	3,429,356	—	—	—	— *h*
Dublin S. District, Electric	,, 16	755	704	+ 51											
Dundee City Tramways	,, 14	787	787	—	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 17	618	594	+ 24	+ 1,509	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 17	13,359	13,179	+ 170	+20,295*h*	143	123	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Gloucester Corporation	,, 14	204	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 14	2,261	2,092	+ 169	+ 4,070	33	30½	March 31	68,283	16,322,054	1,387,885	1·00	11·79	2,059	8·77
Huddersfield Corporation	Nov. 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	Dec. 17	2,115	1,940	+ 175	+10,484	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 17	352	322	+ 30	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 15	93	114	– 21	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 14	183	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 17	5,411	4,956	+ 454	+12 845	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 17	1,701	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 10	9,707	9,526	+ 181	+14,277	103	103	Dec. 31*g*	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 18	1,432	1,589	– 157	– 2,21*h*	6·57	—	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *e*
London County Council	,, 10	11,432	8 908	+2,524	—	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 17	131	137	– 6	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 15	85	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 17	11,677	11,040	+ 637	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 16	1,810	1,061	+ 748	+13,157*h*	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 17	103	89	+ 14	+ 1,298	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corptn.	,, 17	3,543	3,521	+ 22	—	45	38½	,, 25	135,027	39,715,120	4,059,907	1·1	10·94	4,111*b*	—
Newport (Mon.) Corporation	,, 17	511	414	+ 97	+ 692	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 17	1,437	1,374	+ 63	+ 5,792	29	29	,, 31	91,448	18,204,426	1,828,193	1·16	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	,, 31*g*	5,416	925,281	127,456	1·38	10·27	—	7·68
Rotherham Corporation	,, 15	385	391	– 5	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 18	4,548	4,238	+ 310	+ 3,893	34¼	—	,, 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 8	805	861	– 55	– 2,327	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	—	—	—	—	—	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 16	397	343	+ 54	+ 7,963	11¼	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 18	1,116	1,072	+ 44	+ 1 052	19·54	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	—	—	—	—	—	3½	—	—	—	—	—	—	—	—	—
Wallasey U.D.C	,, 17	676	595	+ 81	+ 1,853	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·60
West Ham Corporation	,, 15	1,014	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 14	663	386	+ 277	—	7½	—	,, 31*g*	20,878	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *e* Including one section of horse traction. *g* 1903. *h* Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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NOTES.

New Publication.—The British Electric Transformer Company have this year again sent us an elegantly-bound copy of "Whitaker." There is no need to sing the praises of this hardy annual, the virtues of which are known to everybody.

Bequests to Commerce.—When Benjamin Franklin died in 1790 he bequeathed the sum of £1,000 to be invested and kept intact for a century for the benefit of apprentices in his native city of Boston. By judicious investments this legacy has accumulated into a fund of £54,000, and a large school of industry was founded. Mr. Andrew Carnegie has now presented the same city with a sum of £108,000 for a like purpose.

Wireless Telegraphy.—A good deal has been heard of late of the importance of the North Sea from a naval point of view, and Lieutenant Loring, one of the experts to the Admiralty, has visited the neighbourhood of Fraserburgh with a view to the selection of a site for another wireless telegraphic station. It is reported that the apparatus will not be erected on the coast, as such a situation might leave it unduly exposed to destruction by an enemy, and Lieutenant Loring favours a site at Rathen.

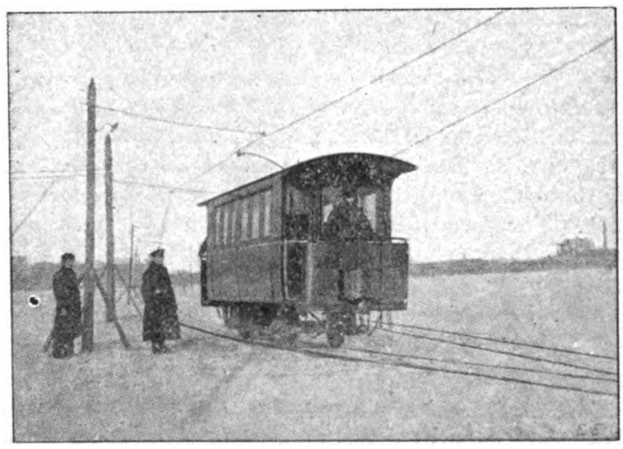
Electricity and Massage.—A reference appears in the *Lancet* to a form of treatment which has been devised by Dr. A. Bobrowa, a Moscow physician, who terms it "auto-conduction." It consists of massage with the simultaneous application of electric currents, the latter being conveyed through the operator's hand, which is the only electrode employed. Faradic or direct galvanic currents are not used in this method, but only high-frequency currents. Dr. Bobrowa has found the treatment useful for a number of maladies, including rheumatism, diabetes, dyspepsia, and neuralgia. This is another instance of the growing favour with which the medical profession regards electro-therapeutics.

Abyssinian Telephones.—Communication by telephone in Abyssinia is making great advances. Already there exists 800 miles of line, and 1,000 miles more have been planned out. A statement issued by the Italian Ministry of Posts, which is entrusted with the work, shows that the undertaking is being conducted in the face of several uncompromising obstacles. In some districts the posts have to be continually re-erected, because, through torrential rains turning the land into soft bog, they have fallen down. In drier districts wooden posts are devoured by insects, and when they are replaced by others of iron they are carried off by the population to be converted into useful implements of husbandry. This necessitates a special police for telephone lines, which have to be constantly patrolled.

Electricity v. Fog.—Prompted by the weather we experienced last week, Sir Oliver Lodge makes an interesting offer in the *Times*. He prefaces his proposal by stating that an electrical method for dissipating fogs is not the right remedy for this artificially-intensified evil, any more than free meals and free doles are a sound remedy for the problem of poverty, yet, like them, it may be useful as a temporary palliative in times of stress and while better methods are being evolved. The cost of applying such a method to a whole city would probably be prohibitory, but there are important centres, says Sir Oliver, where any means of mitigating the nuisance would seem to be legitimate. As a private person cannot conduct experiments in the open streets, and such tests would entail substantial expenditure, Sir Oliver offers to give a private demonstration of some apparatus at Birmingham to a deputation of municipal or other engineers, who could judge how far they could recommend its experimental adoption on a larger scale. Though an installation on a practical scale would mean a large outlay for equipment, operating costs would only be incurred occasionally, and would be small as compared with the expense of artificial illumination on foggy days. The proposed tests may be welcomed as a step towards showing whether the suggestion possesses more than academic interest

Junior Institution of Engineers.—The election is announced of Mr. Philip Watts, F.R.S., director of naval construction, as a vice-president of this institution. On the invitation of the chairman (Mr. Samuel Cutler, jun., M.I.Mech.E), a large number of the members of this institution recently visited the International Gas Exhibition at Earl's Court. They were received by Mr. J. W. Helps, M.I.C.E., chairman of the Advisory Committee of the Institution of Gas Engineers, under the auspices of which the exhibition was held, and shown over by him and Mr. S. Y. Shoubridge, of the South Suburban Gas Company, Mr. A. E. Broadberry, of Tottenham, and Mr. A. W. Onslow, of the Royal Arsenal, Woolwich. On Saturday afternoon, Jan. 7, at 2.30 p.m., a visit will take place to the Voelker Incandescent Mantle Company's factory, Albert Works, South-street, Wandsworth.

A Tramway on Ice.—Our New York contemporary, *Dun's Review*, contains an illustration (which we reproduce) of a remarkable, if not unique, light railway. When the



severe weather sets in at St. Petersburg, and ice sends the ferry-boat into seclusion, a narrow-gauge line with a overhead trolley wire makes its appearance on the crystal track, and conveys numerous passengers across the river at ½d. per journey. Who can say after this that Russia's internal developments are behind the times?

Royal Meteorological Society.—At the meeting of this society last week an interesting discussion took place on Mr. F. J. Brodie's paper "The Decrease of Fog in London during Recent Years," which we noticed in our issue of the 25th ult. A paper by Dr. W. N. Shaw, F.R.S., and Mr. W. H. Dines on "The Study of the Minor Fluctuations of Atmospheric Pressure" was then read. The authors described an apparatus called the "microbarograph," which they have designed to magnify the minor fluctuations, and at the same time to disentangle them from the general barometric surges. They also showed some interesting records from three of these instruments The authors wish to obtain information as to the nature of the disturbances and the causes to which they may be assigned. Among the causes which suggest themselves as likely to produce temporary fluctuations of the barometric curves are stated by the authors to be (1)

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atmospheric billows passing along surfaces where there is discontinuity of density in a manner somewhat similar to ocean waves; (2) the passage of minute whirls or cyclonic depressions of small scale; (3) variations of pressure due to the attraction or repulsion produced by electric stress, as masses of air at different potential pass over; (4) the mechanical effects of wind; and (5) the mechanical effects of rapid condensation of aqueous vapour. As regards Mr. Brodie's paper, it was curious that it should be read at a time when fog had disorganised the whole traffic of London.

New Zealand.—An installation of electric lighting for Hawera and neighbouring towns was recently completed by the electric lighting company of that town, who engaged Messrs. Steuart and Fenn, of Dunedin, as the engineers. Power is obtained from the Waingorgora River, the fall being approximately 40ft. Owing to the peculiar course of the river, it has been possible to obtain power much more easily and cheaply than is usually the case. Without the necessity of a dam of any kind, the water has been diverted through a tunnel, and thence is led through fluming to the turbines, which are of the horizontal type. When working at full load they are capable of developing 230 h.p. each at a speed of 600 revolutions per minute. The speed is kept constant by means of a Woodward governor. The turbines are each directly coupled to a three-phase alternator, having an output of 65 kw. at a pressure of 5,500 volts, which is the highest pressure yet used in New Zealand. From the switchboard the current is transmitted to the various towns through lines of pure hard-drawn copper wire, supported by poles placed at a distance of about two chains apart. To secure safety from fallen wires iron prongs are placed beneath the wires on each post and connected with the earth wire, so that should a break occur the wire will drop into the prong and the current will be conveyed to earth. Transformers are installed at each of the towns to reduce the voltage. The system has been so designed that the output of energy may be increased to 700 h.p. without interfering with the existing arrangements, except that it will be necessary to dam the river at the power-house.

New York Underground.—As the operation of two tracks carrying local trains at one-minute intervals on the New York Underground is in contemplation, it was necessary to devise an adequate system of signalling. The method decided upon, of which an account appears in the *Street Railway Review*, is a development of the electro-pneumatic switch and signal system used for years on steam railways. In the operation of this system electricity and compressed air have joined forces. The electrical apparatus does not embody anything of decided novelty, but the air compressors are unique in design. They consist of two-stage machines, built by the Ingersoll-Sergeant Drill Company, of New York, with horizontal inter-cooler, fitted with the Ingersoll-Sergeant piston inlet valve and designed throughout for maximum economy, simplicity, and reliability. Nine compressor units have been installed, and three more are under construction. Each compressor is connected by a Morse silent chain to a 35-h.p. Westinghouse direct-current motor, taking current from the lines at from 400 to 700 volts. At rated speeds of 120 revolutions per minute, each unit has a capacity of 215 cubic feet of free air per minute compressed to 80lb. pressure. The compressors are automatically controlled and regulated by the air pressure. Working pressure on the system is maintained constant within 5lb. of the fixed standard. When the receiver pressure falls below normal, a combination of electrical circuits operates to bring the compressor to speed with no load, and then to cut out the starting resistance and throw off the load. When normal pressure is reached on the system, the machine is unloaded and the motor cut out. Arrangement is also made whereby the starting and stopping of the unit also automatically starts and stops the flow of intercooling water and lubricating oils. Compressed air for these machines, which are located in sub-stations along the subway, is distributed through 2in. pipe lines running the length of the system, and operates various signal mechanisms, pneumatic switches, automatic train stops, etc. The installation of these electrically-driven air-compressors with their automatic control and regulation is regarded as a great step forward in switch and signal work.

Electrical Production of Iron and Steel.—An extended enquiry as to whether iron and steel can be produced electrically in Canada at a profit has been conducted by Dr. Haanel, Dominion superintendent of mines, Mr. F. W. Harbord, an English metallurgist, and other experts. Mr. Harbord's conclusions are briefly as follows: Steel equal in all respects to the best Sheffield crucible steel can be produced either by the Kjellin, Heroult, or Keller processes, at a cost considerably less than the cost of producing a high-class crucible steel. At present structural steel cannot be produced to compete with Bessemer or Siemens steel. Pig iron can be produced on a considerable scale to compete with the blast furnace only when the electric energy is very cheap, and the fuel very dear; on the basis of 10dol. per horse-power per year and coke at 7dol. per ton, the cost of production is about the same as the cost of producing pig iron in a modern blast furnace. To sum up: Under ordinary conditions, where blast furnaces are an established industry, electric smelting cannot compete; but in special cases, where ample water power is available and blast-furnace coke is not readily obtainable, electric smelting may be commercially successful. Dr. Haanel, however, gives a more hopeful view, and says that where, as at Chat's Falls, near Ottawa, electric power can be produced at 16s. per horse-power per year, and peat coke or briquetted charcoal made from mill refuse, at a cost of not more than 16s. per ton, is used, the cost of two of the heaviest items entering into the production of pig iron is reduced by one-half. He concludes: "When it is considered that the electric process is applicable also to the smelting of ores, such as copper, etc., and that the furnaces are of simple construction, the temperature available, 1,000deg. C. above that of the blast furnace, and the regulation of the heat supply under perfect control, it is reasonable to expect that the near future will witness great strides in the application of electric energy to the extraction of metal from its ores, and that familiarity with handling large currents, and experience gained in electric smelting, will result in solving the difficulties encountered in the smelting of ores which up to the present time have proved refractory to all commercial processes known."

Mercury Sulphate and Standard Cells.—The *Zeitschrift für physikalische Chemie* has a contribution by Mr. G. A. Hulett upon the best method of preparing the mercury sulphate, an abstract of which appears in the *Journal* of the Chemical Society. It is known that the E.M.F. of the Weston cell varies with the method of preparing the mercurous sulphate required. The author has studied the extent of this variation, and recommends an electrolytic method of preparing the sulphate. Sulphuric acid is electrolysed with a platinum cathode and a mercury anode, and the mercurous sulphate formed is prevented by a stirrer from settling on the anode. When this mercurous sulphate is used in the preparation of a Weston cell, the E.M.F. is

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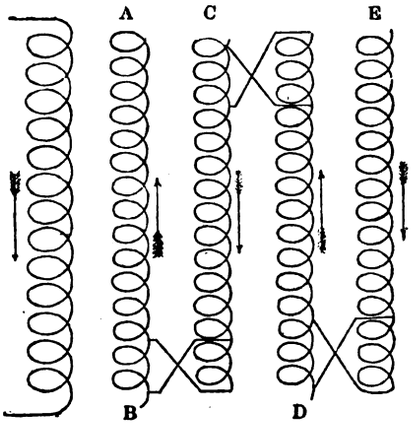
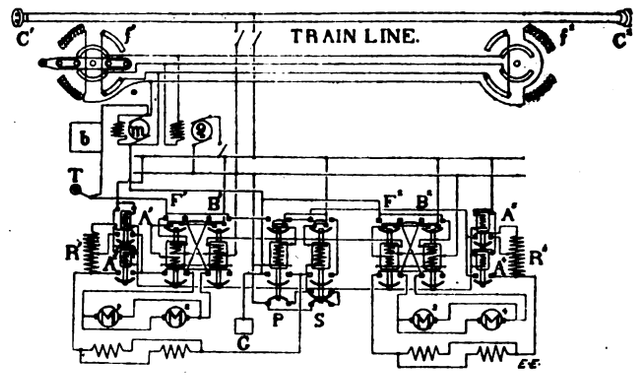
constant from the first, and has exactly the same value in different cells—namely, 1·01908 volts at 21·1deg. By shaking mercuric sulphate and dilute sulphuric acid with mercury for some time, the same equilibrium is reached as when mercurous sulphate alone is used. It is shown that mercuric sulphate is present in the cell, and analysis gives the ratio $Hg^{\cdot}/Hg^{\cdot\cdot} = 40$, a much smaller value than that found by Abel. The experiments indicate that mercurous sulphate is affected by the cadmium sulphate solution, and accordingly the hydrolysis of the former salt has been studied in detail. After prolonged shaking with mercury and water, the water being renewed at intervals, the residue has an exceedingly small solubility, and analysis indicates that the compound $HgHSO_4$ has been slowly removed and that the residue consists of a basic salt; thus: $3Hg_2SO_4 + 2H_2O \rightleftarrows (HgOH)_2,Hg_2SO_4 + 2HgHSO_4$. If this basic salt is substituted for pure mercurous sulphate as the depolariser in a Weston cell, the E.M.F. is considerably greater than the value given above. The author has determined also the solubility of mercurous sulphate in sulphuric acid solutions of various concentration, and finds a marked discontinuity at the concentration $v = 1$. This indicates that the mercurous sulphate used in the standard cells should be prepared from sulphuric acid of greater concentration than that just referred to. It is shown in the paper that mercurous salts may conveniently be estimated as chloride by precipitating with a slight excess of a dilute chloride solution and drying the mercurous chloride obtained in a vacuum desiccator for 12-24 hours.

Transformers in Series for High Tensions.—In a communication to the *Electritchestvo*, Mr. P. Kovalef makes a suggestion for obtaining high-tension current by a new method of employing several ordinary transformers. It is sometimes desirable to obtain a much higher voltage than that for which transformers at hand have been calculated.



To that end, Mr. Kovalef observes that the secondary wires of two or more transformers are generally connected in parallel with a source of low voltage, while the primary wires are connected in series. This manner of connecting, however, involves a high potential difference inside the separate transformers, between the high and low tension coils, and therefore it becomes a matter of risk to connect in series more than three transformers in order to obtain a voltage more than three times as high as the normal voltage of a transformer of a given type. The connection of transformers, illustrated in the accompanying diagram, gives a possibility of reaching much higher voltages. The low-tension winding of only one transformer is connected to the source of E.M.F., and the primary windings of the remaining transformers are left free, connections being established among the high-tension windings. Shunts are taken from these windings at equal distances from the end of each winding, say at one-sixth the total length. The manner of making these connections is shown in the accompanying figure. The second transformer is fed by the first, the third by the second, and so on. It will be seen that, notwithstanding the number of transformers connected in circuit, the inside tension in each of them will not exceed the tension between the extreme points of the winding, while the total tension of the whole circuit will be equal to the geometrical sum of voltage of all the transformers, considering, of course, the tension between the points B and C, C and D, D and E, etc. The above method may also be modified by using the secondary wires of the transformer. Mr. Kovalef acknowledges, however, that the question of voltage obtainable often becomes more complicated owing to the self-induction of the transformers, and the total sum of voltages differs greatly from their algebraic sum.

A Two-Wire Multiple-Unit System.—A patent has been granted in the United States to the Cutler-Hammer Manufacturing Company in connection with a new system for controlling motor-driven cars operated on the multiple-unit principle, a description of which appears in the *Street Railway Journal*. The unique feature of the invention is that both the direction and speed of the driving motors installed on the train are only controlled by means of two small wires running the entire length of the train, and by a controller of about the same size as a standard field regulator for a 3-kw. generator. The two wires constituting the train line are attached at each end of the car to automatic couplings, C^1 and C^2, which enable the cars to be shifted either end to. The maximum current carried by the two-wire train line is the output of a 3-kw. 110-volt generator when used in connection with six cars equipped with four motors on each car, capable of developing 300 h.p. per car. Each car may be equipped with a 3-kw. motor-generator, *m g*, capable of controlling the speed of the motors of the entire train, or by another method each car can be equipped with a ½-kw. motor-generator, capable of controlling the speed of its



own car only. The direction of travel of the train is controlled by the direction of the current flowing in the two-wire train line, and the speed of the train is controlled by the voltage of the current impressed upon the two-wire train line. These wires are utilised for supplying the necessary current for energising the windings of a number of solenoid switches, which control the current supplied to the driving motors, M^1, M^2, M^3, M^4, mounted on the trucks. The two driving motors on each truck are treated practically as one motor, but are provided with an independent solenoid reversing switch, F B, and two solenoid accelerating switches, A, for cutting out the starting resistance, R. Two other solenoid switches, S P, are employed for connecting the motors on one truck, either in series relation with the motors on the other truck, or in parallel relation therewith, in accordance with the speed desired. Each solenoid used on the reversing switches, F B, is provided with two

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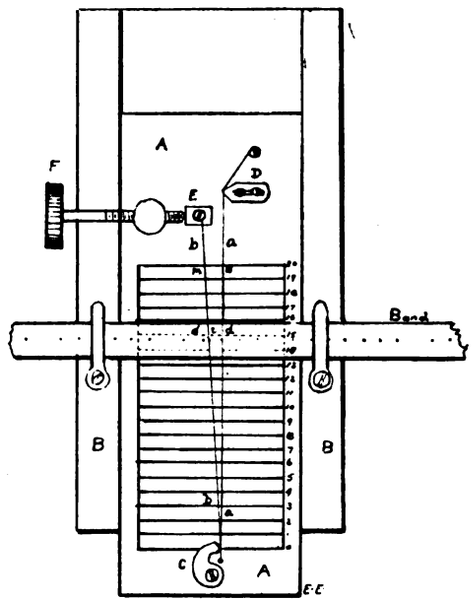
windings, one of which is permanently connected between the trolley, T, or third rail, and the ground, G. while the other is permanently connected to the train line. The coil on the forward solenoid reversing switch, F, is wound left-handed, and that on the back-up solenoid reversing switch, B, is wound right-handed. Thus the operation of the reversing switches in accordance with the direction of the current flowing through the two-wire train line is simple. The accelerating solenoids and the series and paralleling solenoids are wound to actuate their plungers at different voltages. The system is worked by the operator starting the motor-generator by means of an ordinary 3-kw. 110-volt starting box, *b*. He then moves the field regulator lever, F^1, in the direction in which it is desired to move the train, and on this lever making contact with the first step of the resistance, current is admitted through the resistance to the shunt field of the 3-kw. generator, *g*, thereby causing same to impress a voltage on the two-wire train line of, say, 20 volts. This is sufficient to supply enough current to energise the forward reversing solenoids, F^1 and F^2, and to cause them to lift their plungers, assisted by the current taken directly from the trolley. The same voltage also supplies sufficient current to energise the winding of the series solenoid switch, S, which attracts its plunger and closes the circuit of the four driving motors, M^1, M^2, M^3, and M^4, in series relation. The operator then moves the 3-kw. field regulator to the second notch, which increases the voltage on the two-wire train line to, say, 40 volts, which is sufficient to energise the first of the solenoid switches, A^1, A^2, for cutting out the first step of starting resistances, R^1, R^2. The operator continues to advance the 3-kw. field regulator lever, thus gradually increasing the voltage on the two-wire train line, until finally the second step of resistances, R^1, R^2, is cut out. The paralleling switch, P, is then energised and the starting resistances, R^1, R^2, reinserted, the resistances being again cut out until the driving motors are finally operating in parallel relation at full speed.

An Electric Chronometer.—The Mors Company, so well known in the manufacture of automobiles, have brought ought an electric chronometer to supersede the old method of stop-watch timing for races and tests. The human element enters largely into the stop-watch method, seeing that the timekeepers are required to estimate the exact moment of the start and finish, and, moreover, stop watches in general will only register to one-fifth of a second, while in the electric chronometer the personal factor is eliminated, and the result is automatically recorded upon a band of paper, which the apparatus unrolls with an accuracy of the hundredth part of a second. The apparatus is set up at each end of the line, and connected by an insulated wire which is laid along the side of the route. A wire is stretched across the track at the point where the cars start. This wire is connected by a suitable lever with a contact which is mounted inside the apparatus. As the automobile passes over the wire the contact is established, and this movement is registered automatically by the action of an electromagnet upon a band of paper, which is unrolled in the chronometer. When the car arrives at the finishing mark, it passes over a second wire which is stretched across the route. A second current impulse is thus sent over the line into the chronometer box, and the exact time of the finish is registered. The strip of paper is unrolled during the passage of the car by a modified form of Morse register, which feeds out the paper at a practically uniform speed. The moment of starting and finishing is recorded by a needle-point which makes a dot upon the band, so that by taking the distance between the dots the time is obtained. Each one-fifth second is registered upon the band by a second needle-point, which the chronometer operates by means of an electromagnet, so that it is only necessary to count the number of spaces and fractions. In order to make the device thoroughly practical when out on the road, M. Pottier, one of the chief electrical engineers of the company, has devised a compact instrument (an illustration of which we reproduce from the *Electrical Review* of New York) for calculating the position of the recording dots within the spaces they occupy on the band, so that they can be read to one-twentieth of a space (which is 0·2in.) with accuracy, thus obviating a discussion while taking the reading. A brass plate, B, carries the paper band, which is held down by two clips. Below the band slides a second plate, A, which works in a groove in the former, making the surface of A flush with B. The second plate carries a series of parallel and equal divisions, which are numbered from 1 to 20. Below the scale are two fine wires, whose origin is made to coincide with division zero of the scale by means of the curved arm, C. The wire, *d*, on the right is fixed exactly perpendicular to the scale divisions, and is held at the top by a screw and an adjustable piece, D.



The left-hand wire, d_1, is held at the top in the sliding piece, E, and can be adjusted back and forth by turning the thumbscrew, F, thus making its angle with the first wire greater or less. To make the measurement the band is first brought so that the top edge of the paper corresponds with the upper division (No. 20) of the scale. The band is now moved to one side so that right-hand chronometer dot is brought just under the fixed wire, *a*. The movable wire is now adjusted by the thumbscrew so that it coincides with the left-hand chronometer dot. That is, the distance M N on line No. 20 is the measure of the regular time space on the band. It only remains to slide the plate carrying the band until the left-hand wire, *b*, comes over the time dot, *t*, which has been made by a solenoid mounted above the registering apparatus for the purpose. The dot, *t*, lies in the interval, d_1 *d*, and it is this interval which it is proposed to measure. Supposing the wire to coincide with *t* when the band has been lowered to division No. 16 of the scale, the position of the dot is therefore read to sixteen-twentieths of the interval, or $\frac{16}{20} \times \frac{1}{5}$ second = 0·16 second. The position of the corresponding time dot at the other end of the band is then read in the same way as the first, and the two fractions of a space are added to the whole number of spaces between the time dots, thus giving the exact time.

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THE ELECTRIFICATION OF THE METROPOLITAN RAILWAY.

(Concluded from page 918.)

The switchboard arrangements at Neasden are most interesting, and show a complete departure from the older method of arranging the controlling apparatus and measuring instruments on a vertical series of slate or marble slabs. A departure from this system is necessitated both by the high voltage of the three-phase system and by the large switchgear needed by the size of the generating units. The scheme adopted by the Westinghouse Company at Neasden embodies their latest improvements for the remote control of this switchgear by means of electric motors or solenoids. The main control board (Fig. 19) is of the now very general desk type, with an inclined top. On this is fixed the remote control apparatus for operating the main alternator, feeder, and field switches, and the electrically-operated resistances and turbine governors. On the top of the desk is drawn a diagram of the connections, showing the generators, 'bus bars, and switches, and thus the attendant has always before him a clear representation of the conditions under which the station is working—a very commendable feature, and one that might be adopted with advantage in all stations of any considerable size. The switches are all worked by solenoids off a 125-volt direct-current circuit, and for the field rheostats motor control is used. The small motor on each regulator is geared down to work the sliding contacts. At either end of the motion there is a trip mechanism which opens the motor circuit and prevents it running against the stop.

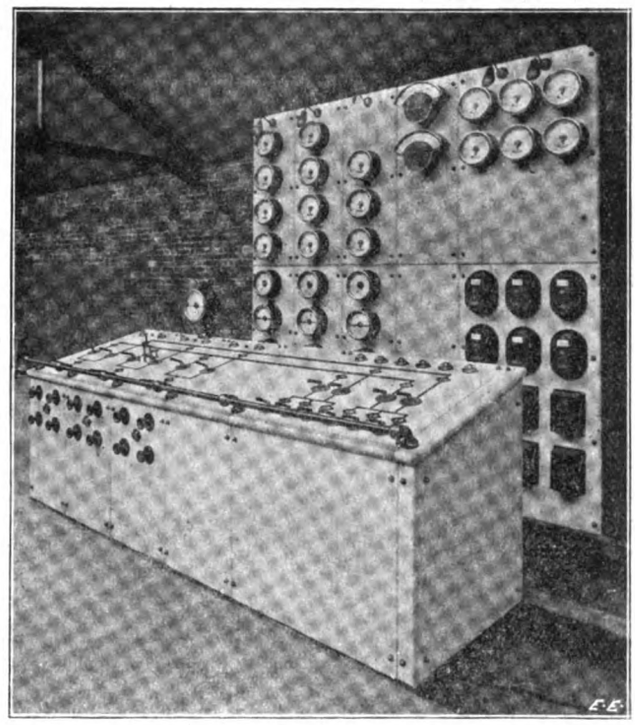
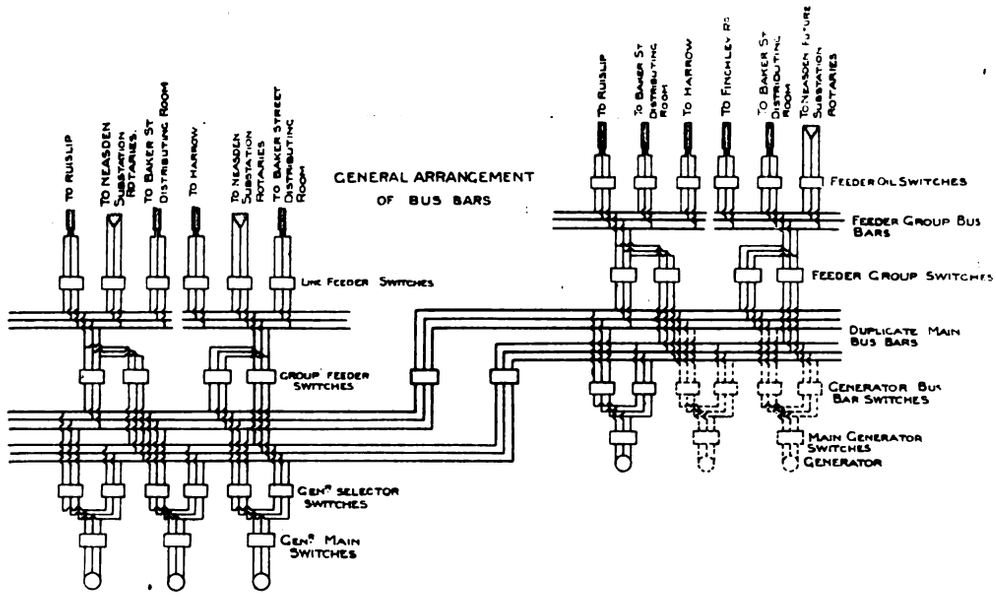


FIG. 19.—The Main Control Board at Neasden from which all the Switchgear is operated.



20.—Diagra of the Duplicate 'Bus Bars at Neasden for the Group Control of the High-Tension Feeders.

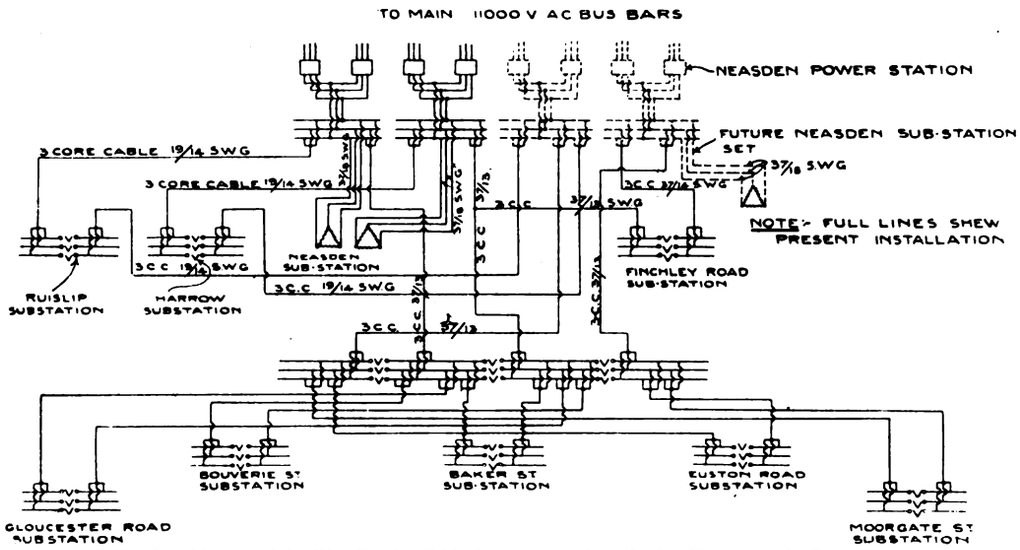


FIG. 21.—Diagram of the High-Tension Cable System connecting the Sub-Stations to the Power House.

The actual arrangement of the 'bus bars for securing continuity of supply under all circumstances is shown in

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Fig. 20. From this it will be seen that the Westinghouse Company have provided duplicate facilities for the splitting up of the load into groups. For instance, there are two complete sets of main 'bus bars, to either of which each of the generators may be connected by the aid of the switch-gear. There are in each generator circuit two switches in series—the one next to the machine a simple main circuit oil-break switch, and the other, between this and the 'bus bars, the selector switch for connecting the generator to either set of 'bus bars In addition, isolating switches are provided and placed electrically right on the 'bus bars to allow for safe inspection or repair of the controlling apparatus. By closing both of the selector switches it is possible to operate with both sets of 'bus bars in parallel. The same arrangement holds good in the feeder circuits, which, as shown, may be connected to either or both sets of bars.

On the separate rheostat, or control board, there is a duplicate set of direct-current 'bus bars, from which the exciting current is taken through two main double-pole, single-throw, quick-break switches to the generator field. These two switches are electrically operated, and may be used either singly or in parallel. In connection with them the usual discharge resistance is provided, and a field ammeter and an electrically-operated regulating resistance completes the equipment for each generator exciting circuit.

For each of the generators the following measuring instruments are provided, arranged in a vertical line behind the marble desk from which the machinery in the station is controlled: an alternate-current voltmeter; three alternate-current ammeters, which are supplied through series transformers linked respectively round each of the three main leads from the three-phase alternator; an indicating watt-

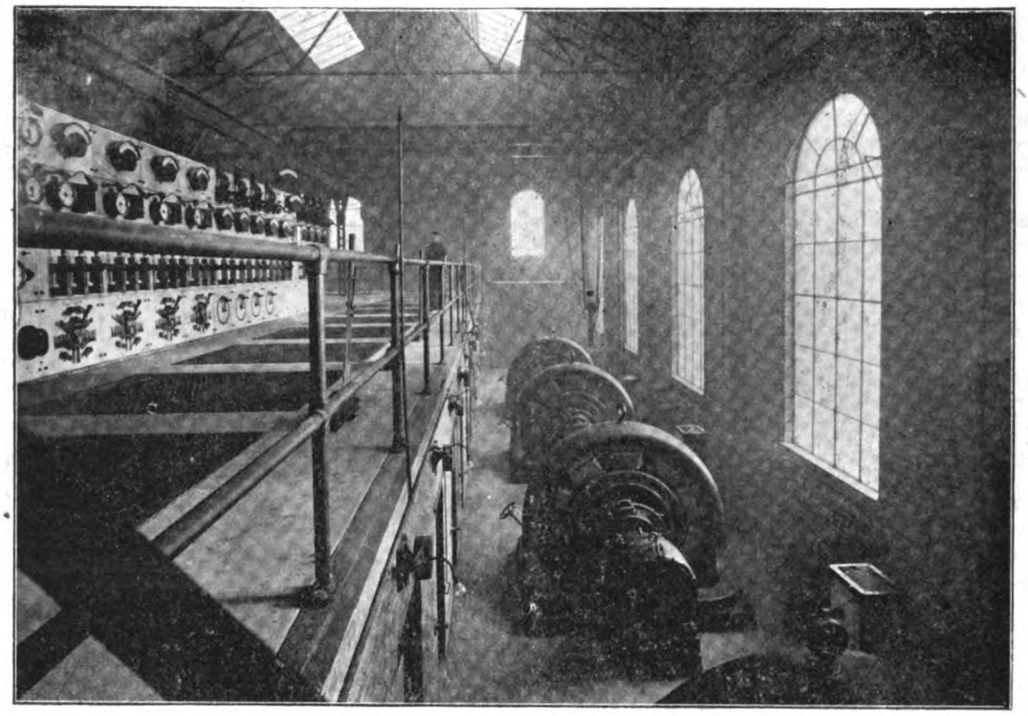

FIG. 22.—Typical View of a Sub-Station on the Metropolitan Railway.

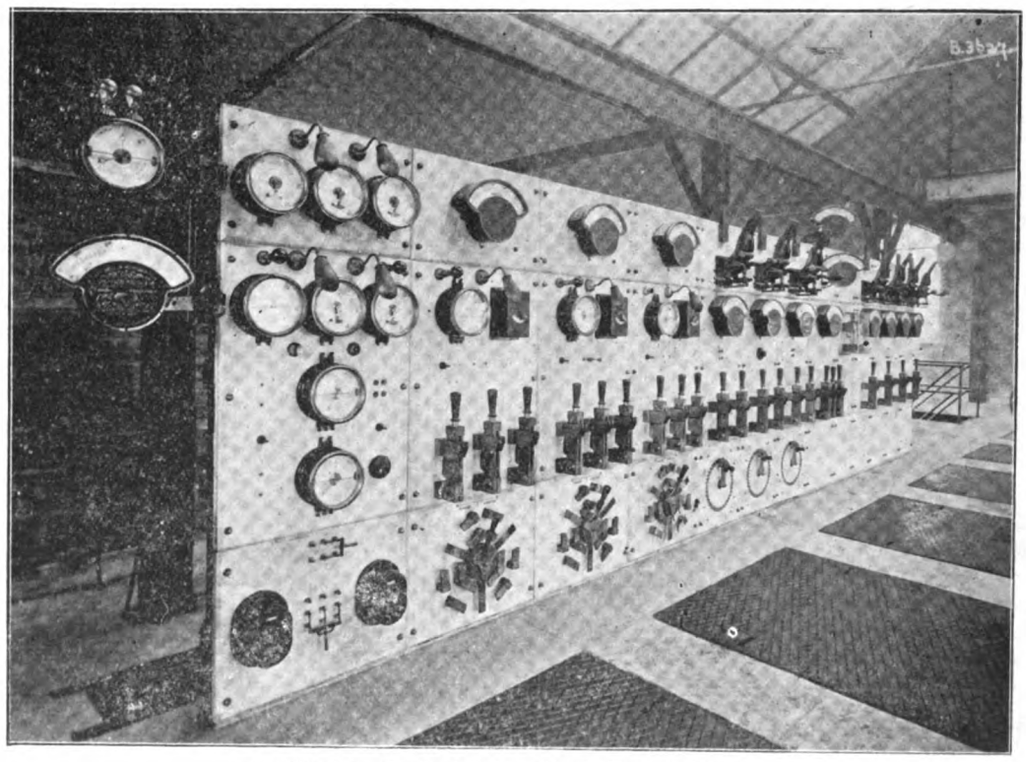

FIG. 23.—A Low-Tension Switchboard in the Harrow Sub-Station.

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meter; a power factor meter; and a direct-current ammeter for the exciting circuit. These power factor meters are exceedingly useful when two machines are connected in parallel, as they enable the operator to see when the alternators have their right excitation, etc., and are all giving supply to the 'bus bars with the same power factor. While the indicating wattmeter, in conjunction with the ammeters and voltmeter, enable the same adjustment to be made, it can only be done after a calculation, which should not be required from the switchboard attendant. The electric control circuit is worked at 125 volts direct current, and the controlling handles are placed at the front of the marble desk on the vertical face of the same. As the potential of the current controlled by this switchboard is 11,000 volts, fireproof construction, safety, and convenience of working have been the leading consideration in their design, and all these conditions are amply met by most efficient means. The 'bus bars and other conductors are supported on heavy porcelain insulators, and where a difference of potential exists, are separated by means of fireproof and insulating walls. All conductors are placed so as to offer the least risk to the switchboard attendants, but at the same time they are arranged to be readily accessible if necessary, and fully in sight. In the lower gallery the 11,000-volt generator and feeder main circuit oil switches are placed, and in the gallery above them the selector switches previously referred to. The top gallery contains the main alternating-current 'bus bars and the various instrument and control boards. All the boards are of white marble, of beautiful appearance, and the characteristic finish of the British Westinghouse Company. They may be taken as thoroughly representative of the best modern practice in which breakdown, fire, and shock risks are reduced to an absolute minimum, in conjunction with the greatest simplicity and ease of working.

The same care which has been shown in duplicating the switchboard arrangement has also been adopted in connection with the high-tension feeders to the various sub-stations. The actual position of these sub-stations and the output of the rotary converters in each was given in our issue for Dec. 16. A diagrammatic plan of the cables to these sub-stations is shown in Fig. 21, which gives the actual size of the cables in each case. From the power station four cables run to Harrow, two of which continue to Ruislip. In the other direction five run to Finchley-road, where one ends and another is tapped off, continuing its course with the remaining three to Baker-street, where they terminate. From Baker-street eight cables run to the other four sub-stations of Gloucester-road, Bouverie-street, Euston-road, and Moor-

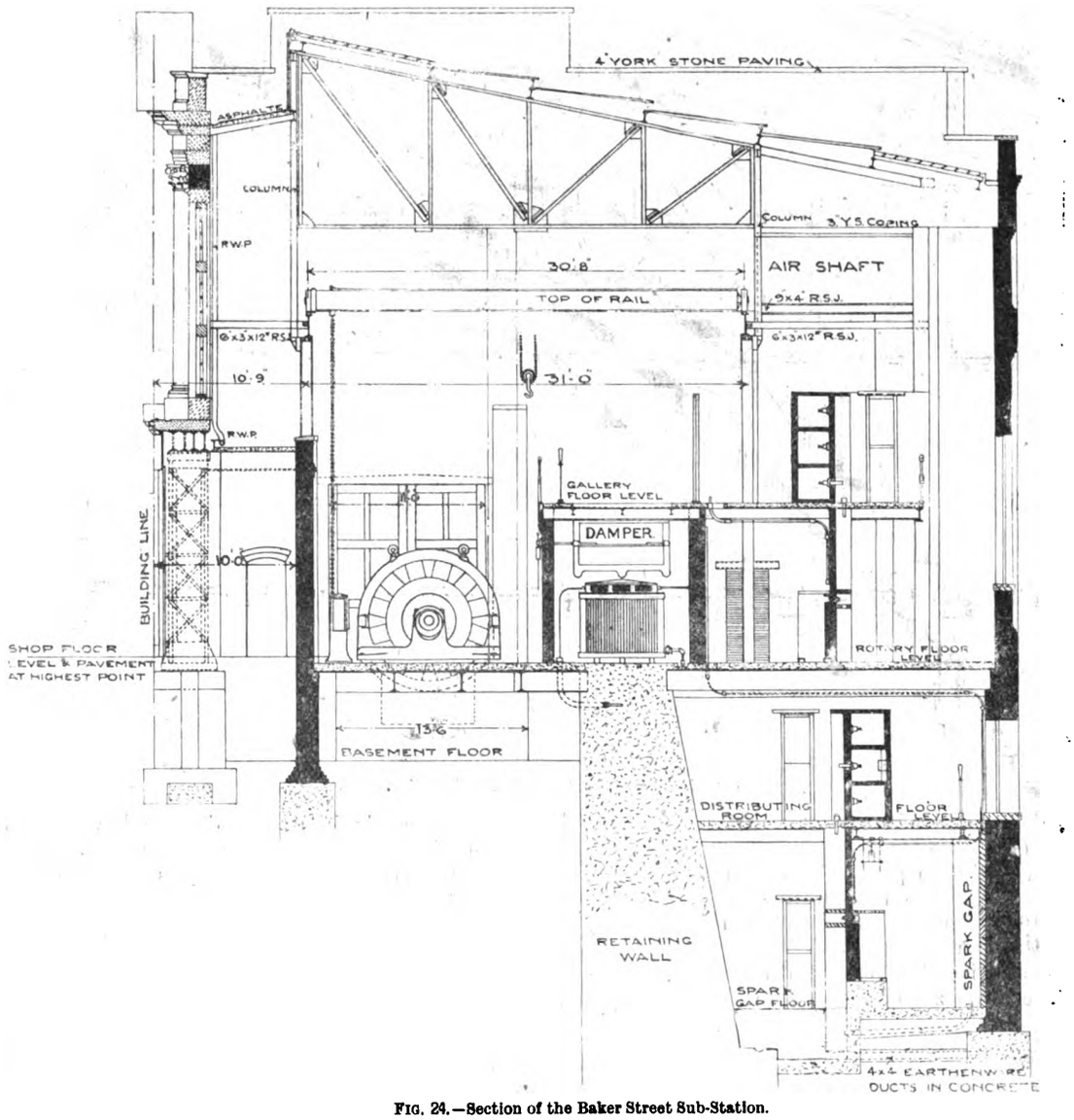

FIG. 24.—Section of the Baker Street Sub-Station.

gate-street—two feeders to each. Thus Baker-street, when finished, will be a highly important station, as it will control all the Metropolitan Inner Circle traffic. It will be seen that every sub-station is supplied from two independent feeders, which will naturally be connected on to different groups of the generating plant when the whole station is completed. The whole of these cables for working at 11,000 volts have been supplied and laid by the British Insulated and Helsby Cables, Limited. The cables are all of the three-core type, paper insulated, lead covered, and armoured. They have been laid on the solid system from Uxbridge to Finchley-road, and on brackets in the tunnels from Finchley-road to Baker-street and on the Inner Circle. This high-tension system has required about 75 miles of three-core cable. The same firm have also supplied all the low-tension, rubber-insulated, lead-covered cables for making the connections to the third and fourth

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rails at various parts of the system. They have been responsible for the laying of the cables, and also for the connecting up, and their resident engineer for the work has been Mr. F. Bradford.

As mentioned in our last issue, the three-phase 11,000-volt current is transmitted to the sub-stations, and there

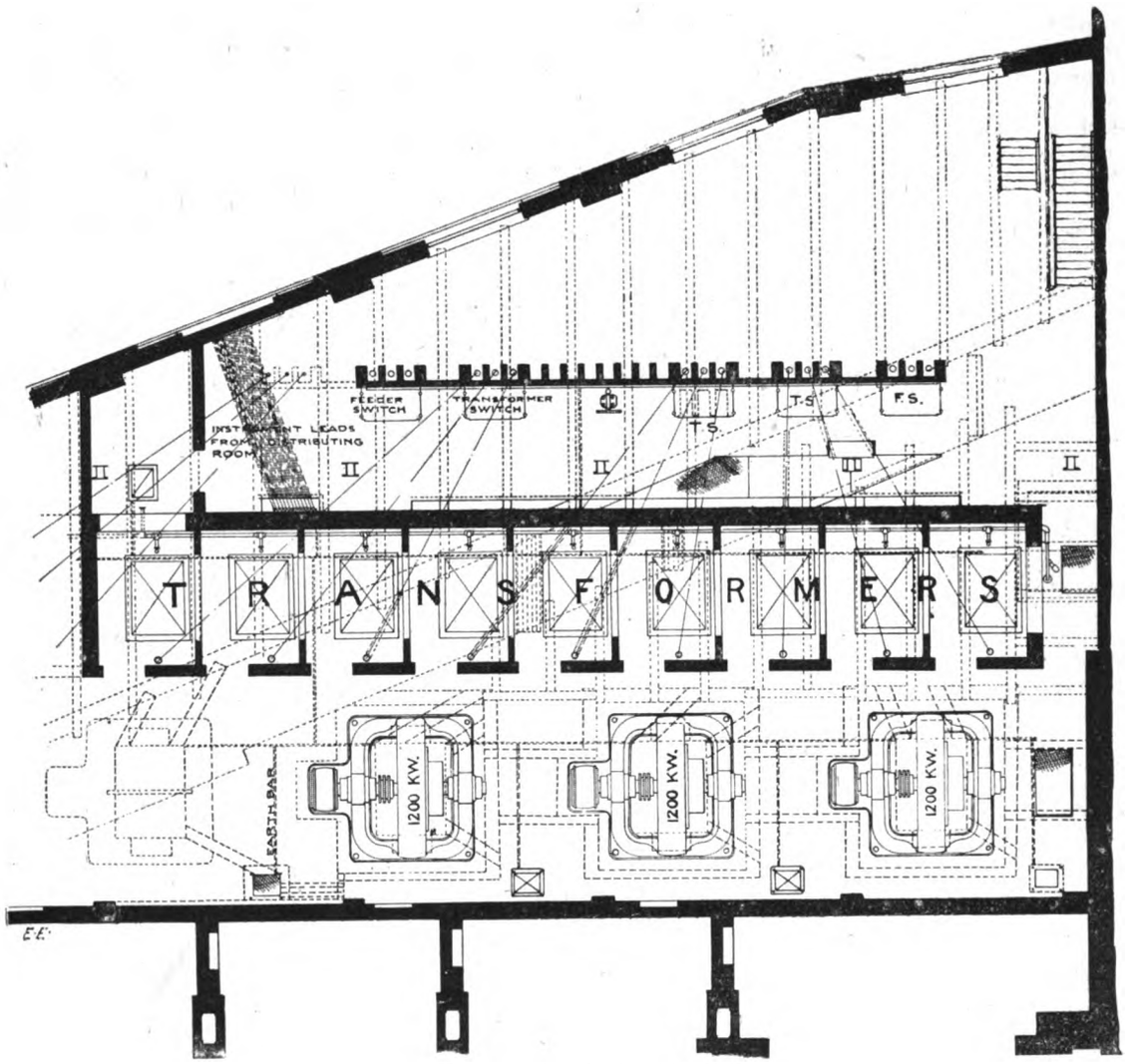
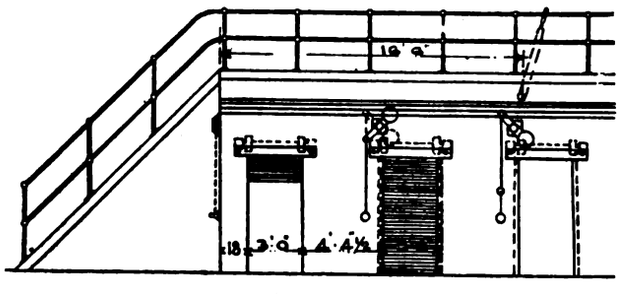


FIG. 25.—Plan of the Baker Street Sub-Station.

transformed down and changed to direct current at approximately 600 volts by means of rotary converters. Though the sub-station equipments vary in size according to their position on the line and the load that they will have to carry, the plant is identical in type and as far as possible in arrangement, having all been designed and installed by the British Westinghouse Company. The two sizes of rotary converters employed,



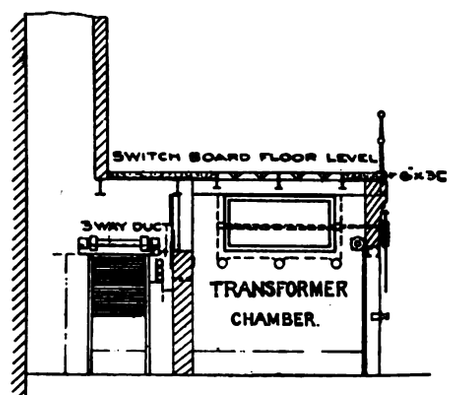


FIG. 26.—Details of the Transformer Chambers, showing Fireproof Roller Screens.

800 kw. and 1,200 kw., have respectively 10 and 12 poles, and run at speeds of 400 and 333·3 revolutions per minute. The transformers used in connection with them are of 300 kw. and 435 kw. capacity per phase, and are of the insulated self-cooling type. A good idea of the general lay-out of the sub-stations is conveyed by Figs. 22 to 25. The rotaries occupy the ground floor, and in some cases a railway siding is brought right into the building in order to facilitate the erection and replacement of machinery. The switchboards, oil switches, and transformer chambers take up by far the greatest space, and are arranged in the manner indicated in the drawings. Each transformer is placed centrally in a separate well-ventilated chamber with its low-tension side facing the door, and a large air-shaft common to all the chambers provides for a through draught. In the ceiling of the chambers, which is the floor of the upper gallery, large iron manholes are inserted to allow of the transformers being withdrawn if necessary, a hand-power travelling crane being in most cases provided for this and other similar purposes.

On the ground floor behind the transformer chambers is a passage containing the high-tension oil-break switches, and at the back of this are the cable ducts, through which the 11,000-volt feeders enter the building and the track feeders leave it. The lightning arresters are

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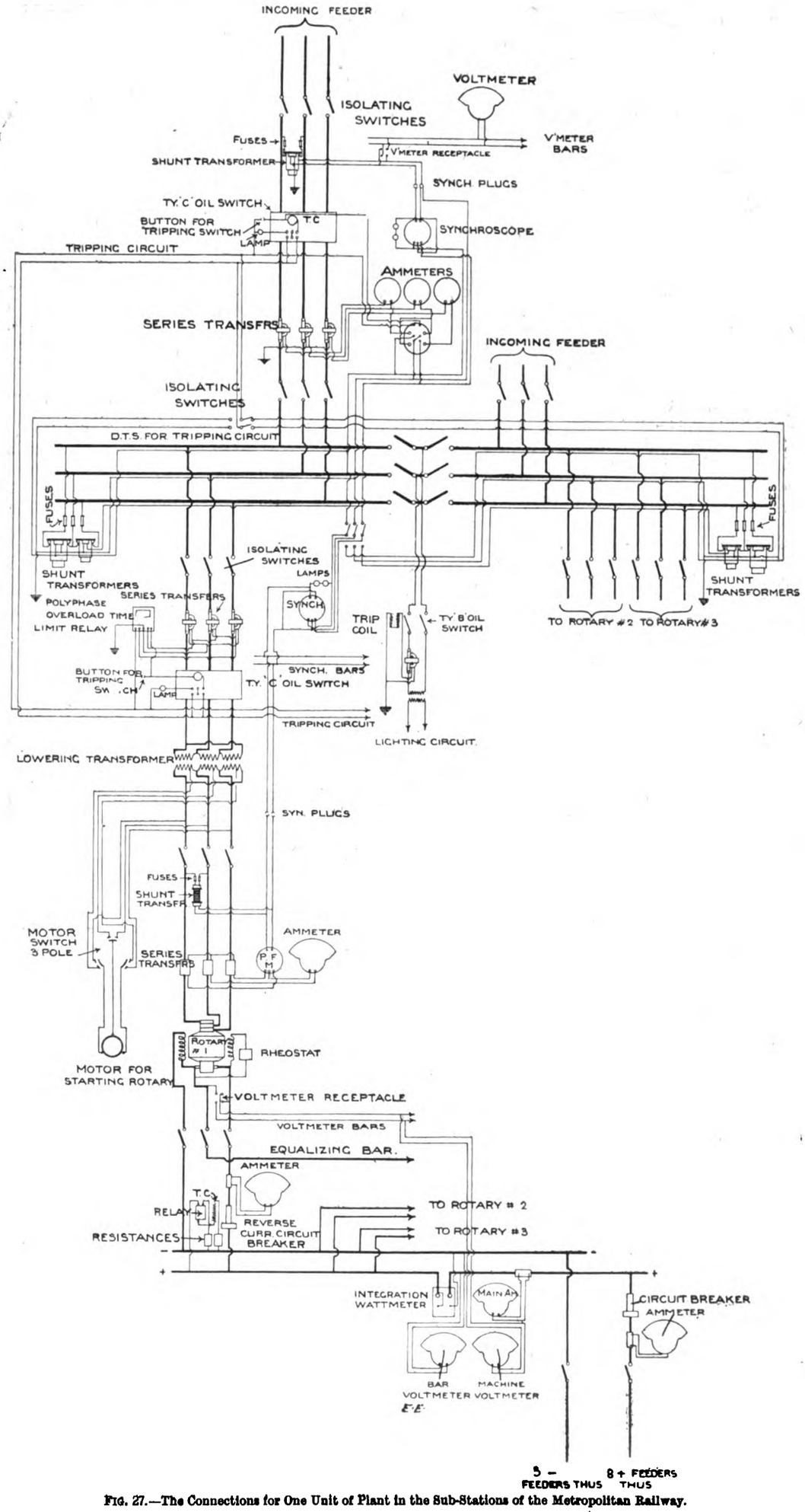

FIG. 27.—The Connections for One Unit of Plant in the Sub-Stations of the Metropolitan Railway.

situated here on the end of each cable in separate brick partitions. All the high-tension switches are hand-operated through gearing by means of levers placed close to the edge of the upper gallery, and in the case

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of those used in the rotary circuits are provided with time-limit relays, while automatic reverse-current relays are installed with the feeder switches. Electrical tripping arrangements are placed both on the switchboard panels on the gallery and the main levers. The high-tension 'bus bars of thin copper strip are contained in brick chambers situated directly over the oil switches. They are supported on substantial and effective insulators, and access is obtained to them through iron doors, which when closed render them inaccessible. The low-tension and operating switchgear is contained on several marble panels placed well in front of the 'bus bar chambers in the upper gallery. They are very ornamental in appearance and quite simple in electrical design. Referring to the illustration (Fig. 23) of the Harrow board, the first panel on the left contains sundry measuring instruments, synchroscopes, etc.; the next three, the rotary converter alternating-current side, starting, motoring, and switching gear. Following these are three panels for the direct-current side of the rotaries, containing circuit breakers, shunt regulating resistances, etc., and next the 11,000-volt feeder and four-track feeder panels. The lighting of each sub-station is effected from a separate small transformer tapped direct off the feeders, and in addition an efficient gas supply is laid on to cope with the remote possibility of entire failure of the current. This latter point is an example of the great care and forethought that has been brought to bear on the design and construction of the sub-stations, where reliability has been made the essential feature; every possible accident or derangement has been foreseen and provided for. The

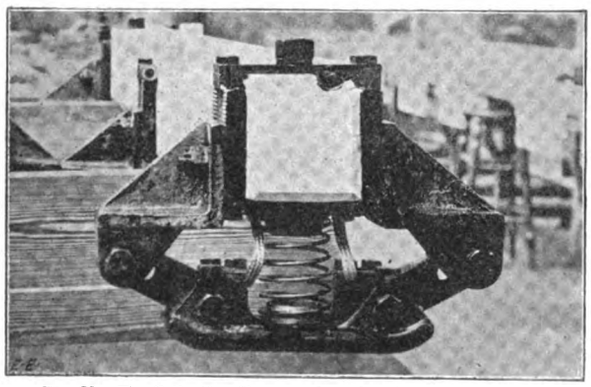

FIG. 28.—The Collecting Shoes used on the Metropolitan Trains.

drawings we reproduce in Figs. 24 and 25 are of the sub-station at Baker-street, where there was considerable difficulty in finding the space required for the apparatus. The arrangements, therefore, are not quite so symmetrical as in other sub-stations where there was ample room available. In Fig. 27 we give a complete diagram of connections of a unit of plant in a sub-station, which our readers will be able to easily follow.

We described the rolling-stock as far as it affects the creature comforts of the public in our issue for Dec. 16, and in our issue for July 29* will be found a complete description of the electro-pneumatic control as used on these trains. A few further details, will, however, be of service here to render our article more complete. Each motorcar, of which there are two in a train of six coaches, is equipped with four 150-h.p. iron-clad British Westinghouse railway motors, one for each axle of the truck. There will, therefore, be the unusual amount of 1,200 h.p. available for propelling each train. The collecting gear carried on the motorcars is shown separately in Fig. 28, in which it will be noticed that the working parts are effectively shunted by flexible copper connections. This gear is installed on both sides of the motorcars, as the current rail is not always on the one side, and a similar arrangement is fixed to a beam in the centre of the truck for making contact with the return rail. The Westinghouse quick-acting brake is fitted to all the trains, and works automatically in conjunction with the unit-switch arrangement. Both the power and lighting wiring of the cars is carried out upon the soundest principles, with all conceivable precautions against fire. The method is illustrated in Fig. 29, which shows some of the cables laid in asbestos grooves, filled in with a fireproof composition and covered with sheet asbestos. All the rolling-stock has been built at Birmingham and Manchester by the Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited, under the immediate supervision of the railway company's carriage and wagon superintendent, and the entire electrical equipment has been designed and installed by the British Westinghouse Company.

For the actual details of the train control we would refer our readers to our previous description, which was fully illustrated. We reproduce, however, in Fig. 30, a photograph of the small master controller in position in the driving compartment of the train. This small controller, working on a 14-volt circuit, operates the needle air valve of the turret controller. The current for this circuit is taken from a 14-volt battery of accumulators, which is kept in series with the lighting wires on the car. This precaution ensures that the accumulators are fully charged. This controller has five notches for both forward and backward running, in addition to the "off" or neutral point. The movement of the controller handle to the first

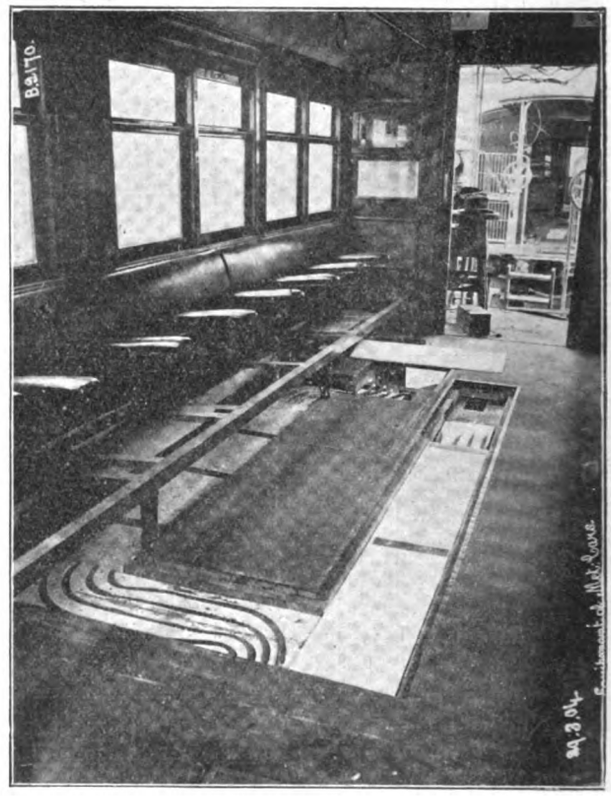

FIG. 29.—Interior of Motor Coach, showing the method of Fireproofing the Wiring.

stop sets the emergency brake valve; the second sets the reverser (a piece of apparatus for controlling the direction in which the car is run), and puts on the main supply current; the third, or shunting notch, connects the motors in series with all resistance in; the fourth brings the automatic accelerator into play, which closes the switches of the turret controller in their right order, unless checked by what is termed the limit switch; and the fifth, opening all the pneumatic switches that have been closed and simultaneously throwing in others, connects the motors in the first parallel stage with resistance in circuit. After the movement of the master controller to the fifth notch has effected the change from series to parallel, the automatic accelerator again comes into play and limits the rate at which the necessary changes in connections are made to attain full speed. The overload and no-voltage return relay is in electrical connection with the actuating magnet of one of the pneumatic cylinders of the turret controller which operates the main circuit breaker. To prevent damage from a resumption of supply after any interruption, such as a break in the third rail or persistent bad contact in the collecting shoes, the no-voltage part of this device returns the controller to a position in which some considerable amount of resistance is in circuit, allowing

* *Electrical Engineer*, vol. xxxiv., p. 153.

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it to be gradually and automatically cut out when the current comes on again. Sudden interruptions and resumption of supply, such as occur when the collectors pass over points or crossings do not affect the relay, it being arranged to work too slowly for this.

Three of the most important points in the control equipment of these cars that are ingenious and have been found to be useful are as follows: The possibility has been recognised that through accident or sudden illness the motorman may leave hold of the controller handle, in which case, especially under the latter circumstance, grave consequences may ensue. This is provided for by means of a strong spring action, which, when the handle is released, returns it to the neutral position, interrupting all the electrical circuits, and causes the brakes to be immediately applied over the full length of the train. In ordinary reversing of the train this arrangement does not operate, provided the handle is passed quickly over the neutral point. The second safeguard is that which prevents any harm being done to the motors if the operator moves the controller handle rapidly over to the full parallel position. In such a case the speed

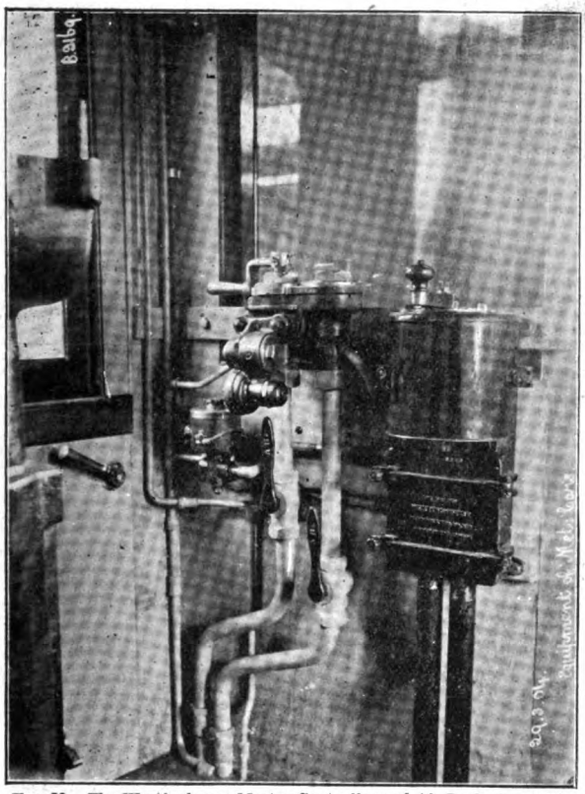

FIG. 30.—The Westinghouse Master Controller and Air Brake in position in the Driver's Compartment of Motor Coach.

of working of the turret controller does not increase, and the various connections passing from first series to full parallel are made automatically at the right pace. This reduction of the human element to a very low value results not only in greater safety and comfort to passengers, but in considerable economy in power consumption, amounting to as much as 10 or 15 per cent. over that obtained by ordinary hand-operated methods. The third provision is a system of interlocking between the control equipment and the power brakes, whereby the controllers throughout the entire train are opened automatically when the brakes are applied, no matter in what position the driver may have or continue to hold the master switch handle.

We have described above the excellent equipment with which the Metropolitan Company hope to more than recover the traffic which has been lost due to competition from the Central London Railway and electric tramways. The laying down of such a large plant, both in the power-house and in the sub-stations, is no light task, and it has involved heavy work on all concerned. Mr. Thomas Parker, M.I.E.E., has been the company's consulting engineer for the work, and he has been assisted by his son, Mr. E. T. Parker. We are indebted to these gentlemen for a great deal of the information given herewith, and for the loan of drawings from which our illustrations have been prepared, and for their courtesy in showing us the Neasden station and train equipment. It is only to be expected that Mr. Thomas Parker, with his pioneering experience in tramway and railway work, should have been called in to assist in this undertaking.

On Mr. A. C. Ellis, the general manager of the company, has fallen the work of organising the conversion of the line. Mr. C. Jones has been appointed the chief electrical engineer to the company. The work on the line has been carried out under the direction of Mr. E. P. Seaton, the company's engineer, and Mr. A. Ingram has supervised the construction of the new rolling-stock. These gentlemen and the contractors, the British Westinghouse Company, have now before them the difficult task of changing over the service from the one system to the other without interrupting the regularity of the running. It is convenient that the line to Uxbridge should be first to change over, as this will allow of full proof being made of all the new rolling stock before it is introduced into the Circle schedule, where an interruption would be much more serious. It is pleasing that the end of 1904 should mark the beginning of a change which in the coming year will render the tunnels between Baker-street and King's Cross habitable.

AMERICAN OIL-ENGINE CENTRAL STATION.

BY FRANK C. PERKINS.

The oil-engine has had the most wonderful development during the past decade as well as the internal-combustion gas-engine, and many plants are now being installed in this country as well as in Europe. The accompanying illustration (Fig. 1) shows a recent gas-engine electric light plant at Jewett City, Connecticut, while Figs. 2 and 3 show the details of construction of these most interesting engines.

This oil-engine is operated on the four-stroke or Otto cycle, and differs from other internal-combustion engines in compressing a full charge of air to a point above the igniting point of the fuel, then rejecting this fuel for a certain period into this red-hot air, where it burns with limits of pressure and temperature under perfect control.

The engines installed at the Jewett City electric light plant have each a capacity of 75 b.h.p. and 100 i.h.p. They are of the vertical marine type with triple cylinders, as mentioned above, with a 15in. stroke, and cylinders 10in. in diameter. In this plant there are two 50-kw. Westinghouse alternators of the single-phase type, supplying a current of 2,200 volts pressure and a frequency of 60 cycles per second. A direct-current exciter is belt-driven from each of these machines. These exciting dynamos each have a capacity of 1·5 kw., and supply a current of 125 volts when operating at a speed of 1,300 revolutions per minute.

The method used for lubricating the cylinders is automatic, and is not connected with other engines. Beneath each cylinder, housed in by iron-plate doors, is an oil well into which the connecting rod crank end plunges, slushing the oil into the cylinder at every stroke. By this means of lubrication the wear on the inside of the cylinders is very slight. There are two storage tanks, provided with a capacity of 6,500 gallons. These tanks are placed under ground, and contain crude petroleum, which costs, delivered, 4·6 cents per gallon. This is received in tank-cars in 6,000 gallon lots, and is drawn to the tank by tank-wagons, and the oil is pumped from the storage tanks into a feed tank above the engine which has a capacity of 40 gallons.

A wooden tank of 7,000 gallons capacity is located outside of the building, and furnishes a continuous flow of water through the cylinder jackets for cooling purposes. Pumps are provided beneath the floor to fill this tank, and they are operated from the main shaft of the engine, the water being taken from the pond below.

In reference to the economy of operation of this plant as to fuel and labour, it may be stated that one of the engines consumed an average of 38 gallons of oil for 12 hours' run, with an average output of 55 h.p. This engine and dynamo was used for doing commercial and street lighting, and the cost of operation, it is claimed, was

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693dol. 50 cents for one year. In this estimate the oil was taken at 5 cents per gallon, making the expense for fuel 15⅝ cents for 55 h.p. per hour, or 1dol. 90 cents for 12 hours.

An engineer of Jewett City places the lowest possible amount of coal used to run a slide-valve steam-engine—not high speed—at two tons for 55 h.p. for 12 hours, which would cost, at 4dol. per ton, 8dol. per night. It is estimated that—with the services of a fireman, who would be needed, at 1dol. 50 cents per night—the total cost would be 3,367dol. 50 cents per year. It is suggested that in cold weather pipes can be attached to the cylinders of the engine and the heat used for radiation.

The gas-engine or oil-engine electric light plant is certainly a most compact equipment, and the engine-room and entire installation may be kept extremely neat and clean at all times, as no boilers, smokestack, coal-bins, stokers, heaters, or ashes are at hand, while the fuel expense begins only when the engine is started, and stops as soon as the valve is closed.

Two 50-kw. Westinghouse single-phase dynamos at the Jewett City electric light plant are belted to the oil-engine.

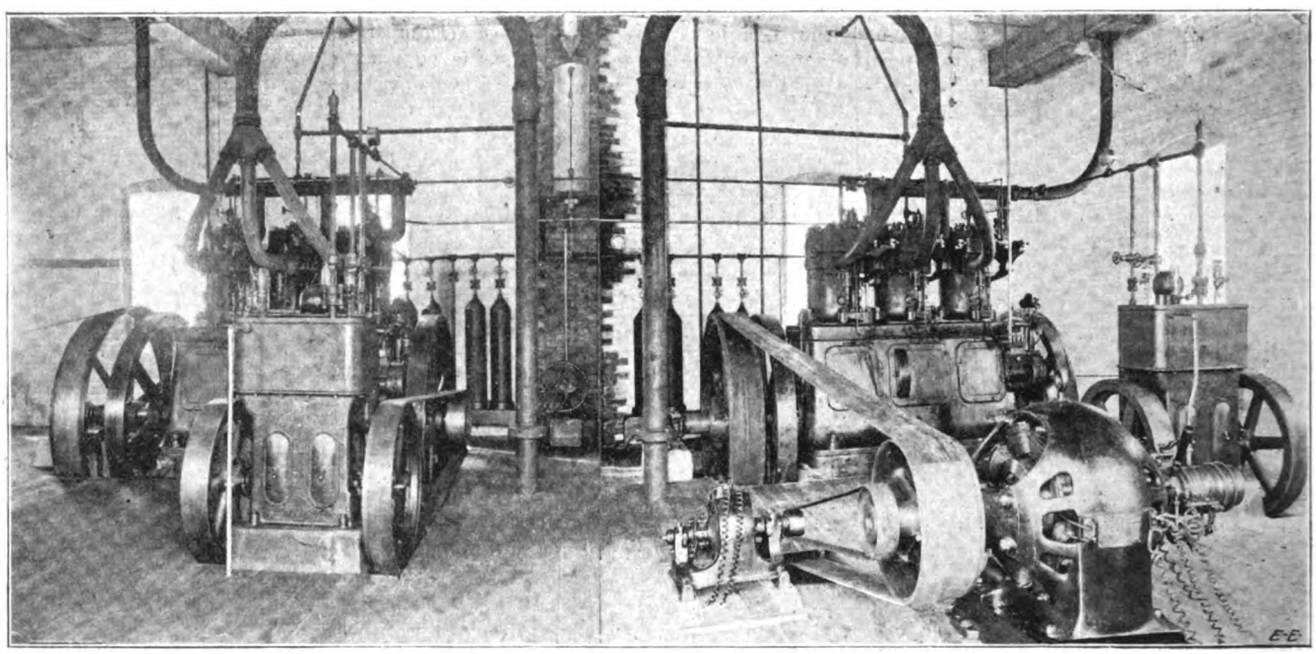

FIG. 1.—Jewett City Electric Light Plant, using Diesel Oil Engines and Westinghouse Single-Phase Alternators.

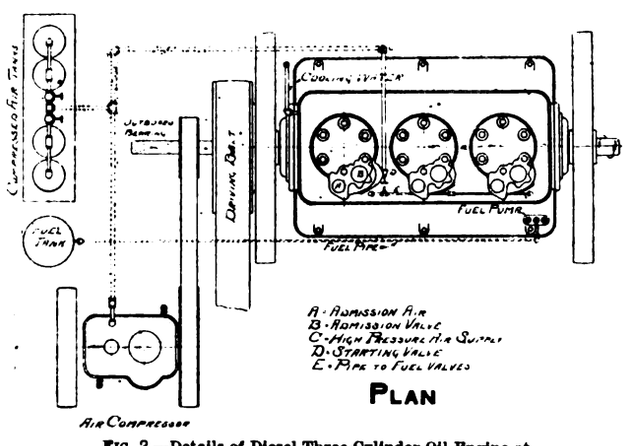

FIG. 2.—Details of Diesel Three-Cylinder Oil Engine at Jewett City Plant.

The wiring from the alternators is carried under the floor to the switchboard, and the 2,200-volt circuits are run in lead-covered cable. The switchboard consists of two panels of marbleised slate 8ft. long and 5ft. high, mounted on a frame of steel tubing. Each of these panels is supplied with a voltmeter and ammeter, as well as a double-throw double-pole interlocking switch for connecting the commercial lights to the generator, also the usual circuit breaker. The lighting system of this town includes about 2,000 incandescent lamps of 16 c.p. each, and 100 5·5-ampere incandescent street lamps.

THE EDUCATION OF BOROUGH COUNCILLORS.

[COMMUNICATED.]

There are certain terrors incidental to the popular control of technical business undertakings which are absent from the minds of men who manage the operations of private engineering companies. In the latter case the non-technical shareholders generally recognise their limitations, being induced to do so by an immediate sense of the pecuniary rightness or wrongness of their procedure. The technical staff is therefore given a much freer hand than is sometimes the case in municipal concerns, where the money value of a mistake is only distributedly felt through the medium of an increased rate. There is a great temptation to a borough councillor, elected for a comparatively short period of authority, to proceed somewhat beyond the limits of his knowledge in the attempt to accomplish something which will place garlands of local glory upon his brow.

It is therefore hardly to be wondered at that the relations existing between borough councillor and engineer are

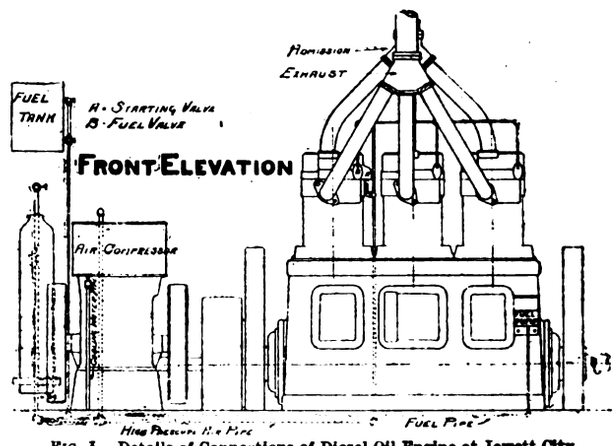

FIG. 3.—Details of Connections of Diesel Oil Engine at Jewett City Electric Plant.

not always of the happiest. The engineer, strong in the consciousness of a special knowledge, combats any interference with the satisfactory performance of the work under his control. The councillor, winning his seat through mazes of impassioned oratory, caustic criticism of accounts, and fervent promises to inaugurate the millennium, is not the man to be "drowned" by a condescending explanation of the reason why apparent black is in reality white, delivered by a gentleman whose technicality is far in excess of his salary. The result is the production of such unfortunate *impasses* as recently occurred in one of our

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metropolitan boroughs. Sympathy with or denunciation of either party is of no value in such a case. The question, a solution to which is more or less urgently required in every part of the country, is: What can be done to produce sympathy of feeling and, if possible, a common point of view for councillor and engineer?

There is no doubt that the Municipal Electrical Association is doing splendid work in this direction by means of its conventions for the inspection of works and the reading of papers bearing on the business and engineering aspects of municipal electrical undertakings. Its effect on the mutual esteem of those gentlemen holding responsible positions who attend these conferences must be very marked, and the severer exercises are judiciously tempered with certain social functions which display to the participants amiable qualities in their fellow-men, the recollection of which may serve as oil on the troubled waters of debates in committee. But not every member of an electric light or electric tram committee can spare the time to run away to the other end of the country for a week of electrified reunion. What is to be done with those councillors who prefer to stay at home and address their constituents?

Briefly, the remedy would seem to be to take advantage of their natural inquisitiveness. A borough councillor who is not anxious to visit the electric light works, to inspect the same, and to ask the greaser if there is anything wrong with the boilers, is inexplicably lacking in initiative. Moreover, if the engineer exhibits symptoms of resentment, the councillor will not desist, but will try to dodge the engineer by calling at unexpected times in the hope of finding out what it is the engineer is trying to hide.

The committee should be encouraged to inspect the works *en bloc*. The individual asperities of the members are modified by combination in very much the same way that a composite photograph presents a much softer outline than any of its component facial representations. A councillor surveying the station alone is apt to imagine himself the "cock that craws on his ain dunghill"; when in company with others he is less assertive. Moreover, the individual stocks of technical intelligence are pooled; the engineer has less popular lecturing to do, and time is economised.

Having, then, got your councillors together, nominally for a tour of inspection, really for a course of instruction, how are you to administer the medicine so that they may have no suspicion that they are being dosed, but rather that they are feeling your pulse? Bare-faced lecturing will not be tolerated; deferential requests for exchanges of ideas let loose the floods of amateur criticism. The best method is probably to turn the generating station into a temporary electrical exhibition for the benefit of the councillors.

Perhaps this may be best illustrated by detailing a very successful process to which a newly-elected electric light committee was subjected by one of our borough council engineers. The members of that committee were of the native-intelligence order. Their business capabilities in their several trades were undoubted; their knowledge of local conditions and facility for expressing the same made them respected of the populace and a power in debate. Their acquaintance with technical matters was, however, superficial. The borough engineer opened fire upon them by inviting them to a species of state inspection of the works, the committee being asked to assemble at a fixed hour in the general office of the station. On arrival they were severally presented with a neatly-typed itinerary, of which the following paragraphs are typical quotations:

"*Test-Room.*—Here will be seen a collection of mains accessories, including feeder pillar, section box, samples of feeder, network and house service cable, a meter board complete with fuse box, meter and demand indicator similar to those installed on consumers' premises. Tests will be made on the efficiency of incandescent lamps by the aid of the photometer during the committee's inspection of this part of the works. The testing set used for the location of faults in cables will also be exhibited."

"*Engine-Room.*—Entering the engine-room from the pump-house, the three Belliss triple-expansion engines will be seen, each having its own condenser and air and circulating pumps." (Particulars of the horse-power, revolutions, etc., follow.) "To the right are two Willans triple-expansion engines, the enclosed moving portions of which are lubricated by the action of the cranks splashing in an emulsion of oil and water. If the state of the load on the station permits, one of these engines will be run round slowly with inspection doors removed, when the lubricating action can be observed."

"*Switchboard.*—This, which faces the dynamos, controls the entire works output. Cables are led to the board from each machine, and the current is then distributed to the mains feeding the load in different parts of the borough. These mains or 'feeders' convey the electrical energy from pairs of switches on this board to the following points, where they are joined to the distributing network through a feeder pillar or section box such as those shown in the test-room." (Here follows a list of the feeding points of local interest only.) "The regulating panel has mounted upon it four voltmeters, two for showing the actual pressure of the machines and 'bus bars at the station, and two for indicating the pressure at the feeding points. The latter object is accomplished by running back three small conductors called pilot leads, which can be connected to the two voltmeters at will, and it is by keeping a mean pressure on the various feeding points in the district that the regulation of the supply is carried out."

In the boiler-house attention was drawn to chain-grate stokers, and samples of condensed water before and after treatment with aluminoferric were shown, a succinct account of the process being given in the itinerary. One of the filters was open for inspection, and samples of the filtering material before used and after some days' running were shown.

The offices were likewise included in the exhibition, for here an arc lamp similar to those used in the streets was hung up, the casing being removed to show the mechanism. Moreover, the image of the arc was projected on to a screen, a caution being thoughtfully included on the programme to the effect that "It will be noted that the projected image of the arc on the screen is inverted owing to the action of the lens." In another part of the offices four incandescent lamps—two new, two blackened—were glowing in front of white card screens. Concerning these the councillors were informed: "Two efficient incandescent lamps are here shown consuming between them one unit in 7½ hours. Beside them are two inefficient lamps, which it will be noted are giving considerably less light and which are consuming one unit in six hours." A small display of Nernst lamps was also made, with the comment that "It is expected that this lamp will take a similar position in the electrical industry to that occupied by the incandescent mantle in gas lighting."

The borough engineer added one final touch which partook of the wisdom of the serpent. Mindful that medicine, even if administered in pilule form, is much more acceptable if sugar-coated, he influenced the chairman of committee to such an extent that on the return to the offices the councillors were gratified with a simultaneous offer of cigars and other comforts, and an appeal as to their opinion of the working of the station. The engineer afterwards put it on record that it was the most entirely enthusiastic committee he ever had the pleasure of meeting. Moreover, as each councillor went away with just that *soupçon* of technical knowledge that so admirably equips the usual canvasser, the borough engineer had in effect turned loose on the borough a dozen or twenty enthusiasts for electric lighting able to speak with exactly that technico-business manner which carries conviction to the man with the gas bill he doesn't like.

APPOINTMENTS VACANT.

Electrical Engineer, Hanley Corporation. Salary £300, rising to £350 by annual increments of £10. Applications to Town Clerk by Jan. 10. See advertisement in last issue.

Junior Assistant, King's Lynn. Commencing salary, £65 per annum. Applications to Borough Electrical Engineer by Jan. 7. See advertisement.

Working Electrician, Bridgend (Glam.) Urban District Council. Salary, £130 per annum. Applications by Jan. 5. See advertisement.

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RAILWAY ELECTRIFICATION.

In this, the last issue for the year 1904, one naturally looks to see in which of its many branches electrical engineering has made the greatest strides in the year that is just closing. This looking back on the work of the year reminds us of the early days when it was possible to give a comprehensive review of the contracts actually completed by the few electrical firms which were then in existence. The rapid growth of the industry and the increase in the volume of business done renders any such review quite impossible at the present day. The striking feature, however, in the electrical engineering work carried out this year is the commencement of the electrification of our railways. The Lancashire and Yorkshire Railway Company have completed the conversion of their Liverpool to Southport and Crossens line, which involved some thirty miles of route, and the North-Eastern Railway Company have completed and opened for electrical working the suburban lines which connect Newcastle-on-Tyne with the seaside residential districts which have sprung up round Tynemouth and Whitley. In this case some thirty-five miles of route are involved, as some lines running westward to country districts have also been electrified. The even larger work of the electrification of the underground railways of London has been in full swing during the year, and the Metropolitan Railway Company have officially opened the line connecting Baker-street and Uxbridge for electric working. The Metropolitan District Railway Company have also run a number of trains on some of their outlying lines, and there is every prospect of the Inner Circle service being worked electrically in the spring of next year. While the work of the electrification of steam railways has now been started, the lines converted form but a small fraction of even the suburban lines which must eventually adopt electricity for motive power. The progress of electric traction on railways in this country has been slow, due, we believe, to the serious financial questions involved. Thus, the earlier electric lines, like the Liverpool Overhead Railway, opened early in 1893, or the pioneer tube railway of the City and South London Company, opened in 1890, were hampered by the excessive cost of construction per unit length, and also by the fact that they were isolated lines without through connection to other railway systems. In consequence of this, the financial returns have not given a sufficiently large dividend to the shareholders to make the public keen to finance other undertakings of a similar nature. The Central London Railway, with its better load factor, was more successful, and clearly proved, like its predecessors, that electricity is a more efficient agent for working rapid suburban lines. There is little doubt but that the competition of these earlier tube railways and of electric tramways is the chief reason why railway managers are beginning to electrify their suburban lines. In the case of the North-Eastern Railway the results obtained already show that traffic returns can be restored by electric traction to at least as high a level as before the tramway competition was commenced. Other railway managers now recognise that electrification is bound to come, and their attendance at the opening functions of electrified lines shows their keen interest in the subject. The work now being undertaken by the Great Western Railway Company and by the London, Brighton, and South Coast Railway Company is an indication that the interest does not stop at schemes on paper only. As regards the technical side of the conversion, it is now clearly proved that with electric trains higher acceleration and mean speeds can be obtained with the multiple-unit system more economically than by the older method of employing a locomotive, whether the same be steam or

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electric. The details of this control of motors in various parts of the train from the driving compartment have yet, perhaps, to be considerably improved, but it is gratifying to know that three of our large firms are independently working on the subject, and they have each obtained success in practice, although their systems of control are radically different. This conduces to the survival of the fittest, and to the more economical electrification of other lines. While the progress in equipment for electrically driving heavy trains is satisfactory, there still remains with us the problem of conveying the current to the cars. All the time that the third rail was used on lines like the Liverpool Overhead or on the tube railways, in which the public have no access to the track, there was little to complain of as regards danger. This is far from the case when railways running through open country have exposed third rails for conveying the current at a voltage approaching six hundred. It is almost impossible to keep people from straying on to the track, and unfortunately with the unguarded rail a considerable number of fatal accidents have occurred. We understand that the London and Brighton Railway Company, acting on the advice of Mr. Philip Dawson, are going to try overhead conductors on their line near London, which is to be shortly equipped for electrical working. It seems to us that the ultimate solution of this problem is intimately connected with the new type of alternate-current railway motor, and that eventually overhead wires will be used with a much higher voltage on them. Increasing the voltage on the overhead wires will not materially increase the danger, as there are numerous satisfactory devices for rendering an overhead wire dead should a fracture occur. There is every sign that the year now before us will see great developments in the spread of electrification on our large railway systems, and we trust that the work will be more remunerative to contracting firms than other branches of the industry are at the present time.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE METRIC FALLACY.

SIR,—My attention has been drawn to a letter appearing in your issue of the 23rd inst. from Lord Belhaven, in which he states that it is obvious "if the proposal of the British Weights and Measures Association is carried out, the confusion would be as great, etc."

His lordship will perhaps be surprised to learn that this association has not yet made any proposal, though I am quite aware that some metricalists, for reasons of their own, have imputed to us a certain proposal which they have worked out in their own way, and made as big a muddle of it as they possibly could, and are now sending it forth as the prosposal of this association—a procedure which is about as correct as their statement that the metric system is "universal on the Continent except in a few nooks and corners."—Yours, etc., GEO. MOORES, Sec.,

British Weights and Measures Association.

London, S.W., Dec. 28, 1904.

SWITCHBOARD INSTRUMENTS, ETC.—Messrs. Cecil Hodges and Co., Balfour House, Finsbury-pavement, London, E.C., have recently published a price list, in which are included descriptions of their gravity and moving-coil instruments, recording instruments, horse-power meters, traction switches, circuit breakers, motor starters and regulators, porcelain switch fuses, distribution boards in cast-iron cases, house service fuse boxes, etc. The list is excellently printed on art paper, the illustrations being from wood blocks. We understand that Messrs. Hodges and Co. have a quantity of switchboard work in hand, including several large central station lighting and traction boards.

MANCHESTER LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Presidential Address by C. D. Taite.

Before touching upon the subject of my address permit me to tender you my most sincere thanks for the honour you have done me in selecting me as chairman for the present session of the Manchester Local Section. This section is now, and has been for some time, by far the most important branch of the parent Institution, embracing as it does over 700 members of the various grades. The chairmanship of the section is, therefore, no empty honour, and while I am fully aware of my own deficiencies, you may rely upon my doing my utmost to follow in the steps of my predecessors, and to uphold—as they have done—the dignity of the chair. In this matter I am happy to know that I shall have the support of all members of the section.

As most of you are aware, a students' section was successfully inaugurated last session, and this immediately led to a large increase in the number of students belonging to the section; in fact, at one meeting of the Institution in London no fewer than 120 new Manchester students were elected. The students start the session with about 250 members, and an excellent syllabus has been arranged, upon which the Students' Committee are to be heartily congratulated. The ardour with which this new development has been taken up by the younger generation of electrical engineers augurs well for the future of this section, as the experience gained by expressing their views at the junior meetings will be of the greatest service to those concerned when they come to take part in these general meetings; the quality of our debate will soon be materially benefited.

I will now pass on to the subject with which I propose to deal principally to-night, as it is the branch of electrical work with which I am best acquainted—namely, electricity supply undertakings—and having had the privilege recently of a tour in America, under the auspices of our own Institution, and also the American Institute of Electrical Engineers, I propose to discuss a few points in which American practice differs from our own. Both in this country and in America the electricity supply business started in a very modest way, with small stations equipped with what would now be considered quite diminutive machines, the main point of difference in the practice of the two countries being that in America all wires and cables were run above ground, while almost from the earliest days both feeders and distributors in this country were laid underground with few exceptions. If we follow the development over here, we find that it has been slow but steady, the small stations being gradually enlarged, until in the big cities they became so unwieldy and so uneconomical that a new generating station on a comprehensive scale with big units became a necessity, the small stations being used as sub-stations for distribution purposes.

A fundamental difference due to legislative enactments in the methods of dealing with the problem of supplying electricity from central stations, was observed in the two countries from the commencement. In Britain, with the sole exceptions of London and Newcastle, competition in the supply business was prohibited, one provisional order being granted for each city, town, or district. In America, on the contrary, a town of the size of Chicago or Philadelphia would be divided up amongst quite a number of companies, totalling sometimes as many as 20, each operating on a comparatively small scale, and frequently adopting entirely different systems as regards voltage and type of current. The development was more rapid over there, on account largely of the absence of those vested interests which here one always finds opposed to any great change, and also because the overhead system of supply enabled cables to be run more easily and much more cheaply than in this country.

To the early success of supply undertaking in America is perhaps traceable a great divergence of practice in distributing electricity. I refer to the almost universal system of supplying current in the States at a pressure of 110 to 120 volts direct current for lighting and 230 volts for motors, as compared with our pressures of from 220 to

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250 for lighting and 440 to 500 for power. It seems not improbable that when the higher-pressure lamp came along it was found it would be so expensive to change the arc lamps and motors that the psychological moment was allowed to pass without any alteration being made. Probably another reason was that no company operating in competition with other companies cared to make a change, which at that time would certainly have caused an increase in consumers' accounts, due to the low efficiency of the high-pressure incandescent lamps. Be that as it may, the Americans, with very few exceptions, did not make the change, and probably will never do so now. The result is that their distributing systems—so far as they are laid underground—are at the present time very much more expensive than ours, and where the supply necessitates sub-stations and transformation from high-tension three-phase to low-tension direct-current, sub-stations have to be much more frequent than over here. When the American engineers found their original sites becoming too small to meet the increasing demand, they recognised the fact that centralisation of large units under one roof would tend to economy, and there began in the various cities and towns the process of consolidation, with the result that at the present time one generally finds in each city one company only operating, this company being a consolidation of the many pioneer companies. By a series of developments, therefore, America has arrived at a point which our authorities foresaw from the first, and provided for by refusing to sanction more than one provisional order for a given area, and the evolution which has taken place over there seems to emphasise the fact that the competition that immediately arises between electricity and gas where light is concerned, and electricity and private plants where power supply is concerned, is in the nature of things so keen that to create competition between rival electricity undertakings in the same area is totally unnecessary, and not to the best interests of the community.

In England we are rapidly becoming converted to the advantages of the steam-turbine for driving our large units, particularly for alternating-current work. The manufacture of direct-current dynamos suitable for the high speeds at which turbines have to be run has not yet become general practice, though there are a fair number of successful turbo-driven direct-current generators in operation, but generally speaking they are of comparatively small size. It is now clear, however, that turbo-alternators can be satisfactorily designed and built for almost any power, and we shall shortly have running the power station of the underground railways in London, equipped with 10 5,500-kw. turbo-alternators, these machines being capable of carrying a load of 50 per cent. above that at which they are rated. The advantages of turbines have been enumerated so frequently that there is no need to tabulate them here. I would only call attention to two of them—namely, the great capacity they have for overloads, and, secondly, the saving in capital expenditure which their adoption renders possible. A 50 per cent. overload can be maintained permanently on a turbine with little loss of efficiency, the principal loss being generally in the reduced vacuum. It is, therefore, important when ordering turbo-driven plants to specify for ample margin in the generator, in order to take advantage of the overload capacity of the turbine, a feature likely to be of the utmost utility in central-station work.

With regard to the reduced capital expenditure required with turbo-driven plants, it is obvious that the plant itself costs much less than a slow-speed set of similar output, and owing to the reduced weight, the even turning moment, and the absence of all downward thrust, the foundations can be made much lighter. Again, a turbine plant—even of the vertical type—can be housed in a comparatively low building, and the floor space occupied is a minimum. On the other hand, in order to get the best results from a turbine, an ample water supply for condensing purposes is essential, and this to some extent restricts the choice of a suitable site. As regards coal consumption, the advocates of turbines and of reciprocating engines both claim the best results for the type which they favour, but I think that one will not be far wrong in stating that with regard to this feature there is little to choose between the two types, when both are working under suitable conditions. In America it did not appear that the turbine was making such rapid headway as in this country; one could not help being struck, for instance, by the very large number of slow-speed machines in course of construction going through the shops of the General Electric Company and the Westinghouse Company of America. On the other hand, at Boston and Chicago turbine stations are in course of construction, the machines being of the vertical type, and of 5,000 kw. capacity. In both these stations, but more especially in the case of the Chicago station, the division of the plant into units complete in themselves has been very thoroughly developed; thus not only was each set supplied with its individual condensing plant and hydraulic pump for the step bearing of the turbine, which is worked at 1,200lb. pressure per square inch, but there was by the side of each machine a boiler feed pump; thus the firemen had nothing to look after but their boilers and stokers. Each turbine, again, had its own range of boilers, which normally was kept quite distinct from the rest of the boilers, there being only a—comparatively speaking—small connecting pipe between two adjacent ranges for use in case of great emergency; there was also a common chimney for two ranges of boilers. The arrangement, in fact, was practically the same as in the Carville power station in Newcastle, the boiler-house being at right angles to the engine-room.

With regard to the control of these large units, the Americans have adopted everywhere—in some cases in a most elaborate manner—a complete system of oil-break motor-driven switches with electrical remote control; in some cases duplicate control boards have been provided, so arranged that while one remains in use the other cannot be operated. Duplicate 'bur bars appear to be universal, and they are so designed as to render it possible to sub-divide the feeders and sub-stations which they supply into distinct groups, each of which can be fed by a separate machine. The safety of the employés—as far as the handling of these large units is concerned—has been dealt with most thoroughly, and at the same time elaborate precautions have been taken to prevent breakdowns, and also to minimise their effect should a failure on any portion of the plant occur. The oil-break switches themselves are usually arranged in lock-up rooms provided for the purpose. The amount of capital expended on switchgear is very great, but figures giving the percentage of the capital expenditure under this heading were not forthcoming

With regard to the boiler-houses, Babcock and Wilcox boilers, sometimes with mechanical stokers and sometimes without, appeared to be the universal feature of American power-houses. It seemed strange to find that in a country where labour-saving devices are specially favoured, owing in some degree to the high rate of wages prevalent, the question of mechanical stokers *versus* hand firing has not yet been definitely settled. The Americans appear to be in the same state of doubt as to which system is the most economical in the long run, as we are in this country. When one hears of widely divergent results being obtained from mechanical stokers of the same make, and using similar fuel, one is driven to the conclusion that the personal factor of the fireman has a good deal to do with the results obtained, and in cases where inexperienced men have been employed, owing to the belief that a mechanical stoker only requires watching and oiling, good results can hardly be looked for. Experience seems to show that the quality of the labour required for the mechanical stoker is quite as high as for hand firing, but the quantity required is less. The fact is the burning of coal—if the best results are to be obtained—requires close attention and strict supervision, whatever be the means adopted for feeding the furnace, and steam users who neglect to take any account of the products of combustion can hardly look for the best results. In these days of automatic recorders there is plenty of choice as regards the necessary instruments for taking records of the flue gases, and when the apparatus is first connected to the flues, the small percentage of CO_2 gas indicated is frequently astonishing.

With regard to the staff employed in a generating station, all those who have visited the States must have been struck by the attention which is given to the personal

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comfort of the staff, and also to the opportunity which is given to them to improve their technical knowledge by providing them with clubrooms, where they may meet and discuss matters of interest; these rooms are open, not only to the technical and office staff, but to every man employed by the company, however humble his position. Encouragement of this kind undoubtedly tends to make a man work more intelligently, and the statement that the men avail themselves largely of the facilities offered them to improve their knowledge seems to point to the fact that education in America has reached a higher standard than has yet been obtained in this country. This system of encouraging all grades of workmen to learn is a good one, and one which station engineers over here may with advantage take into consideration. In America there appears to be a much greater desire to gain knowledge than is the case in this country. Thus, when visiting Harvard University, we were informed that no less than 25 per cent. of the students earn their living while prosecuting their studies, and in the vacation it is no uncommon thing to find university men acting as drivers or conductors of tramcars, or doing other equally humble work. It certainly does appeal to engineers to find that a man is not looked upon with scorn at the highest seats of learning because he uses his hands to pay for the training of his brain. This enthusiasm for work is encouraged by employers, who have created a big demand for college-trained men. These men are paid from the day on which they start work, and their future promotion depends on their own ability and industry. A great deal has been written recently on the subject of the training of engineers. Personally, I feel that the facilities are available at the technical schools for young men to obtain a sound technical training provided that they attend the day classes for a three years' course. There is a necessity, however, for better organisation on the part of the educational authorities for obtaining appointments for their pupils when they have finished their course of technical instruction. It should not be a matter of great difficulty to make arrangements with local manufacturers whereby the latter would undertake to reserve a certain number of appointments annually for suitable scholars from the technical schools if they were forthcoming. In this manner technical training would receive great encouragement, and eventually the employers would certainly reap the benefit. One cannot expect men to give up three years of their life for technical training if at the end of that time there is no prospect of an appointment.

Turning, now, from central-station practice to the question of transmission and distribution of electricity, we find in America conditions which do not exist in this country. Over here, with few exceptions, there is no great difficulty in finding a suitable site for a generating station in any town where a supply is required; to that extent the conditions are the same in America, but there is this great difference that in many parts of the country, water power remote from any large centres of population is available, and is utilised for generating electricity; the power so generated has to be transmitted to the towns, with the result that overhead systems working at what we should consider excessively high pressures are quite widely used. The longest transmission scheme which was visited by the Institution of Electrical Engineers on the occasion of the recent tour was that from Shawinigan, on the St. Maurice River, in the Province of Quebec, to Montreal, a distance of about 90 miles. Power is transmitted on this system at a pressure of 50,000 volts, the current being three-phase at 30 periods, and the conductors being of aluminium. The line runs the whole distance alongside the railway, which is convenient, as the country is quite new, and transport difficulties would otherwise arise. This transmission scheme is typical of many other cases, with the result that three-phase working from the transmission point of view was developed much earlier than was the case in this country, where the necessity for high-tension transmission did not arise so soon. At the same time, it is noteworthy that while the three-phase transmission schemes have been perfected, the distribution schemes are almost invariably on the original system of three-wire, direct-current at 110 to 120 volts between the neutral and each of the outers, with a certain amount of alternating current for the scattered suburbs. The question of speed regulation of motors has undoubtedly had a great deal to do with the general adoption of direct current, while with regard to the low supply pressure referred to previously, it was stated that not only did expense stand in the way of any change to a higher pressure, but in the interests of consumers themselves, the lower pressure was preferable owing to the higher efficiency claimed for the lamps. The latter argument was undoubtedly one of considerable force in this country years ago, when the first changes to the higher pressure were being made, but at the present day there is little to choose in efficiency between lamps of 110 and 220 volts; and the saving in capital expenditure, not only on the cable system, but also in the houses of consumers, makes the higher pressure undoubtedly the most economical for both supplier and consumer. With regard to lamp pressures, the Edison companies control a large number of stations, and arrange matters so that the standard pressure in the various towns differs slightly. This is done in order to utilise to the fullest extent the lamps turned out by the lampmakers, the specification and standardisation of these lamps for the various pressures being very rigid.

Referring to the principle involved in the consideration of overhead *v.* underground conductors, where overhead systems are carried to excess, as has been the case in some of the American cities, particularly in Pittsburg and Montreal, the effect is most disfiguring. On the other hand, there is a good deal to be said for overhead conductors for scattered areas, whether they be suburbs of a large city or only a country district. In such areas the cost of cable per consumer frequently runs out to a very high figure, which could be much reduced if overhead distribution met with favour and could be adopted. Electricity is in much more general use in America for all purposes than is the case in this country, in spite of the fact that in the large cities, at any rate, the price charged is considerably higher than in England. Thus in Boston, where they have a lamp connection of 500,000 16-c.p. lamps and 24,000 h.p. in arcs and motors, the normal flat rate for lighting is 10d. per unit, subject to discounts according to current consumption. A small power consumer pays 3d. per unit, and the lowest figure quoted to any party is 1d. On these prices we were informed that private plants were rapidly being given up. At Chicago the price was on the maximum demand system, with Wright indicators, the tariff being for lighting 10d. for 30 hours' use per month of the maximum demand and 5d. for all current used in excess; similarly for power the price charged was 5d. and 2½d. Similar prices were charged in most of the other large cities visited. Wattmeters are universally used for registering the current, as compared with our system of ampere-hour meters.

With regard to output, the New York Edison Company, with a population in its area of about 2,000,000, has a maximum load of 50,600 kw. for lighting and power, with an annual output of 131,000,000 kilowatt-hours, which is a greater output than all our London companies and municipalities combined can muster. Montreal is an exceptional case, but it is so interesting that its position is worth recording. It has a population of 350,000 and 10,500 customers, compared with the 5,171 consumers of Manchester with a population nearly twice as large. The annual consumption, which includes power for the tramway service, is no less than 85,000,000 kilowatt-hours, and the company which supplies the current is the fortunate possessor of a 75 per cent. load factor. Amongst the consumers at Montreal is a 3,000-h.p. cotton mill, which is driven throughout by electricity, paid for at the rate of ½d. per kilowatt-hour. The mill has arranged its hours of work so that in certain winter months no current is taken between the hours of 4 and 7 p.m., hence the low rate of charge. This alteration has only necessitated a reduction of the average weekly working hours from 56 to 54. We were informed that the output from this mill had increased 40 per cent. since the conversion to electric driving, owing to the greater flexibility of the system and improved machinery as compared with steam driving; that 40 per cent. represented greatly increased profits, the costs, exclusive of the raw material, being practically constant. Other consumers in Montreal are given the benefit of a

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reduced tariff in cases where they undertake not to use their supply in winter months between the hours mentioned above. This system has been adopted to some extent in this country, notably at Brighton, but it is evident that if we are to bring up our load factors to anything like the same figure as at Montreal we must, under certain conditions, reduce our price much below anything quoted at present. There is no doubt but that it would pay many of our North Country stations handsomely to supply current between certain hours at ½d. per unit, and it would not require much modification of mill hours to accommodate themselves to a power supply, which would only be shut off in the months of November, December, January, and February, from 4 to 7 p.m. Such a striking example of what can be done in the way of obtaining a good load factor is well worth the consideration of all those who have to deal with the supply of electricity in this country, it being remembered that improvement in the load factor, even if it be obtained at a low margin of profit, must eventually be the means of a reduction in price to the general body of consumers.

Municipalities in America, at any rate in the larger cities, and to a considerable extent in the smaller ones, have not cared to take up the position of public suppliers of electricity, as has been done in this country; they have instead given franchises, usually for 50 years or thereabouts, to companies, who appear to be organising their business on a very sound basis. The companies frequently have a wiring department, and in some of the cities this department nearly monopolises the wiring business of the city. The lamp question has been solved in America by giving the consumer free lamps. The Edison companies, of which there are a great number, have large local organisations for dealing with this part of their business. Every consumer starts his installation with lamps furnished by the supply company, nominally on loan; he may have these lamps changed as often as he thinks fit, and in case of the theatres, where coloured lamps are frequently required, they are often changed weekly without any charge outside the cost of carriage. All lamps prior to being sent out are tested for candle-power and consumption, the limit for a 16-c.p. lamp being in the region of 14·5 c.p., and the consumption 3·2 watts per candle-power. All lamps are marked with their voltage, candle-power, and with the name of the supply company. When lamps are brought in, should they give less than 14·5 c.p. at normal voltage, they are, if sufficiently good, put aside for colouring for shop signs and theatrical purposes; otherwise, if too much blackened, they are destroyed. The life of the lamp is only reckoned as about 500 hours; their price is 7½d. We were told that the system of giving lamps free added about ½d. per unit to the price of current, but that figure seems to be rather under the mark, the total cost of the system being between ⅓d. and ½d. Be that as it may, the effect of the system on the incandescent lighting is very marked. Lamps in the shop windows always look bright and give a good light, and blackened lamps are as rare in America as they are common in this country. It is difficult, however, for engineers in this country to recommend their directors or committees to adopt exactly the same system here. The companies in America, by doing the bulk of the wiring themselves, have not to consider the effect of giving free lamps on the position of the wiring contractor. In England, on the other hand, it is very rare to find a company or a corporation doing the wiring of the district. This is in the hands of the contractors, who calculate to make a steady income out of the sale of lamps, and there would naturally be a great outcry on the part of these gentlemen if the free-lamp system, as adopted in America, were introduced on a large scale into this country. On the other hand, some such system seems to be the only way of ensuring that the consumers get a thoroughly satisfactory light with a minimum expenditure of current; and if the manufacturers were aware that all their lamps would be tested by an independent authority, and would be returned if below a certain standard of efficiency, it would make them much more careful as regards the class of lamp they sent out. The American system, however, has its drawbacks. Thus the consumer, being assured of a free supply of incandescent lamps, has very little encouragement to try any new type of lamp, such as the Nernst; and it is a fact that in America so small is the demand for Nernst lamps, where direct current is supplied, that a design suitable for direct current has not yet been put upon the market. The lamp is in the hands of the Westinghouse Company, and is used on alternating-current circuits only.

Generally speaking, the average American seems to have a much better appreciation of electricity for all purposes than the average Briton; he has appreciated its virtues, and has adopted it accordingly; he also appears to have made up his mind that it is profitable to him to buy his supply from the public mains at a price giving a reasonable margin of profit to the company, than it is to worry about a private installation; his money can be invested to better account in plant suitable for his own processes of manufacture; and he prefers to put his whole energy into his own business, rather than be troubled with the details of a private plant. Many of our smaller manufacturers in England might well learn a lesson from the American in this matter, though it may be thought that I speak with some bias; nevertheless, I assert unhesitatingly that many works which put down separate installations would find the convenience of a public supply which is always available more than outweigh the saving which they frequently only think they obtain by generating their electricity for themselves. It is a remarkable fact, and one much commented on in America, that while the American generating costs are as a whole no greater than similar costs in England, being, in fact, considerably lower than are obtained, generally speaking, by London stations, yet the selling price of current in America has to be considerably higher than the price in England in order to obtain the same return on the capital invested. It was a matter of great difficulty to obtain detail costs, including management charges, of American supply undertakings, but it seems pretty clear that the cost of the various consolidations that have taken place has been very appreciable. To begin with, the original companies which formed the consolidated company had frequently adopted different systems of generation and supply; thus some would be alternating with different periodicities, while there would also be considerable variation in the supply pressures. To bring these various systems on to a common basis has been an expensive matter, and it is well known also that consolidations of this description rarely take place without the creation of a large amount of paper capital. It has been recently pointed out by Mr. Merz in his admirable paper on "Power Station Design," that an increase of £1 per kilowatt on capital expenditure has a greater effect on the running costs than has a reduction of the coal bill by 6 per cent. where the price of coal does not exceed 6s. per ton. In America the coal bill is low, due to the use of large and economical units, but the capital expenditure per kilowatt installed is high, owing to the charges which have had to be made in assimilating the systems of the various companies, and in effecting the consolidation. From the companies' point of view the position is a satisfactory one, as a monopoly has been established, but from the point of view of the consumer it will be some years before he feels any financial benefit from the process of evolution which has taken place. This experience emphasises in a marked degree the necessity for careful finance with regard to capital expenditure.

The supply of electricity business is different from most others with which we are familiar, owing to the preponderating effect of capital expenditure as compared with running costs upon the selling price, and it behoves us, therefore, to do our utmost to prevent the capital of the undertakings with which we are concerned being unnecessarily inflated. As plant becomes obsolete the capital it represents should be written down out of revenue, and although this may mean a temporary loss of apparent profit, the undertaking will soon reap the benefit by the increased business which the reduced charges will bring in; it cannot be driven home too strongly that a heavy capital expenditure per kilowatt installed is bound, under ordinary conditions, to necessitate a high tariff, with a correspondingly restricted business. To undertakings, whether worked by companies or municipalities, which intend to cultivate a power load, this is a matter of great importance,

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and I am of opinion, therefore, that where current has to be transmitted to scattered areas, overhead wires should be as far as possible adopted. Where it is necessary, as in the case of the power companies, to convey electricity in many directions over huge areas, it would seem that overhead conductors are essential if the companies are to attain financial success. That it is important to all of us in whatever branch of the profession we are employed that these power companies should be successful is, I think, self-evident. Any development in the use of power in their areas cannot but stimulate the demand for electricity throughout the country generally.

We shall all watch, therefore, with the greatest interest—not unmixed with anxiety—the progress made by the pioneer stations which these companies are equipping. Apart from the supply of power to mines and factories, they should have a large sphere of usefulness in supplying current, not only to those towns which have not generating stations of their own, but also to those which have. In many cases I think it will be found to be to the best interests of those concerned to purchase current from outside in preference to carrying out expensive extensions to existing works, provided that the prices quoted are as reasonable as one has been led to suppose they will be. In any case, municipalities and others will do well before embarking on extensive schemes of expansion to enquire what the power companies are prepared to do, and to compare the terms quoted with their own costs, not forgetting the effect of the proposed capital expenditure on the selling price.

In conclusion, I am glad to have an opportunity of placing on record my great appreciation of the facilities afforded us by the American Institute of Electrical Engineers, on the occasion of the recent tour, for fully investigating the most recent practice in the generation and distribution of electrical energy in their country. The programmes in the various towns visited were organised in a manner beyond all praise, and everywhere we were received with unbounded hospitality. Under such favourable conditions a successful tour was assured, and those who were privileged to take part in it will not soon forget the elaborate preparations made to ensure their comfort. The compilation of the electrical handbooks alone, containing as they do a history of each city and neighbourhood visited, together with an account from the earliest days of the various electrical supply undertakings and manufacturing companies connected therewith, was a work of very great magnitude, and one which was thoroughly appreciated by the fortunate recipients. They form a complete work of reference of the progress of electrical engineering in America, and they will always be treasured by the whole party as a permanent memento of the tour.

FORTHCOMING EVENTS.

Jan. 5.—A general meeting of the Röntgen Society will be held at 8.15 p.m., when Mr. C. E. S. Phillips will give a description of an automatic vacuum pump, which will be followed by an exhibition of a method by which strongly-adherent films of aluminium may be applied to glass; and "A Note on the Colouration of Glass by Radium Radiation."

Jan. 10 and 11.—At the Institution of Civil Engineers, Sir W. H. White will deliver an address, entitled "The Recent Visit to the United States and Canada."

Jan. 13.—A lecture, entitled "Theory of Electricity and Magnetism," will be delivered by Mr. J. Swinburne to the students of the Institution of Civil Engineers.

Jan. 27.—The following papers will be read at the Physical Society: "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows; "Action of Radium on the Electric Spark," by Dr. Willows and Mr. J. Peck; "The Slow Stretch in India-rubber, Glass, and Metal Wires when subjected to a Constant Pull," by Mr. J. Phillips; "Determination of Young's Modulus for Glass," by Mr. C. A. Bell; and "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

Jan. 5.—Rugby Engineering Society. A paper will be read on "Patternmaking," by Mr. R. Watson.

Jan. 12.—At the Institution of Electrical Engineers, resumed discussion on Mr. Adams's paper, "The Combination of Dust Destructors and Electricity Works Economically Considered," and, time permitting, Messrs. Booth and Kershaw will present a paper on "Fuel Economy in Generating Stations."

FARADAY SOCIETY.

The tenth ordinary meeting of the Faraday Society was held on Monday, Dec. 19, 1904, at the Institution of Electrical Engineers, Mr. J. Swinburne, vice-president, occupying the chair.

M. ADOLPHE MINET communicated Part II. of his paper on "The Electric Furnace: its Origin, Transformations, and Applications," which was kindly read in abstract by Mr. R. S. Hutton. In the first and introductory part of his paper, which was read before the society on June 9 last, M. Minet showed that the historical development of the electric furnace falls into the three following periods: (1) laboratory furnaces, 1808 to 1886; (2) industrial furnaces, 1886 to 1890; (3) development of industrial applications from 1890 to the present day. The present instalment, after some preliminary general remarks on the E.M.F., current densities, and yields, with arc furnaces and resistance furnaces respectively, proceeds to deal in detail with the evolution of the furnace during the first period. The subject is subdivided as follows: (*a*) original furnaces—namely, Davy's arc, Pepys's resistance furnace for the cementation of iron, and Davy's and Napier's cathode furnace; (*b*) electrolysis at high temperatures—the production of aluminium and its alloys, and the alkali and alkaline earth metals; (*c*) miscellaneous furnaces, of which the most important are the early Despretz and Pichon furnaces, Berthelot's electric "egg" for the synthesis of acetylene, Siemens's and Huntington's well-known steel and other furnaces, the Louis Clerc furnace, interesting as the progenitor of the famous Moissan type, and Borcher's resistance furnace. The paper, which is illustrated with diagrams of the principal furnaces alluded to in the text, closes with a bibliography covering the period dealt with. A final instalment will discuss the furnaces of the second and third periods.

Mr. W. B. CLARKE referred to the importance and difficulty of making temperature determinations of electric furnace processes, and expressed the hope that M. Minet would deal with that question in Part III. of his paper.

Mr. L. GASTA handed round some "siloxicon"—one of the newest products of the electric furnace—and described its properties.

Mr. E. KILBURN SCOTT (communicated) described some of his experiences in the early days of the manufacture of calcium carbide.

The CHAIRMAN described a novel type of furnace that he had once hit upon by accident, and which he thought might turn out to be useful. He was sending a current through fused barium chloride, and the temperature having been allowed to get too high the cast-iron crucible melted and formed a fused mass that was kept together by an outer skin of solidified chloride. This suggested the use of a neutral substance like barium chloride for heating to a very high temperature alloys or metals which it was desired not to contaminate with impurities.

Dr. F. MOLLWO PERKIN read a paper by himself and Mr. W. C PREBBLE on the "Electrolytic Analysis of Cobalt and Nickel."

Cobalt.—The aim of the experiments was to obtain bright deposits of the metal that should be quantitatively accurate. Various reducing agents were first of all employed, but only with sodium hypophosphite were brilliant deposits obtained, and then phosphorus was found to be present. Salts of the various organic acids were next tried, but only ammonium oxalate and tartrate gave satisfactory results, the latter having the better appearance. Traces of carbon, however, were deposited with the metal. Ammoniacal solutions of ammonium borate were also tried. The most satisfactory results were obtained with a solution containing an alkali phosphate and a little phosphoric acid, the latter to prevent the precipitation of the double sodium cobalt phosphate. To remove a brown anodic deposit which forms, the addition of a little hydroxylamine is recommended. By this method the whole of the metal can be thrown out in from 3 to 3½ hours.

Nickel.—Similar solutions were tried for nickel deposition. In this case splendid results were obtained with the borate solution, while the phosphate solution, which gave

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such good figures in the case of cobalt, was not at all satisfactory. The authors have not yet succeeded in devising an accurate electrolytic method for the separation of nickel of cobalt, and they find that the methods given in books are unreliable.

Dr. O. J. STEINHART discussed the problem of the separation of the metals. The present method is based on the fact that cobalt is more easily oxidised by chlorine than is nickel. He also referred to the possible industrial bearing of the work of the authors in connection with nickel extraction.

Dr. L. DOBBIN, in a written communication, drew attention to the work of Marshall on the same subject. In the case of cobalt, he merely added a little nitrate to the ordinary double sulphate solution.

Dr. PERKIN said that the presence of nitrate rendered deposition very slow.

Mr. F. GELSTHARP presented two short papers entitled "The Electrolytic Preparation of Tin Paste" and "Note on the Electrolytic Recovery of Tin" respectively, which were read by the Secretary. The author first describes briefly the original Indian mode of making tin paste—which is used for the production of metallic paper and other ornamental purposes—and the chemical process as generally carried out. The latter is troublesome on account of fumes, and some of the tin is precipitated as bright crystals, which are useless for this purpose. Moreover, the electrolytic process is less costly, in spite of the low current efficiency (50 per cent.), and can be worked continuously. The process consists in dissolving anodes of tin, roughly cast from commercial ingots, in dilute hydrochloric acid, and depositing the metal in the form of sponge on cathodes of block tin or tinned iron. The current density at the cathode is 270 amperes per square metre. The electrolyte is kept in a state of rapid circulation. The deposited sponge is allowed to grow to a thickness of about an inch and is then scraped off the cathodes. It then floats to the top of the bath and is scooped away. To produce 20cwt. of paste a week requires a generator giving 1,500 amperes at eight to ten volts. Mr. Gelstharp's second note describes an experiment that has some bearing on the conditions necessary for electrolytically stripping tin plate. A current was sent through an electrolyte of pure caustic soda at a temperature of 80deg. C. by means of an anode and cathode of tin plate. The voltage was 3½, but a current of only one third of an ampere passed through the cell; there was very little gassing, and the tin did not strip from the anode, but became coated with a light-brownish adherent deposit. the author considers this to be an oxide of tin, for on reversing the current for an instant and then reversing again, a current of 1½ amperes at one volt passed freely, and the tin was effectively dissolved, due to the reduction of the oxide film to metal by the hydrogen evolved at the moment of reversal. The deposited tin generates hydrogen in water. The author considers that, besides containing an alloy of tin and hydrogen, tin paste deposited from an alkali solution also contains sodium. Agitation of the cathode is of great importance in tin recovery. A quick succession of shocks by reducing polarisation reduces the consumption of energy by 30 to 40 per cent. Finally, the acid and alkali processes for tin recovery are compared. The former is the more suitable for making tin paste, and the latter for tin recovery from scrap.

Mr. W. C. PREBBLE thought an endless band would be a less crude method of removing the paste than that given by the author. Regarding the presence of arsenic, which was hurtful here, it was curious that in the case of zinc this actually causes a spongy deposit to form.

Dr. O. J. STEINHART gave a few particulars of an electrolytic detinning process that was now successfully treating in London seven or eight thousand tons of scrap per annum. A great difficulty found in practice was to dry the tin sponge without its firing.

Dr. T. C. CAIN did not think it probable that sodium was deposited with the tin.

Mr. H. SAYER asked what percentage of the tin was recovered. An objection to an alkali process was that it would not remove the tin from the alloy at the surface junction of the two metals.

Mr. A. C. BAWTREE sent in a written communication describing an electrolytic method for making tin powder that he had worked out some years ago. His solution contained 0·5 per cent. $Sn Cl_2$ and 0·33 per cent. $Sn Cl_4$, and was worked cold with an E.M.F. of 2·32 volts. This solution successfully overcame the difficulty of crystalline deposits.

Mr. H. S. COLEMAN also communicated some of his own experiences in tin deposition. He had worked under conditions similar to those described by Mr. Gelstharp. He found, however, that if the bath were worked between 50 deg C. and 60deg. C., no difficulty was experienced in starting the current, and the scrap was stripped clean in 20 minutes.

TRADE NOTICES AND NOVELTIES.

Catalogues, etc.

HART ACCUMULATOR CO.—This company, of Marshgate-lane, Stratford, London, E., are issuing a serviceable blotting-pad for 1905.

ELECTRICAL POWER STORAGE COMPANY, LIMITED, 4, Great Winchester-street, London.—The above company have issued as usual their useful combined blotter, pad, and calendar illustrative of their E.P.S. storage batteries, which are now used in 200 central stations and over 10,000 private installations in the United Kingdom, and which we learn have obtained the highest awards wherever exhibited.

XMAS CARD.—Mr. F. Hope Jones sends us a Xmas card in the shape of snapshot taken in September of the Electricity Building at St. Louis, where the "Synchronome" system was awarded a gold medal.

DRY BATTERIES.—A leaflet which we have received from Messrs. Krupka and Jacoby, 61-62, Watling-street, London, E.C., gives some particulars of Dr. Lessing's dry battery, seven sizes of which are listed. It is claimed that these batteries possess very high efficiency, excellent insulation, low internal resistance, reliable recuperative power, and neither leak nor burst open.

TANGENTIAL WATERWHEELS.—The Abner Doble Company, of San Francisco, California, U.S.A., have sent us an illustrated pamphlet describing the tangential waterwheels which they make to operate under high heads of water.

ELECTRIC LIGHT ACCESSORIES, ETC.—The Sun Electrical Company, Limited, 118 and 120, Charing Cross-road, London, are now issuing Section X of their 1905 catalogue. This section deals with electric light accessories, switches, switchboards, distribution boards, cables, instruments, incandescent lamps, Simplex conduit, etc. It runs into some 130 pages, and is well illustrated.

GAS AND OIL ENGINES.—The latest illustrated catalogue issued by the Acme Engine Company, Limited, Budhill-avenue, Shettleston, Glasgow, contains a great deal of information about gas-engines, oil-engines, and suction gas producers of their manufacture, besides some useful hints to users of gas-engines. On p. 31 there is illustrated a 44-b.h.p. Acme gas-engine, combined with a 60-b.h.p. suction gas producer, the whole making an exceedingly compact plant.

PERSONAL.

The resignation of Mr. E. Moxon, mains superintendent, has been accepted with regret, and Mr. J. W. Turner has been appointed chief electrical assistant at Huddersfield.

Mr. Heron, the late electrical engineer for Elland, who has resigned his position as a protest against the dismissal of his assistant (Mr. Barton) is beginning business in Huddersfield as a consulting engineer. Mr. Barton has received an appointment as chief electrical engineer under the Horsham Council in Sussex.

The Acton District Council have confirmed the appointment of Mr. James Harry Chick, of Horsham, as senior charge engineer in the electricity department at a salary of £130 per annum.

A presentation was recently made to Mr. J. J. Lightfoot by the staff of the electricity department of the Woolwich Borough Council before he has obtained his present appointment with the County of London Electric Supply Company, Limited. The present took the form of a gold albert. Mr. Lightfoot has the good wishes of his former colleagues for his future success.

One hundred and forty-seven applications from all parts of the kingdom were received for the position of electrical engineer to Leigh Corporation. The Tramways and Electricity Committee have decided to recommend the appointment of Mr. A. T. Smith, of Bury. The salary is £250 per annum, rising by annual increments of £25 to £350. Mr. D. M. Kinghorn, the present engineer, has been appointed electrical engineer of Southwark at a salary of £350 per annum.

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LEGAL INTELLIGENCE.

A TRAMCAR NOT A HACKNEY CARRIAGE.

The Lord Chief Justice, Mr. Justice Kennedy, and Mr. Justice Ridley heard an appeal by the Yorkshire (Woollen District) Electric Tramways (Limited) against a decision of the justices of Dewsbury, who had convicted and fined them 2s. 6d. The appellants were a light railway company, formed under provisional orders in accordance with the Light Railways Act of 1896; and the respondent, Mr. Hiram Ellis, the town clerk of Dewsbury, summoned them for allowing one of their cars to ply for hire in the borough without a license, his contention being that under the Towns Police Clauses Act of 1847 the vehicle must be regarded as a hackney carriage. The magistrates had upheld this contention, and this appeal was against this decision.

Mr. Danckwerts, K.C., for the appellants, said the decision that a carriage run upon a light railway was a hackney carriage carried with it the absurdity that a light railway must get a license from every local authority through which the line ran, and each local authority would have the discretion of saying how many of these carriages there must be.

The Court allowed the appeal, with costs, and quashed the conviction.

The **Lord Chief Justice** said they could not come to the conclusion that that which was in substance a railway was to be subject to the provisions of the Towns Police Clauses Act in regard to the licensing of hackney carriages. The absurdity of the thing was too great. The appeal, therefore, must succeed.

ACTION AGAINST THE LONDON UNITED TRAMWAYS COMPANY.

An action came before Mr. Justice Ridley and a jury in which Alfred John Simpson and his wife claimed damages for injuries alleged to have been sustained through the negligence of the servants of the London United Tramways.

The plaintiffs were driving a pony and trap along the Chiswick High-road in the direction of Kew, and when opposite Linden-gardens, Mr. Simpson pulled on to the tramlines to pass another van going in the same direction, when the wheel of the trap skidded in the tramlines, and threw the horse and cart across the other set of metals. A tramcar which was proceeding towards Hammersmith was then 20 or 25 yards distant, but the driver, according to the plaintiffs' account, made no effort to stop his car, and ran into the trap, throwing out Mr. and Mrs. Simpson, both of whom sustained injury, the trap being smashed beyond repair.

The defence was that the tramway lines were in a perfect condition, only having been repaired the week prior to the accident, which was due to the pony either shying or being driven across the up metals right in front of the oncoming car.

His Lordship, in summing up, stated that the real question for the jury to consider was, Had the driver of the car time to avoid the accident?

The jury returned a verdict for the defendants, with costs.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION.

The interim report of this Company states that the directors have not undertaken new obligations of any magnitude, and the policy of restricting capital commitments as much as possible for the present has enabled them to reduce considerably the administration expenses, whilst some promising schemes are kept in reserve to be dealt with when conditions are more favourable. There has been an increase in the aggregate traffic receipts of the associated companies, although, owing to the general depression in trade which has prevailed during the year, the increase has not been so large as was anticipated. It is hoped, however, that with the expected revival in trade there will be a further improvement in traffic receipts and in the income from the Company's investments, which last year yielded £136,230. The award of the umpire in the matter of the sale of the undertaking of the Poole and District Electric Traction Company, Limited, to the Bournemouth Corporation has not yet been made, but may be expected shortly. This has since been announced, and is referred to in our "Traction" notes. The directors have declared the usual interim dividend at the rate of 6 per cent. per annum upon the ordinary shares for the six months to Sept. 30 last.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH).

A special meeting of debenture holders of this Company have had laid before them a scheme for writing off 20 per cent. of the debenture stock, 3½ per cent. instead of 5 per cent. being paid on the balance for the next 11 years. At the end of that period, if the Company achieved the success anticipated, the written off debentures were to be reinstated, and the difference between 3½ per cent. and 5 per cent. paid on the whole stock. The debenture holders appointed Messrs. Percy Musgrave (Bolton), A. M. Sing (Liverpool), and Joseph Wilson (Liverpool) to associate with the trustees (Mr. Harmood Banner and Alderman Joseph Heap) as a committee "to consult as to the best course to be taken in the interest of the stockholders." This committee was empowered to raise £10,000 to meet the immediate requirements of the Company and to finish the construction of the tramway, and to appoint managers of the undertaking. The consideration of the financial scheme was postponed to another meeting of the stockholders, to be held on a date to be fixed by the trustees.

FLYING MACHINES.

Under the winding-up order made against the Sir Hiram Maxim Electrical and Engineering Company, Limited, meetings of creditors and shareholders have been held at the Holborn Restaurant before Mr. A. S. Cully, assistant receiver.

Proofs for £10,611 have been lodged by 167 creditors, but the statement of affairs has not yet been completed. The unsecured debts are stated to amount to £29,804, in addition to loans on debenture bonds, £20,000, and interest thereon £305, while the assets are valued at £57,000, showing a surplus, as regards creditors, of about £7,000. The Company was formed in May, 1899, as the Maxim Electrical and Engineering Export Company, Limited, with a nominal capital of £100,000. Its object was to acquire the sole rights for the sale in Australasia, Africa, and Asia of all articles to be manufactured by the Hiram Maxim Electrical Company, Limited, and by J. F. Pease and Co., Limited, of Middlesbrough-on-Tees. In February, 1901, the name was changed to the Hiram Maxim Electrical and Engineering Company, Limited, the capital being increased to £175,000, and in September, 1903, a further increase of £15,000 was made, making the total capital £190,000. The present issued capital was £170,399. Mr. Alfred Hardie had acted as managing director since January last. In the following March the Company acquired from Sir Hiram Maxim his patent rights relating to captive flying machines, and another company was afterwards formed, with a nominal capital of £30,000, and acquired those rights for £20,000, payable in shares. Several thousand of the Flying Machine Company's shares had been sold at par. A reconstruction scheme is contemplated, so it is proposed that a liquidator other than the official receiver shall be appointed. Mr. Alfred Hardie and Mr. A. F. Whinney have been nominated for this office, and the appointment will be settled by the Court.

Sir Hiram Maxim said he had put a great deal of money into the Company, and had not sold a single share. Owing to the state of his health he had been out of England during the greater part of the Company's existence, and had, therefore, but little knowledge of its affairs. He had derived no pecuniary benefit from his association with it.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Oporto.—The Municipal Authorities require tenders for lease o their electric tramways. Tenders by March 15.

Bucharest.—Tenders are required by Jan. 5 at the offices of the Roumanian State Railway, Bucharest, for the supply of a 20-h.p. motor-wagon.

Berne.—M. G. Anselmier, of Berne, has obtained authority to construct and work three electric funicular railways in that city; the cost of the construction is estimated at £16,000.

Caen (France).—The Prefect requires tenders for concession of a tramway from Eyes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1, 1905.

Completion of Works.—A local authority in possession of powers for the electric lighting of its area is open to negotiate with suitable persons for the execution and completion of the works. See advertisement.

La Paz (Bolivia).—The Municipality require tenders for the electric lighting of the town for 12 years. There is an old central station and water power of 150 h.p. to 200 h.p., which is sufficient for the number of lamps required. Tenders by Jan. 15, 1905.

Port Elizabeth.—Messrs. Davis and Soper, 54, St. Mary-axe, E.C., agents of the Municipal Corporation of Port Elizabeth, South Africa, invite tenders for various works in connection with the Corporation electricity supply undertaking Tenders by Jan. 16, 1905.

Pudsey.—The Corporation invite tenders for underground electric mains, switchboard, etc. Specifications, etc., may be obtained on application to Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds, Tenders to the Town Clerk by Jan. 20.

London, N.—The Metropolitan Asylums Board invite tenders for installation of fire-alarms at Northern Hospital, Winchmore Hill, N., in accordance with plan and specification prepared by Mr. W. T. Hatch, M.I.C.E., M.I.M.E., engineer-in-chief. Tenders by 10 a.m. on Jan. 24.

Swindon.—The Corporation invite tenders for the supply and erection of one 30ft. by 8ft. Lancashire boiler with down-take superheater, steam, exhaust, and feed piping, etc. Tenders to be delivered before 10 a.m. on Tuesday, Jan. 24, 1905, to Mr. Robt. Hilton, town clerk. See advertisement.

Erith.—The Urban District Council invite tenders for overhead line equipment, poles, etc.; underground feeder cables, boxes, etc.; rotary converters, transformers, and motor-booster; and main high and low tension switchboards, cable connections, etc. Tenders by Jan. 9. See advertisement in last issue.

Hull.—The Public Libraries Committee invite tenders for the necessary electric light installation and fittings required at the Carnegie Library, West Park, Anlaby-road. Specifications may be obtained at the office of Mr. Joseph H. Hirst, city architect, Town Hall, Hull. Tenders are to be addressed to the Chairman of the Libraries Committee, and delivered at the Town Clerk's Office, Hull, before 10 a.m. on Jan. 2.

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Johannesburg.—The Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach screws, and dog-spikes. General conditions, specifications, and forms of tender may be seen at the offices of the Council's consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and may be obtained on payment of five guineas. Tenders by Jan. 26. See advertisement in last issue.

South London Electric Supply Corporation.—The Directors invite tenders for the construction, supply, and erection at their works at Bengeworth-road, Loughborough Junction, S.E., of one 750-kw. steam alternator with pipe connections and sundry ironwork. Sealed tenders must be forwarded to the secretary of the company, Mr. H. H. Boyer, Bengeworth-road, Loughborough Junction, S.E., before noon on Jan. 16. See advertisement in last issue.

Shanghai.—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Peok and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

Plasencia.—Tenders are required for the concession for 10 years of the lighting by electricity of the town. Adjudication of tenders will take place on Jan. 28, and tenderers, if not appearing in person, must be represented by a duly authorised agent. The conditions of concession are set out in the notice in the *Gaceta*, which may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

Copenhagen.—The Public Lighting Office of Copenhagen invite tenders for the installation of a central electrical station at the Valley gasworks in accordance with conditions and drawings which can be inspected at the Ostre and Valley Gasworks, or obtained therefrom on payment of £1. 2s. 3d., which will be returned provided a tender is sent in in due time, accompanied by the drawings, etc. Tenders must be sent in to the Director for Public Lighting, 22B, Vestre Boulevard, Copenhagen, by noon on Jan. 23.

Madrid (Spain).—An application has been made by the Société Générale des Tramways de Madrid et d'Espagne for a concession for an electric tramway in Madrid to extend the existing Northern Madrid tramway. Tenders, which will be adjudicated on Feb. 25, are invited for this concession on more favourable terms than those proposed by the company in question. The adjudication will turn in the first case on the reduction of the tariffs proposed, and if two or more identical proposals are made, a further verbal adjudication will take place with a view to the reduction of the period of the concession (60 years).

London, W.—The Great Western Railway Company invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, etc.: (Specification No. 8) steel conductor rails, cast-iron and steel ramps and fastenings; (9) porcelain insulating supports and their fastenings for conductor rails; (10) copper bonds, insulated cable connections, cable terminals, bonding presses, and accessories for connecting up conductor rails. Tenders, addressed to the Secretary, Great Western Railway, Paddington Station, W., will be received on or before Jan. 3.

Melbourne.—Tenders will be received at the office of the Deputy Postmaster-General until noon on Feb. 7 for the supply and delivery of (1) 3,500 trunk-line multiple jacks, in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications may be seen at the General Post Offices at Melbourne, Sydney, Brisbane, and Adelaide. Tenders, endorsed "Tender for ——," as the case may be, addressed to the Deputy Postmaster-General, Melbourne, may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. The deposit to be enclosed with the tender is 5 per cent. on the total amount.

Porto (Portugal).—The Town Council opens a competition, which will close on March 15, at 3 p.m. precisely, for the concession of the exclusive right of the working of tramways for collective transports of passengers, luggage, and goods in all the municipal public ways, present and future, which favour that service, or in a special way within the limits of the town of Porto, according to the conditions approved in the meeting of Dec. 1 of the present year. The bases to which the eighth condition refers, the Herman Lourenzo Feuerheerd's request, and the rates, with the minima of the journeys, and the maxima of the prices of the passages, are published to the town hall's office for those who want to examine the conditions of the competition. The conditions of the competition are published to the Portuguese Consulate in London.

RESULTS OF TENDERS.

Bermondsey.—The Borough Council have accepted the tender of Sweet Bros., of Hampstead, for electric wiring at Rotherhithe Town Hall, at £33. 17s. 6d. The highest tender was £118. 10s.

Southend.—The Town Council have accepted the tender of Wimshurst, Hollick, and Co., at £415, for the provision of a new electric crane in lieu of the old steam crane now used on the loading pier.

Withington.—The Guardians of Chorlton Union have accepted the tender of Smethurst and Co., 67, Trevelyan-buildings, Corporation-street, Manchester, for electric lighting of old nurses' home, Withington Workhouse.

Kingston-on-Thames.—The Town Council have accepted the tender of Siemens and Co., at £174, for the supply of half a mile of 1 high-tension armoured cable; and that of Henley's Telegraph Company, at £115, for half a mile of 5-ampere and a like quantity of 20-ampere twin house service cable.

Cardiff.—The Electric Lighting Committee have accepted the following tenders for new plant for the extension of the Roath power station, which is to be made to meet the increased demand for electric lighting in the town: Musgrave and Co., Bolton, two 1,600-i.h.p. engines, with extras, £14,304; General Electric Company, Birmingham, two 1,100-kw. generators, £3,114.

BUSINESS NOTES.

TRACTION.

Raworth's Traction Patents, Limited.—Letters of allotment were posted on the 23rd inst. The company commences business with orders for 65 cars.

Dover.—The Corporation held a special meeting last week to inspect the plans and drawings in connection with the River light railway scheme, and it was decided to invite tenders, returnable on Jan. 10.

Llanelly.—A special meeting of the Estates Committee of the Town Council was held last week for the purpose of considering the agreement with the traction company, but the proceedings were held *in camera*, and the result has not so far been made public.

Birmingham.—An informal offer has been made by the traction company to instal a section of track on the Kingsland surface-contact principle, the company to work the line for a certain period, and, if it prove unsatisfactory, to substitute overhead equipment free of charge.

Kirkcaldy.—A movement is on foot for extending the Corporation tramways to Dysart. It is understood that the Dysart authorities are likely to guarantee against loss to the extent of 2½d. on the rates, while Sir Michael Nairn and other local gentlemen are offering a further guarantee against loss.

Newark and District Light Railways.—The Balderton Parish Council have unanimously approved of this scheme, and have appointed representatives to support it at the enquiry which the Light Railway Commissioners will hold shortly. The draft order names five years as the period for completing the system.

Ashton.—The construction of the new line to the borough boundary at the County Bridge, Dukinfield, which will be about 700 yards in length, has been commenced. The question of its lease to the Stalybridge Joint Board, when completed, has not yet been settled, there being a difference as to the amount payable to Ashton for the use of the line.

Bury.—At a meeting of the Bolton Corporation the Bury Corporation notified their intention of presenting a Bill to authorise the construction of tramways between Radcliffe and Ainsworth. The Bury Corporation also deposited plans with the Bolton Corporation for the proposed extension of tramways joining up to the borough boundary at the Coach and Horses.

West Cumberland.—The Whitehaven Rural District Council have received notice from the West Cumberland Tramways Company with regard to their application to Parliament for extension of time. Last year, when the Bill was before Parliament, the Council assented, and they have decided to do so again. As we mentioned in our issue of the 2nd inst., there are now signs that the scheme is to be proceeded with.

Hobart (New Zealand).—Hobart has had electric tramways for 11 years, the shares in which are mostly owned in Britain. Last year over two million passengers were carried, the average being about 5,500. It may be mentioned that the company is not extending its rails, but is importing motor 'buses to take passengers further afield. It is proposed to undertake electric lighting, for which the company has power under its incorporating Act.

Middlesbrough.—An account of a resourceful act by a motorman comes from Middlesbrough, where Driver Bates observed a child, unconscious of danger, standing on the track. The child did not move when the gong rang, and as it was impossible to pull up the car in time, the driver swung himself in front of the car, and after moving the child with his feet from the track, swung himself back to his post, his promptitude exciting the admiration of the witnesses.

Falkirk.—The Falkirk and District Tramways Company and the Town Council are at issue on the question of power supply. The former propose to take the current for their electric cars from the Scottish Central Electric Power Company, and the Town Council, who have a lighting and power plant, have resolved to write to the company pointing out that, according to the Act, the Scottish Central Power Company are precluded from supplying energy for use within the town of Falkirk.

Coventry.—A lengthy discussion ensued at the meeting of the Town Council, when the Streets Improvement Sub-Committee, after an interview with Mr. Winslow, engineer to the tramways company, recommended that the question of opposition to the tramway company's Bill, seeking an extension of time for reconstruction, remain in abeyance for a month in order that it might be seen what progress is made with the work under the altered arrangements made by the company with their contractors. Eventually the matter was referred back to committee.

Rochester.—The first section of the Rochester municipal tramway has been inspected and passed by Major Pringle, the Board of Trade inspector, and the line, which is on the overhead system, has been opened to the public. This line brings Rochester into direct tramway communication with Chatham, and the Gillingham and Chatham Light Railway Company, by agreement with the Rochester Town Council, will operate it as part of their system. The other sections of the Rochester municipal tramways will be deferred pending the adoption of a scheme of main drainage.

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Leicester.—With the opening last week of the Fosse-road circular route and the Groby-road route the whole system of electric tramways in Leicester has practically been completed. Twelve cars will work the former route, which is expected to prove one of the most popular and best paying on the whole system. All parts of the town now possess an excellent service, but the committee are making a few experiments in the running arrangements for the different routes so as to work the system to the best advantage.

Bournemouth.—The result of the arbitration between the Corporation and the Poole and District Electric Traction Company in connection with the purchase by the Corporation of the company's lines between Poole and Bournemouth and the rights they possess in Bournemouth and Christchurch districts is that the umpire, Mr. Justice A. T. Lawrence, and the referees, Mr. W. Eve and Mr. R. Vigers, have fixed the price at £112,000, the Corporation to pay the costs of arbitration. The company's original claim amounted to some £450,000, while the Corporation's estimate was between £60,000 and £70,000.

Cardiff.—Mr. Ellis recommends a parcels service, which, he anticipates, will earn an appreciable revenue. The Corporation look upon the suggestion with favour, and are to consider it further on a report from Mr. Ellis. Another recommendation on the part of Mr. Ellis has been accepted by the Tramways Committee, and will be presented to the Council. This is that, instead of all the cars following a through route, some of them should serve particular districts, so as to provide an adequate number of trams for the busy districts. It is also proposed to eliminate several stopping places, the present speed of the cars being low.

Underground Railway Fares.—It is highly probable that after all zone fares will not be adopted on the District Railway. The firm refusal of the Metropolitan Railway to discontinue 1d. fares and the issue of season tickets has considerably increased the difficulties of the adoption of the scheme, and made it practically impossible, as far as interchange tickets on the Inner Circle are concerned. The District Railway, who hitherto have refused to grant renewals of season tickets beyond Dec. 31, 1904, now announce that for the present they will continue to issue monthly season tickets. This change of attitude on the part of the directors is regarded in well-informed quarters as the first step towards the abandonment of the zone system.—*Daily News.*

Ilford.—At the meeting of the Urban District Council, Councillor Bailey proposed that the Council should consider the surplus moneys standing to the credit of the tramways undertaking and decide how much may be applied to specific purposes; and also generally lay down the principles upon which annual surplus sums shall be dealt with in the future. The profits up to date total about £7,000, as last year there was a profit of over £4,000, and the councillor anticipated that this balance would be maintained during the current year. He contended that the balance should now be definitely earmarked. If £4,000 were invested at 3½ per cent. for 25 years it would amount to £161,253, or £22,000 more than the undertaking originally cost, so that at the end of that time they would have paid off their obligations and saved £161,000 for the benefit of the coming generation, but it was only fair that the present ratepayers should be considered. He suggested that £2,000 a year should be put by, and that the other £2,000 should be expended in the relief of the rates, which stand at 7s. 10d. in the £. Eventually it was agreed to refer the matter to the Tramways Committee for report.

Melbourne.—The Bill to authorise the construction of an electric tramway from St. Kilda to Brighton Beach, Melbourne, has been circulated. The expenditure for the construction of the line, excluding rolling-stock, is limited to £19,500, payable out of the Country Tramways Trust Fund. The average wage to be paid to the workmen employed in the construction of the line is to be equal to 7s. per day of eight hours. The width of land taken from the line is not to exceed 33ft. except at stations or other points where a greater width is necessary. The local municipal councils are indemnified in respect to any accident which may happen in consequence of the work. The construction of the line is contingent on a guarantee being given by the two municipalities for payment of interest at the rate of 4½ per cent. on the total cost of construction, including land and equipment. In the event of Crown land at Elwood being enhanced in value, the enhancement is to be set off from time to time as the land is sold against the cost of construction. It is also provided that if there is a profit on the line in one year such profit is to go in reduction of the amount payable under the guarantee in any other year. The maintenance of the road when the electric railway is laid is imposed on the Railway Commissioners. It is not proposed to erect a special power-house for the generation of electricity, the present intention being to make arrangements with the power company.—*N.S.W. Railway Budget.*

Swansea.—A special meeting of the Tramways Committee has been held for the purpose of having explained to them the various clauses in the draft lease between the Corporation and the tramways company with reference to the leasing of the new tramways in the borough. The deputy town clerk explained that the Brynhyfryd section was to be leased under the Tramways Act, and the remaining sections under the light railway order. Regarding the latter, the rent to be paid by the company is as as follows: an amount equal to the interest which the Corporation have to pay all on all capital property expended in the construction of the works, together with the further sum equal to 3 per cent. per annum on such capital, and, further, in the event of the company in any year paying interest on its capital expended on the existing tramways and proposed light railways, amounting to 6 per cent., the company to pay to the Corporation a further sum equal to 1 per cent. per annum. With regard to the Brynhyfryd section, the rent to be paid is as follows: for the first seven years of the lease a sum equal to 5 per cent. upon the capital expended, for the next seven years 6 per cent., and for the remainder of the term 7 per cent. In both instances all rates, charges, assessments, impositions, and outgoings, and outgoings in respect of the tramways and light railways, are to be paid by the company. It was decided to send a copy of the proposed lease to all the members of the Corporation for the purpose of inviting suggestions.

Glasgow.—With reference to the proposed extensions in the direction of Barrhead on the part of the Corporation and the Paisley District Tramway Company, about which we had a note last week, a deputation of the Barrhead Town Council waited the other day on the Tramways Committee of the Corporation, with a view to further discussing the details of the proposed introduction of the electric cars into Barrhead. When the first tramway scheme was submitted by the Glasgow Corporation it was proposed to run the cars along Main-street and Cross Arthurlie-street to the Joint Line Railway Station. This would have involved an awkward lowering of the roadway underneath the Caledonian Railway bridge, and in the present scheme it is proposed to terminate the line in Main-street at the Cross Arthurlie corner. Mr. Murphy, of the Paisley Tramways, is also seeking power to introduce his cars to Barrhead by an extension of the line which presently terminates at Potterhill. His idea is to bring his cars along Cross Arthurlie-street to a point in Main-street near the terminus of the Glasgow cars. There would thus be two awkward lowerings of Cross Arthurlie-street, the other being underneath the Joint Lines bridge. These proposals are not meeting with the approval of the public, to whom they mean considerable inconvenience. Passengers could not travel the full length of the burgh without changing from one system to the other, a change which would be necessary for most people wishing to reach the railway stations. Over and above this there is the disfigurement of Cross Arthurlie-street. The feeling of the community seems favourable to the Glasgow cars being run on to the Joint Line Station, as originally proposed, thus traversing practically the whole length of the burgh. The Paisley cars could turn on the other side of the station, and Cross Arthurlie-street would be cut up only at one point. This view of the matter was discussed at the conference with the Barrhead representatives, but the result has not yet transpired. The Upper District Committee have decided to stipulate with the company for a double line throughout in connection with the proposed extensions from Glenfield-road to Barrhead and from the boundary at Johnstone to Kilbarchan. This will entail considerable street widening. The committee have resolved to take no action with regard to the notice given by the company relating to the abandonment of two short lengths of line.

Sheffield.—The *Daily Telegraph* of this city publishes an interesting *résumé* of the past year's working of the trams. More than a million passengers have been carried in excess of the total last year, the number up to the 4th inst. aggregating 62,579,886, and the receipts amount to £235,939, an increase of over £7,000. The car miles run have been 5,658,926, which is considerably more than a million over the number last year. The total number of cars is 247, an increase of 29 on the year, and the average number of ordinary cars running daily has been 138 6-7, and special cars 58. There are 64 miles 6 furlongs 2·4 chains of single track (excluding depôts), and the total number of employés is 1,386. Mr. A. R. Fearnley was appointed general manager in succession to Mr. A. L. C. Fell on Jan. 14 last, and several changes have followed. The bell punch and ticket department, including the supervision of cashiers and collection of traffic receipts, formerly under the supervision of the city treasurer, is now under the direct control of the general manager. By thus doing away with dual control a saving is anticipated in the management of the department. The erection of the Queen's-road car-sheds is now practically complete. The various workshops are being fitted up; tenders have been accepted for the machinery required; heating apparatus has been fixed; and the extensions are being fitted with electric light by the Sheffield Corporation electric supply department. It is interesting to learn that the automatic point controller, which was fixed at the junction in High-street in June last, is working very satisfactorily. Various improvements have been carried out on the cars during the year. About 230 vehicles have been fitted with the "hanging gate" type of lifeguard, and the remaining cars will shortly be fitted in the same way. Outside end indicators, with the name of the route in full only, have been ordered, and are being fitted on all the vehicles. Twelve double-deck cars with top covers are under course of construction at the Nether Edge depôt. One old horse car has been converted into an electric car. The committee have decided to order a further lot of 30 car top covers from Messrs. G. C. Milnes, Voss, and Co., of Birkenhead. The following new routes and extensions have been completed during the past year: Shoreham-street, Wolseley-road, siding in Cherry-street, Bramall-lane; Nether-green terminus, Snig-hill, Bridge-street, Suffolk-road, and Queen's-road. The question of running motor omnibuses from some of the present outside termini to outlying districts has been considered, but as the Corporation have not the power to run such vehicles under the existing Acts, the committee have decided to defer the matter, and to apply for the necessary powers in the next parliamentary Bill. During the year grants of free tram tickets amounting to about £53 have been made by the Tramways Committee to various nurses' associations, etc., in the city. The rate of pay for conductors has recently been increased, and, to complete the review, the clause limiting liability for accidents to £25 has been abandoned.

London County Council.—Mr. J. D. Gilbert, the Progressive Whip, is reviving his scheme for a southern embankment between Westminster and Blackfriars Bridges so as to provide a suitable site for a new county hall, with a service of trams between. The question of bringing the trams over the bridges was referred to at last week's meeting of the City Corporation, but the proceedings were of a formal character. Colonel Dunfee stated that the Streets Committee had had a long and amiable discussion with the members of the County Council on the subject, views being exchanged without either party being pledged. The committee had passed a resolution stating that they were not in a position to recom-

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mend the Common Council to do anything in the matter at present. Since the subject of London street traffic is under the consideration of the Royal Commission, and until its report has been issued, the Streets Committee think it would be unwise to come to any decision. The committee recognised, however, that trams within the City would be most useful in some respects. He suggested that the meeting should pass a resolution approving the action taken by the committee. Mr. Campbell said he thought they should drop the matter entirely. It would then be understood that they left the matter in abeyance until the report of the Royal Commission was received. Colonel Dunfee said his idea in bringing the matter forward was to give the electors an opportunity of expressing approval of the action taken by the committee. Mr. T. V. Bowater proposed "That this ward meeting approves of the action taken by the Streets Committee of the city of London on this question." Mr. Campbell seconded, and the motion was carried unanimously. At last week's meeting of the County Council a joint report was submitted by the Bridges and Improvements Committee on the question of removing Charing Cross railway station to the south side of the river, the widening of Hungerford Bridge, and the construction of a double line of tramways over the bridge so as to link up the northern and southern systems of tramways. They expressed the opinion that, having regard to the very large expense involved, and also having regard to the attitude of the South-Eastern Railway Company, there was no alternative but to advise the Council for the present not to give further consideration to the matter. At the request of Mr. J. Burns, the report was ordered to stand over until after the recess. Mr. J. Allen Baker, chairman of the Highways Committee, discusses at great length the subject of the New York Underground Railway, which he visited on behalf of the Council, and on which he has prepared a report. He regards the system as one of the great achievements of the age. A considerable portion of the subway had to be cut through solid rock, huge buildings had to be undermined, a complicated network of pipe, mains and cables had to be dealt with, sewers had to be diverted and reconstructed, and the street railways (elevated and surface) had to be underpinned, and their daily running and the general street traffic maintained without interruption while the subway construction work proceeded underneath. Notwithstanding these obstacles the system was constructed expeditiously, and practically without inconvenience to the public. The way in which the New York Rapid Transit Board has sought a solution of the street problem in its city is, he thinks, suggestive of what should be undertaken for London "if the same problem, which is equally pressing here, is to be solved." The electrification of the District and Metropolitan Underground Railways and the lines in connection therewith constitute, in his opinion, an important step in the co-ordination of London locomotion, but the real solution, he is convinced, is to be found in the further electrification and extension of the County Council tramways, and in the construction of further subways under some of the streets in the more central parts to make east and west, as well as north and south, connections. "New York has shown us an example of what enlightened civic enterprise can accomplish. London has the opportunity, with its existing tramway systems and its first tramway subway under construction, to extend, connect, and build up a complete and uniform system for the whole of the county that will be a credit to the capital of the Empire," concludes Mr. Baker. The estimates for street widenings submitted by the Finance Committee—viz., £21,500 in respect of the Lordship-lane and Forest Hill tramway, £103,300 in respect of the tramway from Lewisham High-road to Forest Hill, £149,300 in respect of the New Cross-road to Lee Green tramways, £26,050 for the Greenwich and Catford tramway, and £14,400 in regard to the tramway from Bostal-hill to Kneehill have been approved.

LIGHTING AND GENERAL.

Bridlington. — On Wednesday a report was adopted which estimated the total cost of street electric lighting at £2,107 for 43,703 c.p.

Pearith.—An enquiry has been held into an application by the Urban District Council for power to borrow £6,850 for purposes of electric lighting.

Wellington.—The Urban District Council's electric lighting order has been referred for further consideration to the former Electric Lighting Committee.

Sale of Plant.—The West Ham Electric Lighting and Tramways Committee have various plant for sale. Particulars appeared in an advertisement in our last issue.

Worthing.—An enquiry has been held into the Town Council's application for sanction to borrow £1,600 for the purpose of the extension of electric lighting mains.

London Gazette.—The partnership between John Thomas Mayfield and Thomas Champness, electrical engineers, 63, Cannon-street, London, has been dissolved by mutual consent.

Acton.—The consulting electrical engineer has reported upon the progress of the laying of electric cables in the district, and on the plant at present being manufactured. It is expected that the Council will be ready to supply electric light by the middle or end of January.

Stratford-on-Avon.—The Town Council are applying for a provisional order under the Electric Lighting Acts, 1882 to 1899, to extend the time limited by the order of 1901 for laying the mains in the compulsory area, and to allow the transfer of powers to a company.

East Indian Railways.—The arrangements for the electric lighting installations for the ferry steamers "Tara" and "Lakshmi," which ply in connection with the Sakrigally-Manihari ferry service, have been sanctioned at a cost of about Rs.24,000.—*Indian Engineering.*

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 5 a special settling day for W. T. Henley's Telegraph Works Company, Limited, further issue of 5,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 35,001 to 40,000; and have ordered the said securities to be quoted in the official list.

Beckenham.—At the last Urban District Council meeting, the following resolution was discussed: "That it be referred to the Electric Lighting and Tramway Committee to consider and advise the Council as to the advisability of extending the lease of the Beckenham electric lighting undertaking." The motion was lost by ten votes to five.

Lahore.—Sir Thomas Higham, representing the Punjaub Power Association of London, has arrived here with the object of acquiring from the Government concessions enabling him to harness the enormous water power, and especially the irrigation canals of the Punjaub, which has hitherto been wasted, and to supply electricity wholesale.

Dunfermline.—Notice has been given for the February meeting of the Council to go forward with the electric lighting provisional order. In the meantime a committee is to negotiate with the Fife Electric Power Company again in conjunction with Mr. Sayers, and try to come to an agreement whereby full control of the town would be in the hands of the Council.

Removal.—Messrs. A Ransome and Co., Limited, engineers and ironfounders, Stanley Works, Newark-on-Trent, are removing from 304, King's-road, Chelsea, S.W., on Saturday, the 31st inst., and will open new London offices at 63, Queen Victoria-street, E.C., on Monday, Jan. 2, in charge of Mr. F. W. Baker, who has been connected with the firm for the past 23 years.

Mexico.—The following applications are recorded: By Señor Gustavo A. Lilliendahl for the appropriation, for the production of power, of 1,500 litres of water per second from the River Arteaga, municipality of Arteaga, state of Coahuila; and by Señor Luis Urquiza for the appropriation, for the production of power, of 12,000 litres of water per second from the River Lerma, district of Maravatio, state of Michoacán.

Leven.—The post office has been extended by the addition of rooms at the rear providing accommodation for telephone instruments, etc. Mr. Hunter has in the commodious room set apart for telephone work secured a double-switch section, enabling the staff to have one trunk to Dundee, three to Kirkcaldy, an additional one to Glasgow, two to Edinburgh, and two to the East Coast, the Edinburgh and Anstruther offices to be connected shortly.

Huddersfield.—The borough engineer in his last report states that the number of consumers in December was 2,026, as compared with 1,999 in November, showing an increase of 27. The number of lamps connected in December was 139,028, as against 137,643, an increase of 1,385. Sanction has been received to the borrowing of £4,300 for the purpose of the extension to Golcar. A special sub-committee is about to report on the development of motive power.

Chelsea Electricity Supply Co.—The company's Bill provides for the extinction of the 500 £1 founders' shares in the company. As a result of negotiations between the directors and the holders of these shares, an arrangement has been come to for their surrender in consideration of the allotment and issue to the holders of 10 fully-paid ordinary shares of £5 each for every founders' share. In accordance with this preamble, the Bill provides that on "the thirtieth day after the passing of this Act" the founders' shares shall be converted and the capital of the company reduced by £500.

Longton.—The Corporation Gas and Electricity Committee, finding the use of electricity for motive power purposes gradually extending and coming into favour with manufacturers and tradesmen, have decided to make a reduction in the price charged for current used for motive power, hoping thereby to still further encourage its use. For the future, the following is the reduced rate at which current will be supplied for electric motors: for 500 units per quarter or less, 2½d. per unit; above 500 units, and under 1,000 per quarter, 2¼d. per unit; above 1,000 units, and under 1,500 per quarter, 2d. per unit; above 1,500 units, and under 2,000 per quarter, 1¾d. per unit. The price paid by consumers of electricity for lighting purposes last year averaged 4¼d. per unit.

St. Austell.—On the 22nd inst. the town was again lit up with electricity. About 12 months ago Messrs. Veale and Co. ceased to supply the light, and the undertaking was taken over by the St. Austell and District Lighting and Power Company. The company then erected a new station, and put in new plant at a cost of £7,000. Two 85-h.p. engines and three dynamos have been fixed. There are two sets of producers. A new cable has been laid, nearly a mile in extent. The general lighting is on the direct-parallel system. There is an accumulator battery for the supply from midnight and during the small hours. The company has secured about 75 per cent. of the old consumers. The charge for current is 5d. per unit. The works are under the management of Mr. A. Childs.

Swansea Telephones.—The Telephones Committee have decided to make provision for placing 260 new subscribers on the present switchboard. The consulting engineer estimates the cost of cables and ducts for the underground extension at £727. Henley's (the only tender) price was £884, and Mr. Bennett has been instructed to obtain tenders for cables for extensions, the committee deciding to do the work themselves. The committee have decided to retain his services in the expenditure of £2,000 to be expended for the extensions, etc. The question as to the practicability of placing an instrument in St. Mary's Church and the various halls to enable subscribers to enjoy organ recitals and concerts without leaving their homes, has been referred to Mr. Mackay for a report.

East Barnet.—At the last meeting of the East Barnet Valley Urban District Council the chairman reported on his interview with

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Mr. Pelham *re* the Council's application for extending the time of their lighting order. Mr. Pelham told the deputation that the Council had no right to hand over the order to a company, and that the Council ought to carry out the lighting themselves. He agreed to extend for another two months the time for carrying out the order, and said that if the Council wanted to do the work themselves they could apply at the end of two months to the Board, who might grant a further extension. The Board were in favour of councils themselves doing the work. If an application were made for an extension of time, with a view to getting a company to carry out the order, the Board would look with disfavour upon it. A long debate ensued. A motion "that the lighting of the district with electricity be undertaken by the Council" fell through, and the following resolution was adopted: "That the present sub-committee be authorised to continue negotiations with the North Metropolitan Company."

Liege Exhibition, 1905.—With reference to previous notices which have appeared in the *Board of Trade Journal* respecting the International Exhibition to be held at Liége in 1905, the following information has now been received from the Association of Chambers of Commerce of the United Kingdom: "An influential committee has taken up the formation of a British section, and has secured an option to take the whole available space reserved for this country. The British section in the machinery hall is already full, and no further applications from exhibitors of machinery in motion can be entertained. In the industrial section a good many exhibitors have taken spaces, and it is hoped that exhibitors will come forward in large numbers so as to make the British section compare favourably with that of other nations. The fact that the autumnal meeting of the Association of Chambers of Commerce will be held at Liége should give an increased interest to the exhibition and add much to its popularity with exhibitors as well as visitors. The Commissioner-General is Mr. Thomas Cope, to whom all applications for space should be addressed at the British Commissioner-General's Office, 54, Great Tower-street, London, E.C.

Special Indian and Colonial Trade Enquiry Offices.—India: The India Trade Enquiry Office at 73, Basinghall-street, London, E.C., has been established for the purpose of supplying the general public with all available information as to the commercial products, manufactures, and trades of British India. The office is under the superintendence of an India Office official, who is in daily attendance to answer personal or written enquiries. The current publications of the Government of India dealing with Indian trade statistics, tariff charges, railways, economic products, etc., are kept in the office, and can be consulted free. The various Indian directories are also filed. Canada: The Canadian Government have secured premises at 73, Basinghall-street, London, E.C., where an office has been opened, under the designation of "High Commissioner for Canada, City Trade Branch," for the convenience of the commercial community. In due course it is intended to equip and maintain a display room, illustrating the products, resources, and manufactures of the Dominion. In the meantime a Canadian representative attends daily to deal with enquiries and applications in connection with Canadian import and export trade, and to supply information about Canadian matters generally. Personal appointments can be arranged when desired. Cape of Good Hope: The Government of the Cape of Good Hope have opened offices at 73, Basinghall-street, London, E.C., for the purpose of a commercial agency for that colony which will be under the direction of the Agent-General for the Cape of Good Hope. Mr. Lewis Atkinson, who has been appointed commercial agent, attends daily to deal with enquiries on all commercial and trade matters connected with Cape Colony. Queensland: For the convenience of the commercial community in the City of London, the Agent-General for Queensland has opened a branch office at 73, Basinghall-street, London, E.C., where a representative attends daily to give information to enquirers regarding trade, mining, and all other matters in connection with Queensland. A reading-room will also be provided, in which maps, directories, statutes, Government reports, and other publications of the State can be seen.—*Board of Trade Journal.*

Tredegar.—The conflicting interests of the Council, who prefer to use electric light themselves, but would like others to continue using the municipal gas, have led to a ridiculous position at Tredegar. Last week an application by the Tredegar Company came before the Special Gas and Water Committee for permission to carry electric wires across the roadway between the Tredegar company's stores and general offices, and was deferred, and the clerk was instructed to intimate to the company that the work was not to proceed until the necessary permission was granted. In answer, the company wrote a letter, which explains the situation succinctly, as follows: "With reference to electric light passing over the highway between the stores and the offices of the Tredegar Company, we are very much surprised to note that you decline permission for us to carry an electric main between our stores and the offices. We cannot understand this, seeing you have already given us permission to cross the highway with the main lighting wires between Tytrist and the works, and now refuse us permission to light our offices from this main. We must point out that you yourselves are using electric light supplied by the company at Bedwellty, and are arranging to do the same at Pochin. It seems to us an extraordinary position that you should refuse us permission to light our offices with electric light on the one hand, and on the other hand you ask us to supply the same to meet your convenience at the above-mentioned places. We shall be glad, if possible, if you will consider this matter before the 11th prox., as we are desirous of putting this work in hand at once. We may say that the whole of the office staff have suffered from the inefficiency of the gas light, and it is in order to obtain the best light under the healthiest conditions that we wish to instal electric light, and your opposition of this, seeing the way you have already committed yourselves in the matter, certainly requires some reasonable explanation. Our only reason for deferring the lighting of the offices was in view of the reconstruction of the offices, which has since been postponed, and we wish to proceed with the lighting straight away." A debate ensued, a member remarking that they had formed their resolution and he hoped they would stick to it. Others said the Council had granted permission to cross the road down below and they refused permission to cross the road above, because they did not lose anything by the former permission, but if they granted permission in this case there would be no gas consumed in the company's offices. Finally, the committee refused to pass any resolution on the matter.

Cape Town:—From the annual report of the city electrical engineer, Mr. Walter F. Long, A.M.I.E.E., we note that considerable changes have taken place in connection with the plant at the various generating stations belonging to the Corporation during the year ended June 30, 1904. Due to the increased size of the generating units, the steam plant at Molteno was shut down, and the 150-kw. Bumsted and Chandler set, and the Belliss-Mather and Platt units were removed from Dorp-street, and from there temporarily in an old shed at Dock-road respectively to the new power-house at Dock-road, where one of the new 700-kw. machines was switched on with supply on April 14. This practically completed the movement of placing the whole of the generating machinery under one roof, and consequently the cost of generation has been reduced, and also there has been a considerable increase in the consumption. The whole of the condensing plant, with the exception of the "Klein" and cooling tower, is now erected, four Davey-Paxman boilers are under steam, and it is proposed to shut down for a while the Babcock boilers in order to overhaul the economisers. Mr. Payne, the station superintendent, left the employ of the Council last month, and it was decided not to fill the vacancy. The running of the plant is now left in the hands of the two senior shift engineers, and the construction work undertaken by Mr. Cooke, formerly in charge of Dorp-street and Molteno. Considerable alterations and additions have been carried out in connection with the mains for the distribution of electric energy, and a large number of arc lamps have been erected. During the year a considerable amount of work has been carried out in connection with the electric light installation and the new city hall. Messrs. Cunningham and Gearing were the contractors. The electrical standard instruments in the test-room are all set up and in constant use. New wiring regulations were promulgated in the Government *Gazette* of Sept. 15, 1903. These regulations give the Council power to refuse to connect up defective installations, and under the rigid enforcement of the same the class of electrical material and the standard of workmanship has greatly improved. In September an alteration was made, increasing the hours, by about 40 per cent., during which energy is obtained at the half rate; this is equivalent to reducing the price of current to day consumers. The day consumption to private consumers has increased from 353,809 units for the year ended June 30, 1903, to 511,457·2 units for the corresponding year in 1903-04, equivalent to an increase of 44·8 per cent. In 1901-02 22 per cent. of units sold to private consumers were supplied in the daytime, in 1902 03 33½ per cent., and in this year 40·1 per cent., equivalent to 30·6 per cent. of the total units sold. There are at present connected 1,307 consumers, with 86,191 8-c.p. lamps, as against 20 with 2,100 in 1895. In 1896-7 a consumer took on an average 350 units per annum; in 1902 3, 1,004; and last year, 973·5, the falling off being due to the large increase in connections made to small houses. The motors connected are equivalent to 1,727 h.p., as against 1,011 h.p. in the preceding year. We draw attention to the fact that Mr. Long recommends that a more up-to-date reversible booster be obtained, as the accumulator battery in its present condition is quite capable of giving 300 to 350 amperes for a couple of hours or so, whereas the present booster will only allow of a maximum discharge of 150 amperes.

Sheffield.—The *Sheffield Daily Telegraph* gives the following interesting *résumé* of the Corporation's electric light undertaking during 1904: Another year of progress has to be recorded for the electric light department of the Corporation. It has seen the opening of the new power station at Neepsend, a scheme which is evidence of the foresight of the committee in acquiring a site and erecting plant which, although not yet fully employed, will, with the increasing demand for electricity for illumination and motors, gradually come into operation. Under the superintendence of Mr. S. E. Fedden, the general manager and engineer, the power house has been admirably equipped, and Sheffield now possesses a source of supply worthy of the city. One of the most interesting features in connection with the department this year has been the increasing demand for electricity for driving machinery. A few years ago only a very small number of motors were used by customers of the department. But a remarkable change has occurred, and to-day motors may be found driving all kinds of machinery—rolling-mills, grinding wheels, pneumatic and power hammers, annealing furnaces, steel tape, tempering and grinding machines, wire-drawing machines, lathes, saws, buffing lathes, and quite a host of other machines. As a leading Sheffield engineer recently said, "The greatest revolution that steelworks have experienced of recent years has undoubtedly been the introduction of electric driving, and the engineer of ordinary ability has found in electricity a simple means for remedying extravagance in works more readily than by other methods." This departure in the use of electricity instead of steam in Sheffield is a sign of the times. It is anticipated that a few years will see a remarkable development in the Corporation department owing to this change alone, and with such a prospect it is satisfactory to learn that the committee have invested in a powerful station. During the past year there have been applications for electric motors to the extent of 115 h.p. Several cutlery firms are now having their machinery driven wholly by electricity. There are 20 elevators for passengers and goods being worked by electricity, and a large number of travelling cranes are also being worked by electric

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power. A "boom" in trade would probably make a vast difference in the power supplied, and lead to a much more extensive use of motors. A few statistics may be interesting. The customers have increased in number during the year from 2,549 to 3,000. The lamp connections have reached a total of 275,363. The units sold up to last March were 2,980,049; it is estimated that five millions will be reached at the end of the current year. After paying all charges, the department had a surplus at the end of the financial year of £5,431, against £6,534 at the end of the previous year. In this connection it must be remembered that interest is being paid on a large amount of capital which has not yet become revenue earning. Several new features in electrical illuminants must have been observed recently in Sheffield. One of the most striking is the brilliant arc lamp, which is growing in favour for lighting shop fronts. The brilliancy of the light is undoubted. The lamps have not yet come into general use, but there are now about 20 in the city. For interior lighting the Nernst lamp is rapidly growing in popularity. This is being regarded as a dangerous rival to the incandescent gas lamp. Taken as a whole, the past year has been one of undoubted progress in the department. The opening of the power station at Neepsend has been an important step, the resources which are contained there for providing light and power being sufficient probably to meet the demands of the city for many years to come; and the sooner the value of the resources is appreciated, the better it will be for the department as a revenue-earning concern.

"Year Book of New South Wales."—This handbook, compiled by Mr. Coghlan, the editor of "The Year Book of Australia," for circulation by the Agent-General in London, Westminster-chambers, 9, Victoria-street, Westminster, S.W., has been brought fully up to date. Among other valuable information given is the following: The annual value of the goods imported into and exported from New South Wales affords the surest test of its material advancement, rising from £400,000 in 1825, when the official records begin, to £53,508,280 in 1903. The progress of the trade of the State is shown by the following amounts, in decennial periods: 1825, £400,000; 1835, £1,796,998; 1845, £2,789,840; 1855, £7,552,649; 1865, £20,199,325; 1875, £27,532,530; 1885, £40,487,568; 1895, £37,927,200; 1900 (quinquennium), £55,725,587. The value of imports during 1903 was £26,770,169, and of exports £26,738,111, the total trade being at the rate of £37. 12s. 2d. per head of population. In 1825 the value of the exports from New South Wales was £100,000. Ten years later, in 1835, it had risen to £682,193, the subsequent decennial increases being: 1845, £1,555,986; 1855 £2,884,130; 1865, £9,563,818; 1875, £13,797,397; 1885, £16,750,107; 1895, £21,934,785; 1900 (quinquennium), £28,164,516; 1903, £26,738,111. The general character of the articles imported is illustrated by the following items included among the imports of 1903: apparel and attire, £850,940; bicycles, etc., £28,108; boots and shoes, £263,525; piece goods, £1,943,401; canvas, £50,926; iron, steel, and galvanised iron, £480,051; machinery, £866,358; arms, ammunition, etc., £430,771; agricultural implements, £203,318; beer in bulk and bottle, £191,501; cement, £36,835; drugs, etc., £131,252; earthenware and china, £76,716; fruit, green and dried, £416,904; furniture, £72,589; gloves, £61,190; lead, £147,892; paints and colours, £97,289; gold, £3,433,218; coin, £637,377; grain and pulse (prepared or manufactured), £2,525,980; grindery and leather, £206,075; hats and caps, £173,727; hay and chaff, £557,845; musical instruments, £91,549; kerosene, castor, and other oils, £332,522; live stock, £2,164,483; malt, £93,874; paper, books, etc., £511,265; silver and plated ware, £49,989; spirits, £353,736; medicines, £101,606; milk (preserved), £100,426; skins and hides, £489,984; sugar, £710,708; tea, £279,781; cocoa and chocolate (prepared and raw), £49,581; timber, £530,766; tobacco, cigars, and cigarettes, £363,796; tramway and railway plant, £185,675; fancy goods, £101,584; watches and clocks, £62,959; wines, £75,700; wool, £578,555; potatoes, £213,675; tallow, £29,273; tin and tinware, £323,870; bags and sacks, £162,028; fish (fresh, dried, and preserved), £165,594; copra, £156,827; floorcloth and oilcloth, £63,140. Many of the imported goods, such as wool and tallow, were intended for re-export, being sent from the other States for convenience in the work of shipment. The gross amount of duty collected by the customs during 1903 was £2,902,687. Of the exports from New South Wales during 1903, £7,559,759 was represented by exports to Great Britain, £8,992,930 by exports to Australasia, £2,190,347 exports to other British possessions, and £7,995,075 exports to foreign countries. A considerable portion of the goods exported from New South Wales consists of articles imported from Europe, America, and elsewhere. The value of these in 1903 was £8,072,307, leaving the sum of £18,665,804 to represent the value of the exported Colonial produce. Coal is, like wool, a staple article of export, the value of the quantity exported during 1903 being £1,704,993; gold is exported both in the form of coin and of ingots, the value of these in 1903 being £4,913,478. The copper exports were valued at £604,923, and those of silver and silver ores at £1,658,471. To these may be added the export of tin, etc., valued at £312,933.

Waipori Falls Electric Power Co. (N.Z.).—The *New Zealand Mining, Engineering, and Building Journal* in a leader on the purchase of the above undertaking by the Dunedin City Corporation says: "As the result of the private Bill promoted by the above company, the Dunedin City Council has agreed to purchase the whole undertaking for £31,000. The result of the evidence adduced before the Parliamentary Committee that sat on the Bill has amply demonstrated that the Dunedin City Council did not sufficiently go into the merits of the Waipori scheme as compared with the combined Taieri and Lee Stream scheme. What is evident from that evidence? It clearly shows that to provide 2,000 e.h.p. from the Waipori will only cost the city, even after purchasing out the present company, £80,000, whereas the cost to bring in the same power from the Lee Stream would be £104,000. Further, the Lee Stream is a doubtful supply, the whole evidence being that there was no assured supply in drought seasons or in frosty weather even for 2,000 h.p., while the evidence is that 6,000 h.p. could be got from the Waipori by the same expenditure as was required to supply 2,000 h.p. from the Waipori. For the adduction of this evidence we have to thank a Parliamentary Committee, as it was quite evident the City Council and their Tramways Committee burked all discussion, and were it not for the promotion of this Bill, the city would be committed to the fatuous and ruinous expenditure of £104,000 on a very third-rate water scheme. How, then, are we to account for the conduct of those who should be guardians of civic affairs in Dunedin? It was simply due to the fact that instead of treating this as a business proposition, these guardians were more concerned, not with the value of the water rights to the city, but with the fact that a syndicate were going to make more money out of it. To burke this syndicate in getting a fair price for these valuable rights the Council entered upon a game of bluff. Anyone who knows the card game of 'poker' knows how such a game ends if the bluffer holds an inferior hand and is compelled at last to 'show it' and pay up. That is exactly what the city has had to do in this instance. Had the city bought these rights in the first instance they would have saved money, and they would have to-day an hydro-electric power in the city at a cost of, say, £7. 10s. per horse-power, instead of £29 per horse-power, which it is at present costing them to generate with steam. The useless expenditure upon Lee Stream, which has cost more than £10,000, would have been avoided also. But supposing this Bill had not been promoted the whole of the city bungle in adopting a third-rate water scheme would have been buried out of sight, and perhaps for an indefinite period. The city is paying to the company £10,000 more than it cost the company. It must not be assumed, however, that this £10,000 is all loss. For the city has had the advantage of the works being so far constructed under private agreement, and we know from past municipal management that this means probably a saving of 33⅓ per cent. Then the company has a first-class engineer whose contract will be taken over by the city. If the City Council had to select such an officer, it would probably end in the selection of an incompetent and expensive man not acquainted with his business, as such appointments generally are. Then the city gets the benefit of the private contracts entered into by the company for the supply of the plant. It is probable, therefore, that the whole £10,000 paid to the company has been saved in the good arrangements made by the company, and which have been taken over by the Council. But this splendid water power has now been acquired by the city, and we have to congratulate the citizens of Dunedin upon that fact. There is little doubt that this is the best asset the City Corporation has now in its books, and one which will in the course of years altogether free the city from its indebtedness. This is apart altogether from the great advantages that will be conferred upon Dunedin by the supply of plentiful and cheap water-generated power. Of all the foremost cities in New Zealand, Dunedin is the one which is at present under the greatest disadvantage. Until the advent of large ships she was the foremost commercial centre of New Zealand. But with the advent of large ships her position as such a centre is gone. All the other harbours in the large centres (if we except Bluff) have better harbours than Dunedin. Even the Bluff is better off by reason of the large area of level and fertile land in its neighbourhood. It is only the freezing industry which has enabled Otago settlers to take full use of the large amount of hilly country in Central Otago for sheep growing that has kept Dunedin from decadence. But Dunedin has always been a manufacturing centre, and it is the building up our position in that respect (for which cheap power is necessary) that we must look to support the city in case of a set-back should come to our foreign meat trade. Fortunately, the City Council has been forced into the position of acquiring this cheap power. For that we have to thank, not the City Council of Dunedin, but the enterprise and energy of the private citizens of Dunedin, who have not been sufficiently rewarded for the splendid asset which they have compelled the city councillors of Dunedin, much against their will, to accept. The moral is that city councillors should always deal with matters in a fair, honourable, and businesslike way. To play the game of bluff with other people's money is not one that will commend itself to anyone, but, as the Council has found out, does it pay in the long run?"

PROVISIONAL PATENTS, 1904.

DEC. 16.

27424. Device for magnetising iron by means of an alternate current and improvements in dynamo-electric machines. Miles Walker, 7, Skerton-road, Old Trafford, Manchester.

27434. Improvements in the construction of single and two-way electric switches. Clement Brown, Folke Olai, and Brown and Barlow, Limited, 16, Loveday-street, Birmingham.

27437. Improvements in and relating to arc lamps. Gustavus Martin Zingel, William Wolf, and Arthur Reiner, 72, Fenchurch-street, London.

27443. Improvements in electric arc lamps and carbons for same. August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

27444. Improvements in electric switches. August Eckstein and Albert Julius David Krause, Peel Works, Adelphi, Salford, Manchester.

27449. Method and apparatus for electrostatic separation. Wallace Fairweather, 65, Chancery-lane, London. (Charles Henry Huff, United States.) (Complete specification.)

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27456. Electromagnetic ignition device for explosion engines. Friedrich Lutz, 65, Chancery-lane, London.

27475. Improvements in electrical switches. William Righter Comings, Wharncliffe, Wimbledon Park, London.

27479. Improvements in and relating to inverted arc electric lamps. Nicholas Pentreath Andrew and Thomas Macduff Mackelcan Johns, 55, Chancery-lane, London.

27537. Improvements in vapour electric apparatus. Howard Irving Wood, 83, Cannon-street, London. (Date applied for under Patents Act. 1901, Dec. 17, 1903, being date of application in United States.) (Complete specification.)

27538. Improvements in means for transforming electric current. Charles Proteus Steinmetz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 17, 1903, being date of application in United States.) (Complete specification.)

DEC. 17.

27582. Improvement relating to clay ware, stone ware, and similar conduits for electrical cables. Horace Rendall Mansfield, Broom Leys, Coalville, near Leicester.

27605. Improved electric system of driving vehicles in an arena or course. Edward Ernest Lehwess, 111, Hatton-garden, London. (Complete specification.)

27627. Improvements in and relating to portable electric conductors. Arthur Bergtheil, 1, Queen Victoria-street, London.

27636. Improvements in and relating to electric systems of train lighting. The Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 19, 1903, being date of application in Germany.) (Complete specification.)

27637. Improvements in and relating to vapour electric apparatus. John Thomas Henry Dempster, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 19, 1903, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 5, 1905.

1903.

20129. Mechanism for use in conjunction with apparatus for utilising electromagnetic or "Hertzian" waves. Smith.

21819. Automatically-operated telephonic exchanges for a small number of lines. Bullard.

22003. Conduits for electric cables or conductors. Devonshire.

22368. Means for generating intermittent electric currents for igniters of oil or gas engines and other purposes. Howorth. (Ryder.)

23604. Electric incandescent lamps. Riethof and Basch.

24102. Mountings and connections for electrical conductors, especially applicable to the supports for collecting brushes of dynamo-electric machines. Phœnix Dynamo Manufacturing Company, Limited, Oelschläger and Haddock.

24142. Electric interrupters or spark-gap apparatus for high-frequency currents. Johnson.

24343. Electric signs. Heinemann.

24394. Means for connecting electric circuits, especially applicable for the lamps of motorcars. Couverchel. (Date applied for under International Convention, Dec. 19, 1903.)

24560. Electric testing clip. Frankel. (Date applied for under International Convention, Dec. 2, 1903.)

24572. Electric igniters for internal-combustion engines. De Dion and Bouton. (Date applied for under International Convention, Aug. 16, 1904.)

24663. Electrical valve-controlling systems. Waterman.

24715. Incandescent gas and electric globe lamps. Lea and Perrins.

24722. Electric tramcars and the like and lifeguards or obstruction removers for use therewith. Whittaker.

24770. Electric signalling devices for elevators or the like. Imray. (Payne.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	15/32-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	5¼-5⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	–	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	–	2⅜-2⅝
—— 4 per cent. Mortgage Debenture Stock	100	–	88-90
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	⅝-¾
—— Non. Cum., 6 per cent. Pref.	2	–	1⅝-1⅞
—— 4½ per cent. 1st Debenture Stock	100	–	93-96
—— 4½ per cent. 2nd Debenture Stock	100	–	68-72
Callender's Cable, Debentures	100	–	104-106
—— Ordinary	5	–	9¼-10
—— 5 per cent. Pref.	5	–	5-5¼ xd
Crompton and Co.	5	–	1⅜-1⅞
—— 5 per cent. Debentures	100	–	93-98
Edison and Swan United, "A" Shares, 1-98,261	5	–	⅜-½
—— "A" Shares, 01-017,139	5	–	1-1¼
—— 5 per cent. Debentures	100	–	79-84
—— 4 per cent. Deb. Stock, Red.	100	–	78-83
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¼-1½
—— 7 per cent. Cumulative Pref.	2	–	2⅛-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	98-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	–	91-96
W. T. Henley's Telegraph Works, Ordinary	5	–	10¼-10⅜
—— 4½ per cent. Preference	5	–	5¼-5⅜
—— 4½ per cent. Debentures	100	–	110-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	15½-16¼
—— 4 per cent. Debentures	100	–	99-102
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Telegraph Construction and Maintenance	12	–	38-40
—— 5 per cent. Bonds	100	–	103-105
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	–	12-13
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9½-10
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	11-12
—— 4½ per cent. Debenture Stock. Red.	100	–	104-106
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	101-104
Brompton and Kensington, Ordinary	5	–	10¼-11
—— 7 per cent. Preference	5	–	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	7⅞-8¼
—— Nos. 20,001-20,000	5	–	7-7⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	–	12¼-13¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	–	104-107
Charing Cross and Strand, Nos. 1-70,000	5	–	8¼-8⅜
—— 70,001-80,000	5	..	8-8¼
—— 4½ per cent. Cum. Pref.	5	–	5 9/16-5 13/16
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	4 15/16-5 1/16
—— 40,001-80,000	5	..	4 15/16-5 1/16
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	–	101-103 xd
Chelsea Electricity Supply	5	–	6⅝-7
—— 4½ per cent. Debentures	100	–	109-111
City of London, Ordinary	10	–	10⅜-11¼
—— 6 per cent. Cumulative Pref.	10	–	13¼-14
—— 5 per cent. Debenture Stock	100	–	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	103-105
County of London Electric Supply, Ordinary	10	–	9 9¼
—— 6 per cent. Cum. Pref.	10	–	12-12⅜
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	101-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	–	6¼ 6⅜
—— 6 per cent. Cum. Pref.	5	–	6-6¼
—— 4½ per cent. First Mort. Deb.	100	–	107-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	–	1¼-2⅛
—— 5 per cent. Debenture Stock, Red.	100	–	88-93
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	–	102-105
Havana Electricity, Limited, 1-15,000	10	–	9¼-10¼
Hove Electric Lighting, Limited, Ord., 1-13,000	5	–	7½ 8
Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.	100	–	100-102
Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000	1	–	9/16-11/16
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5		12¼-13
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red	100	–	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	2 1/16-2 5/16
—— 6 per cent. Pref.	5	–	5 9/16 5 13/16
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	95 97 xd
Metropolitan Ordinary	10	–	16¾-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-117
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	–	97-99
Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.	100	–	93-96
Newcastle-upon-Tyne Electric Supply, Ordinary	5	–	98-101
—— Preference	4	–	100-102
Notting Hill Electric Lighting	10	–	14¼-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	101-103
Oxford Electric, Ordinary, 1-96 and 41-14,510	5	–	6¼-6⅜
—— 4 per cent. Debenture Stock	100	..	99-101
Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures	100	–	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2⅜-3¼
—— 4 per cent. Debenture Stock	100	–	83-87
South London, Ordinary		–	4¼-4⅜
South Metropolitan Electric Light and Power Co., Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1⅜-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	107-110
—— Ditto, June, 1904		..	
St. James's and Pall Mall, Ordinary, 101-80,080	5	–	13¾-14¼
—— 7 per cent. Pref.	5	–	8¼-9
—— 5½ per cent. Deb.	100	–	99-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	–	4 15/16-5 1/16
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	5-5¼
Westminster, Ordinary	5	–	13⅜-13¾
—— 5 per cent. Cum. Pref., 110,101-138,251	5	–	6¼ 6⅜
Electric Tramways.—			
Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007	5	–	5 7/16-5 9/16
—— Ord.	5	..	7⅜-7½
—— Permanent 6 per cent. Debenture Stock, 1888	100	–	143-146
Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	106-107
Barcelona Tramways, Limited, Ord., 1-20,000	10	..	10¼-11
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9¼-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	95-100
Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.	1	..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Belfast Street Tramways, Ord., 1-26,600	10	..	10-11
Blackpool and Fleetwood Tramroad	10	–	13⅝-15⅝
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	1¼-2¼
—— 5 per cent. Cum. Pref., Nos. 1 75,000	5	–	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	100-103
—— Ord Pref.	100	..	100-103
—— Non. Cum. 5 per cent. Pref.	10	–	10¼-10⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each	40	–	102-104 p c
—— 4½ per cent. Vancouver Power Deb.	100	–	98-101
British Electric Traction Ord. 1-300,000 & 60,001-90,000	10	–	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	10 13/16-11 1/16
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	–	95-97

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Name.	Amount paid.	Last price.
	£	£
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	3¼-3⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5⅛-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5⅛-5⅜
—— 5 per cent. Deb. Stock, Red.	100	106-108
—— Prov. Cert., all paid	100	103-106
Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red.	100	97-100
Calcutta Tramways, Limited, 1-102,268	5	7⅛-8⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	108-110
Cape Electric Tramways, Nos. 1-480,000	1	1⅛-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4⅞-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	101-104
Cork Electric Tramways and Lighting Co. Ordinary	10	9⅛-10
—— 5 per cent. Cum. Pref.	10	11-12
—— 4 per cent. Debentures	100	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-5,000, Red.	100	94-97
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb Stock	100	108-11
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	3¾-4
—— 4 per cent. Debenture Stock	100	90-93
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	10⅛-10⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	103-105
Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red.	100	103-105
Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016.	1	⅞-7/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	15/16-1
—— 4½ per cent. Deb. Stock, Red.	100	104-106
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000	$1,000	108-113
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	100-103
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-1¼

Name.	Amount paid.	Last price
	£	£
Oldham, Aston, and Hyde Tramway, Ordinary	10	·12½
—— 5 per cent. Cum. Pref.	10	9⅛-9⅜
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	103-104
Potteries Electric Traction, Ordinary 20,001-40,00	10	8-9
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-8¾
—— 4½ per cent. Debenture Stock	100	99-102
South Lancashire Electric Traction and Power Company		
—— £250,000 Ordinary	1	⅛
—— £101,152 5 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Electric Railways.—

Central London, Ordinary	100	90-92
—— 4 per cent. Pref.	100	101-103
—— " " deferred	100	84-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	108-110
City and South London, Consolidated Ordinary	100	45¼-46¼
—— 4 per cent. Debenture Stock	100	104-107
—— 5 per cent. Pref. Stock '91	100	122-125
—— " " " '96	100	117-120
—— " " " '01	100	116-119
Liverpool Overhead, 5 per cent. Pref.	10	10-10⅛
—— Ordinary, 1-50,000	10	3¾-4
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	97-98
Waterloo and City, Ordinary	100	88-90

Telephones.—

National Telephone, Preferred	100	108-109
—— Deferred Stock	100	101-102
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5 5/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100	98-99
—— 4 per cent. Deb. Stock, Red.	100	103½-105½
—— 4 per cent. Prov. Cert.	—	67½-68½
Oriental Telephone and Electric Company	1	1-1⅛
—— 6 per cent. Cum. Pref.	1	1⅛-1¼

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1904.	1903.	Week.	Current year.	1904.	1903.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 17	1,063	1,076	− 13	+ 5,714h	19¼	19¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 24	177	172	+ 5	+ 501	8	8	,, 15	14,160	3,201,586	336,049	1·03	10·11	1,770	5 04
Barking Corporation	,, 24	62	40	+ 22	+ 92	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 24	1,026	1,113	− 87	+ 638	23·53	23½	March 31	56,0·3	11,327,932	1,319,701	1·158	9·98	2,383b	6·1
Birmingham Corporation	,, 24	342	—	—	—	—	—	—	—	—	—	—	—	—	—
Birmingham Tramways Co.	,, 24	5,550	4,9 9	+ 581	—	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 16	765	723	+ 42	+ 3,353	24	23	,, 25	43,374	7,742,692	951,484	—	10 94	—	4·59
Blackpool Corporation	,, 22	276	280	− 4	+ 5,956	17½	17½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Trams.	,, 24	182	226	− 44	+ 344	16½	16½	Dec. 31	32,021	2,258,984	600,757	3·34	12·75	2,001	7 05
Bolton Corporation	,, 25	1,625	1,884	− 258	+ 288	38	38	March 31	94,151	19,895,496	2,188,030	1·14	10·32	3,766	5·89
Bournemouth Corporation	,, 21	8·7	873	− 14	+ 2,007	10·15	10½	—	—	—	—	—	—	—	—
Bradford Corporation	,, 17	3,729	3,766	+ 363	—	77	41	—	—	—	—	—	—	—	—
Brighton Corporation	,, 25	852	872	− 20	+ 3,256h	9	7½	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 23	5,076	5,265	− 189	—	51½	51½	Dec. 31g	253,150	44,391,439	6,033,528	—	—	—	—
Burnley Corporation	,, 24	982	1,017	− 35	—	10·60	10	—	—	—	—	—	—	—	—
Burton Corporation	,, 11	295	291	+ 4	—	8¼	—	March 31j	11,574	2,556,134	282,378	1·08	9·81	1,570	7·57
Cardiff Corporation	,, 3	1,816	1,700	+ 116	+ 1,653	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 24	174	205	− 31	+ 185	—	—	Dec. 31g	9,987	2,805,277	334,393	—	7·17	—	—
Central London Railway	,, 24	7,744	6,412	+1,332	+ 1,077h	6	6	,, 31	362,471	44,953,938	1,292,674a	1·87	64·87	58,229	35·60
City & South London Railway	,, 25	3,769	2,979	+ 788	− 1,623h	6¼	6⅜	,, 31	165,003a	19,069,319a	—	—	—	—	—
Colchester Corporation	,, 14	156	—	—	—	7	—	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 22	446	482	− 36	− 2,515	—	—	,, 31g	26,657	6,353,823	919,676	1·00	6·95	—	3·9
Darwen Corporation	,, 9	206	96	+ 10	+ 78	7·23	7·23	March 31a	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 17	180	169	+ 11	—	4½	4½	,, 31	11,255	2,871,332	280,901	0 9	9·63	2,503	—
Dublin & Lucan Electric Ry.	,, 23	105	96	+ 9	— h	7	6¾	Dec. 31g	6,234	888,905	107,164	3·88	14·09	952	7·39
Dublin U. T., electric cars	,, 23	4,152	4,301	− 149	—	47	46	,, 31g	134,643	—	3,429,356	—	—	—	— h
Dublin S. District, Electric	,, 23	830	839	− 9											
Dundee City Tramways	,, 21	815	830	− 15	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 24	563	641	− 80	+ 1,429	10·77	10·75	March 31	34,312	12,950,269	807,002	0·63	10·2	—	—
Glasgow Corporation	,, 24	14,064	13,497	+ 569	+20,865h	143	123	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Gloucester Corporation	,, 21	219	—	—	—	5½	—	—	—	—	—	—	—	—	—
Halifax Corporation	,, 14	2,261	2,092	+ 169	+ 4,070	33	30½	March 31	68,283	16,322,054	1,387,885	1·0	11·79	2,059	8·77
Huddersfield Corporation	Nov. 12	1,260	1,173	+ 87	—	35	35	,, 31	65,545	11,893,287	1,632,000	1·2	9·31	1,873	—
Hull Corporation, E. S.	Dec. 24	2,291	2,318	− 26	+10,457	25	19	,, 31	87,707	21,065,999	2,218,696	1·00	9·49	5,004	5·0
Ilford Corporation	,, 17	352	324	+ 30	—	10½	—	—	—	—	—	—	—	—	—
Ilkeston Corporation	,, 22	87	120	− 33	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 21	1·3	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 24	5,285	5,625	− 340	+12 497	89	81½	,, 25	280,562	60,739,234	6,215,799	1·10	10·94	3,407	—
Leicester Corporation	,, 24	1,781	—	—	—	7¼	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 17	10,121	9,753	+ 368	+14,645	103	103	Dec. 31g	531,484	113,057,234	11,734,838	1·11	10·73	5,160	6·98
Liverpool Overhead Railway	,, 25	1,495	1,561	− 66	− 2,315h	6·57	—	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
London County Council	,, 10	11,432	8,908	+2,524	—	46¼	40	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 17	131	137	− 6	—	—	—	—	—	—	—	—	—	—	—
Maidstone Corporation	,, 22	92	—	—	—	2	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 24	11 003	11,605	− 602	—	131½	—	—	—	—	—	—	—	—	—
Metropolitan Elec. Tramways	,, 16	1,810	1,061	+ 748	+13,157h	10	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 24	103	126	− 23	+ 1,275	2¾	—	March 31	5,200	1,420,759	171,132	8·3	6·47	—	—
Newcastle-on-Tyne Corpn.	,, 24	3,670	4,002	− 332	—	45	38½	,, 25	185,027	39,715,120	4,059,907	1·1	10·94	4,111b	—
Newport (Mon.) Corporation	,, 17	511	414	+ 97	+ 692	15	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	,, 17	1,437	1,374	+ 63	+ 5,792	29	29	,, 31	91,448	18,204,426	1,328,193	1·16	12·39	—	—
Rochdale Corporation	—	—	—	—	—	4½	4½	31g	5,416	925,281	127,456	1·38	10·27	—	7·56
Rotherham Corporation	,, 22	395	477	− 81	—	—	—	,, 31	20,968	4,914,479	525,840	1·02	9·570	2,247	6·68
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	7¾	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 25	4,465	4,769	− 304	+ 3,590	34¼	—	,, 25g	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 22	908	977	− 69	− 2,424	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Southend-on-Sea Corporation	—	—	—	—	—	6¼	—	—	—	—	—	—	—	—	—
Stockport Corporation	,, 23	380	423	− 43	+ 7,915	11½	—	—	—	—	—	—	—	—	—
Sunderland Corporation	,, 18	1,116	1,072	+ 44	+ 1 052	19 5⅞	18·48	,, 31	62,506	14,848,958	1,433,463	1·01	10·46	—	6·08
Swindon Corporation	—	—	—	—	—	3½	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 24	633	638	− 5	+ 1,848	10·5	10·5	,, 31	35,864	6,564,493	757,688	1·28	11·36	4,100	7·80
West Ham Corporation	,, 22	1,012	—	—	—	8·62	—	—	—	—	—	—	—	—	—
Wolverhampton Corporation	,, 22	696	400	+ 296	—	7½	—	,, 31g	20,878	4,263,066	417,335	—	12·005	—	—

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Includes rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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Supplement to "The Electrical Engineer,"

JULY 8, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

703. In calculating the cable losses for a certain high-voltage long-distance polyphase transmission scheme with underground cables, an addition was made on account of "dielectric hysteresis." Can this be found in ergs per cubic centimetre as with magnetic hysteresis, and, if so, what are reliable figures for different classes of cable? In the vector diagram, should the current taken by this loss be plotted with the watt-current or the capacity-current? CEDILLA.

704. How would you calculate a blow-out magnet for a controller, given horse-power and voltage. Give the respective advantages and disadvantages of the different designs.—H. E.

705. What is the most practical method of preventing oil being thrown from the connecting rods and discs of horizontal engines running at 95 revolutions per minute, and having a 3ft. stroke. The engines are fitted with ordinary "Hood" splashguards, but these do not prevent the oil from being thrown out at the sides on to the floor and the frames of engine.—BARON.

ANSWERS.

Question No. 696.—It is stated that boilers fitted with superheaters (steam) should not take their feed through an injector. Why is this?

Best Answer to No. 696 (*awarded* 10*s.*).—The question is stated the wrong way about, there is no objection to feeding boilers fitted with superheaters by injectors, but there is a very great objection to using superheated steam to work an injector. The proper way to use injectors in such a case is to take steam for the injectors from the boiler side of the superheater. The objection to using superheated steam to work an injector is that so great a quantity of water would be necessary to condense the steam that the velocity of the steam is too much reduced in driving forward the large volume of water, and the steam is unable to force the water into the boiler. A consideration of the action of the injector will make this clear. The velocity of an issuing jet of steam is 16 to 18 times that of an issuing jet of water under the same pressure, and if steam while issuing from a boiler be condensed to water, but not reduced in velocity to that of water issuing under the same pressure, it is then able to overcome the pressure of the water in its own boiler. This is exactly what takes place in the injector. The steam enters the injector, and passing down the cone is condensed on coming into contact with the feed water (admitted a little below and on the opposite side to the steam), without losing its velocity further than that due to the friction of the passages. The vacuum formed in the injector by the condensation of the steam causes more water to rush into the injector, and this water is carried by the force of the condensed steam jet into the boiler. The velocity of the steam jet is of course reduced by imparting a high velocity to the volume of water, but provided the water is not too hot, or the steam superheated, the volume of water necessary to effect condensation is not great enough to reduce the velocity of the condensed steam jet to that of a jet of water issuing under the same pressure, and consequently it is able to overpower and drive back the water in the boiler. The feed water should not be hotter than 135deg. F. for low pressures and 105deg F. for the highest pressures. Taking the average cold feed water as being about 50deg., it will thus be apparent that a very small increase in temperature seriously affects the working of the injector, and, of course, this increase has the same effect whether due to hot feed water or to superheated steam, the effect being, as mentioned, to so increase the amount of water required for condensation as to reduce the velocity of the steam jet to such a point that it cannot overpower the water in the boiler. Obviously, if the injector has to lift its feed water the above troubles are accentuated.—W. T. W.

Answer to No. 696 (*awarded* 5*s.*).—There is no reason why injectors should not be used where superheaters are installed, unless it may be due to the following causes: In some types of injectors large quantities of air are drawn in, due to there being no non-return valve on the overflow. This air would mix with the feed water and be delivered to the boiler It would then pass with the steam through the superheater tubes, which might tend to become overheated, due to the poor heat-conducting properties of the air.—H. B.

Question No. 697.—How would you arrange and what materials would be most suitable in making-up a set of ambulance requisites for a central station?

Answer to No. 697 (*awarded* 10*s.*).—The most convenient arrangement for containing a set of ambulance requisites for a central station would be a glass-fronted cupboard, about 2ft. high by 2ft. wide, with one 10in. shelf spaced about 1ft. 3in. above the bottom of the cupboard. The door of the cupboard should be closed by a simple spring catch, to allow of it being quickly opened, without having to obtain a key. It should be fixed to the wall in any convenient dry place, where it will *always* be readily accessible, such as just inside an office, the door of which is never locked; and it is a special advantage if it can be close to a tap and lavatory basin.

The first part of the outfit should be contained in some form of havresack, so as to be portable complete, and should contain the following: 1 pair wooden splints (each made of two parts sliding in a metal sleeve, so as to be of adjustable length), 6 triangular bandages (which might be made by cutting diagonally three pieces of calico, each about 40in. square), 6 assorted roller bandages, ½lb. boric lint and ½lb. cotton wool in tin cases, 1 roll adhesive plaster, 1 piece linen tape, 1 pair scissors, 1 pair forceps, 1 knife, 2oz. bottle olive oil, 2oz. bottle tincture eucalyptus B.P.C., 2oz. bottle sal volatile, 2oz. bottle of ether comp., 1 graduated glass measure, 1 elastic band tourniquet, 1 small camel-hair brush, pins, needles, thread. A set containing most of these articles is supplied in a strong haversack by St. John's Ambulance Association, St. John's-gate, Clerkenwell, E.C., at the moderate cost of about £1. 12s.

In addition to this, the cupboard should also contain: 1 small basin and sponge, 1 drinking glass, 8oz sal volatile, 4oz. spirit ether comp., 4oz. tincture eucalyptus B.P.C., 1 flask olive oil, 1 small flask brandy, 4oz. tin bicarbonate soda, 4oz. tin powdered boric acid, 1 bottle strong smelling salts, 1 cake of carbolic soap.

The small pocket "Aide Memoir" and the handbook "First Aid to the Injured," both published by the St. John's Association at a total cost of 1s. 3d., should also be provided. The cost of the whole set of necessaries should not exceed about £2. 5s., excluding the cost of the cupboard. A reduction could be made if the liquids mentioned twice were included only in the haversack, but it is convenient to have a larger supply than that contained in small 2oz. bottles, as these particular liquids will be in fairly frequent demand for simple cuts, burns, scalds, etc.

Answer to No. 697 (*awarded* 10*s.*).—It is a strange and surprising fact that there are at the present day many central stations—large stations—that cannot boast of even

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a bottle of carron oil within their walls. In all well-appointed manufacturing works, whether mechanical or electrical, special attention is always given to ambulance requirements. The same cannot, unfortunately, be said of the majority of central electricity stations. Quite recently the writer had brought to his notice a case of a labourer who had fallen from a scaffolding where some iron netting guards were being erected, and who was injured about the head and arms in a shocking manner. No ambulance dressings being available, the poor fellow remained in great pain until the arrival of the horse ambulance from the town fire station, the ambulance, fortunately, being in at the time. In the meantime, the only thing done to the poor fellow was the profuse application of engine cloths and waste, these, by the way, being none too sweet or clean. The unfortunate man's injuries were so serious as to necessitate his detention at the local hospital, where he remained for several weeks, and he will carry with him always ample evidence of the severity of his injuries. It is rather curious to note, by the way, that this man served through the Boer Campaign without receiving any injury. Another case which the writer witnessed was that of a stoker who had the misfortune to fall into a hot-feed tank, and was scalded very badly about the lower parts of his body. One member of the staff had the presence of mind to run to a house near by and obtain some flour and linseed oil, and the timely application of these was, no doubt, the means of saving the man much suffering. This case was rather unfortunate, as, owing to his being a new hand, the stoker had not had time to become a member of the work's sickness and accident club, and during the two months he was away he received no pay.

For a large station having 40 or 50 men in or about the works during the daytime, a complete litter and several ordinary stretchers are indispensable, as the charity and municipal ambulance stations should not be depended upon. This is more particularly so in the case of a large manufacturing town, where accidents requiring ambulance removal are of daily occurrence. The litter should be kept as near as possible to the road or street which offers the best and most convenient way to the nearest hospital. The stretchers could be kept in cupboards say, one or two convenient to the offices, and one in the engine-room. A case, containing an ample stock of dressings, etc., should be kept in the engine-room, preferably near to the main switchboard, and a good supply for restocking should be kept in the works' stores. It is not necessary to keep these necessaries under lock and key, as keys, not infrequently, have a nasty knack of being absent when most wanted. For moderate and small size stations perhaps a litter might be dispensed with, although advisable. A couple of stretchers and a case of dressings, arranged as in the above-mentioned case, would do.

In all stations, framed instruction sheets on "first aid" should be hung in prominent positions. The staff should be trained in the rendering of "first aid," and kept up to concert pitch by classes and demonstrations, from time to time, by a competent medico. The writer remembers a sad case of a labourer who was at work standing on a ladder only some few feet above the switchboard floor, falling, due to the ladder breaking, and injuring his head and back so severely as to render him quite unfit for any laborious work again. In this instance, the Corporation to whom the works belong were generous enough to give the unfortunate man an easy berth for the rest of his life. The nearest hospital was two miles away, no ambulance necessaries being kept at the station. Not very long ago the writer received a severe burn on the hand, together with a temporary partial blindness of the eyes, caused by the fusion of some switchgear connected to a faulty dynamo. In his case, also, there were no dressings at hand, and he had to run out (perspiring from a hot engine-room into the cold night air) to a chemist's shop some distance away, where the injuries were dressed. For a few nights following the eyes were so painful as to render sleep practically impossible.

The list given below is issued by the St. John Ambulance Association, St. John's-gate, Clerkenwell, London, E.C., from whom all articles mentioned therein may be obtained.

Litter complete, with ordinary stretcher and iron tyres to wheels, £11. 2s. 6d. and £12. 17s. 6d.; or with india-rubber tyres to wheels, £14. 7s. 6d. and £16. 2s. 6d.

Ordinary stretcher for general use, £1. 17s. 6d.

Telescopic-handled stretcher for working in confined places, £2. 5s.

Large hamper for ambulance station and railway purposes containing: 1 set of cane splints, 1 elastic band tourniquet, ½lb. carbolic cotton wool (in tin case), ½lb. boric lint, 1 roll adhesive plaster, 20 roller bandages (assorted), 1 dozen triangular bandages, 3 pieces tape, 4oz. sal volatile, 4oz. bicarbonate of soda, 4oz. olive oil, 4oz. spirit ether comp, ½lb. tin powdered boric acid, 4oz tincture eucalyptus B.P.C., 1 pair Pean's forceps, 1 pair scissors, 1 knife, 12 surgeon's needles, 1 packet each safety and plain pins, ½oz. carbolised Chinese twist, ½oz, silkworm gut, 1 reel each black and white sewing thread, 1 kidney-shaped basin, 1 stopper loosener, 1 graduated measure, 1 cake 20 per cent. carbolic soap, 1 nail brush, 3 empty 8oz. bottles. Price complete, £4.

Small ambulance hamper, with waterproof cover and strap, for use in factories, collieries, stations, and large works, containing 1 set splints, 1 elastic tourniquet, 3 tampons (for washing wounds), 2 packets lint, 4 roller bandages (wide and narrow), 4 triangular bandages, cotton and boric wool (in tin cases), spool of adhesive plaster, knife, scissors, thread, tape, needles, and pins. Weight complete, 6½lb. Price, £1. 11s. 6d.

First aid box for litter or ambulance station—can be placed on litter or hung up on a wall; a leather handle is also fitted for carrying purposes—containing 1 set wooden splints, 1 elastic band tourniquet, carbolic wool, boric lint (in tin cases), 1 roll adhesive plaster, 12 roller bandages (assorted), 6 triangular bandages, 3 pieces tape, 1 pair scissors, 1 knife, 1 kidney-shaped basin, 1 graduated measure, 2oz olive oil, 2oz tincture eucalyptus, B P.C., 2oz. sol volatile, 2oz spirits ether comp., 8oz. carron oil, pins (safety and plain), needles and thread. Price complete, £2. 10s.

The following list of books, etc., is recommended to those who take an interest in Red Cross work: "First Aid to the Injured," by J. Cantlie, M.B., F.R.C.S., 1s. "First Aid to the Injured" (six ambulance lectures), by Prof. F. Esmarch, 2s. Dr. G. H. Darwin's "First Aids," being a card to hang up, giving treatment of various accidents, 2d. "Emergency Book," for instantaneous reference, giving concise instructions, to hang on wall, 2s. 6d.—S. L.

Answer to No. 697 (*awarded* 10*s.*).—A very important function of the ambulance outfit is its relative position to the boiler and engine house of the central station. It is desirable to have it on the ground floor, and yet in as central a position as possible. In, I think, the majority of stations the boiler-house is on a lower level than the engine-room. If the difference of level is not very great I recommend that our ambulance outfit be placed in the engine-room. A cupboard should be purchased which will lock, and yet easily and quickly open when required. It should contain three shelves or divisions—one for medicines, one for instruments, cotton wool, towels, etc., and one for a large washing basin, soap, and nailbrush. This cupboard should be placed at a convenient height on the wall, and, if possible, near some warm-water service.

The necessary, or, at any rate, desirable materials to stock I will give you in list form: 1 magnetised needle, 1 set cane splints, 1 elastic band torniquet, ½lb. carbolic cotton wool, ½lb. boric lint, 1 roll adhesive plaister, 20 rolls bandages (assorted), 1 dozen triangular bandages, 3 rolls of tape, 1 bottle brandy, 1 bottle whiskey, 4oz. sal volatile, 8oz. glycerine and absolute phenol (50 per cent.), 4oz. bicarbonate of soda, 1 bottle Carron oil (equal parts of limewater and salad oil), ¼lb. tin powdered boric acid, 4oz tincture of eucalyptus, 1 pair Péone forceps, 1 pair medical scissors, 1 knife, 1 packet each safety and plain pins, 1 bottle Friar's Balsam, 1 bottle witch hazel, 1 sponge, 1 reel black and white cotton, 1 large enamelled basin, 1 stopper loosener, 2 soft towels, 2 cakes 20 per cent. carbolic soap, 1 nail brush, 1 stretcher.

Roughly I estimate the whole of this to cost £5, exclusive of the cabinet and stretcher. A stretcher, which perhaps is not absolutely necessary, but very desirable, would cost, say, £1. 10s. Far more important than all

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this is some knowledge of "first aid to the injured," as of course all the above materials are valueless unless some members of the staff are aware of which to apply immediately an accident has occurred. The uses for a large number of items in the above list are obvious, so I propose to explain only the methods for treating the most likely and common accidents.

Burns.—First wash, and apply carron oil, then cover up the wound with tape over cotton wool. For the washing use Friar's Balsam and warm water.

Cuts.—An ordinary cut must simply be washed with a very weak solution of Friar's Balsam, and then bound up either with plaister alone, or cotton wool, and plaister and tape, according to the severity. More important is the case where an artery or vein is cut. Here it is absolutely necessary to stop the circulation immediately, else the patient will probably bleed to death. The circulation can be stopped by tying a bandage tightly round the limb; in the case of an artery, nearer the heart than the wound; in the case of a vein the reverse. It is very easy to see whether it is a vein or artery that is cut, as in the former the blood comes out slowly, and is dark in colour, whereas in the latter it spurts out, as it were, under great pressure, and is bright red in colour. If the cut is in the body where the circulation cannot be stopped by a bandage, your thumb must be applied, and held in position until medical aid is procured.

A Broken Limb.—Whether the fracture is compound or simple, the limb must be set in splints and temporarily bound up until a doctor can be brought; in the meantime the patient must be given a stimulant (brandy) and made as comfortable as possible.

Concussion.—Concussion of the brain is a common result of even small knocks, and the patient is usually very sick. This, again, is a case only for the doctor, but it is well to remember, above all, do not apply any stimulant.

Apoplectic Fits.—These fits often accompany concussion of the brain, but are sometimes brought about by excessive heat. Apply no stimulant, and allow the fit to take its course, taking care the patient does not hurt himself or bite his tongue.

Eye Troubles.—The magnetised needle mentioned above is to be used for extracting iron or steel splinters out of the eye. The needle only having to be placed over the splinter to attract it, and unless very deeply embedded, will extract it with very little pain.

Blood Poisoning.—This is caused generally by negligence in cleaning wounds before dressing them. If the wound is well cleaned and washed in warm water there is little chance of blood poisoning setting in. Friar's balsam I consider a much preferable disinfectant to "Iodoform," the latter having a very sickly and objectionable odour, and also making it impossible in many cases, on redressing the wound, to determine whether any festering has taken place.

Faint.—Whilst dressing wounds the patient very often goes faint. To prevent this, double up the patient; put his head between his knees for, say, one minute. A very great mistake made by many people is to sit their patient upright when in a faint, this being the worst treatment possible. A faint is due to the absence of blood in the head, and is, therefore, only cured by accelerating the flow of blood into that member of the body.

In conclusion, I should like to impress upon everyone the necessity for studying to some extent first aid, and to point out the number of lives lost, not only in central stations, but everywhere (even in the streets), solely through the deplorable ignorance of those about in even the very fundamental principles of first aid to the injured.—E. D. S. S.

Answer to No. 697 (*awarded 7s. 6d.*).—The best way to arrange this desirable idea is to communicate with the St. John's Ambulance Association, St. John's Gate, Clerkenwell, London, E.C., and to get a properly qualified man to attend and give the usual course of lectures. He would give about six lectures or lessons with practical illustrations, and at the end of about six or eight weeks a properly appointed examiner would attend and give certificates to the efficient members of the class. By this the men gain by the experience of others, and are brought up to date and in line with the best practice in "first aid." The instruction is good and definite and all can qualify easily if they give proper attention. My men have lately done this. The total cost to each man was about 4s. 6d. If the men on the station are not sufficiently numerous they can arrange with some neighbours to join the class, as there are many about who are eager to join as soon as they hear of the opportunity. This is by far the best mode of proceeding because it gives definite practical instruction and points out what must be avoided. The above-named cost includes 1s. for a most excellent little book, published by the St. John's Ambulance Association under the title of 'First Aid to the Injured," which should certainly be obtained in any case, whether the lectures are to be had or not, as it gives most valuable information in simple language. The latest edition is the best. In arranging a scheme of this sort it is very important to realise that the best of good intentions may fail in their object, simply through the want of proper instruction or through the want of knowing what to avoid. "First Aid" may be summarised as taking proper care of the patient while the doctor is being fetched. Unfortunately there is a tendency to avoid sending for a doctor, and there is a real danger in any officious, uninstructed person assuming the doctor's duties.

The materials most suitable to keep handy would be a roll of surgical lint, with a medium-sized pair of scissors to cut it, a few rolls of bandage, some non-poisonous disinfectant—*e.g.*, Rowan's or Jeyes'—an earthenware basin, and some warm water to wash dirt from a wound, about a pint of carron oil for burns, a reel or so of white cotton, and a suitable needle to fasten a bandage; and if serious accidents are feared, a stretcher and splints should be kept as illustrated in the little book on "First Aid." A blanket or rug to lay the patient on and keep him warm would also be advisable, and in the case of high-tension currents, insulating gloves and mats should be kept in definite easily accessible places, so that anybody may safely extricate the patient from his dangerous position. All the above must be kept scrupulously clean, and the book on "First Aid" gives very valuable instructions as to using them. A board of instructions should be hung on the wall, giving the address of the nearest doctor, and any other local instructions which may be necessary, such as where to stop steam or hot water, to shut off a dangerous current, etc. All the above should be put under the care of the most trustworthy man who has passed his examination in "first aid,' and is willing and anxious to undertake the responsibility which should be treated as an honour. This man should be able to take the lead, give directions, and prevent confusion. The most important thing to provide for is the necessary knowledge, for without it artificial respiration cannot be applied, serious bleeding cannot be stopped, and a patient with broken limbs cannot be moved safely.

To the above I would add that many accidents may be prevented by judicious forethought before starting any serious work, and by careful inspection while it is in progress—*e.g.*, provide that heavy weights cannot fall far unexpectedly, that ladders cannot slip, that chains are strong enough and have no faulty links, that earth is well timbered and cannot fall upon diggers, that hand-rails are provided on stairs and scaffolding, that no holes are left in the ground unprotected, that steam pipes and wires are joined to the sources of supply last instead of first, etc.—F. G. A.

Answer to No. 697 (*awarded 5s.*).—The following is a list of articles used at a large generating station in this city, which have in the past been very useful in cases of emergency—viz.: 1 16oz bottle carron oil, 1 12oz. bottle carbolic acid, 1 4oz. bottle Friar's balsam, 1 4oz. bottle tincture of steel, 1 4oz. bottle sal volatile, 1 4oz. jar boracic acid powder, 1lb. absorbent lint, 1lb. cotton wool, roller bandages ½in. to 2in. wide, 1 "Esmarch's" triangular bandages, 1 roll "Johnson's" adhesive plaster, 1 graduated glass, 1 pair scissors, 1 torniquet, 1 1s. edition of "First Aid to Injured," published by the St. John's Ambulance Association, London. All the above are contained in a box 18in. by 18in. by 10in., on the front of which is a label describing the various contents and their particular uses.—J. MUNGOVEN.

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Question No. 698.—A certain mill is equipped with a 60-h.p. waterwheel of the "undershot" type. The mill is subjected to periodical shortages of water. It is proposed to provide a 50-h.p. induction motor of the single-phase type, the motor and waterwheel to be run in parallel on the shafting, it being assumed that the motor will automatically take up any excess of load as the waterwheel slows due to lack of water. During the winter months the shafting is occasionally but lightly loaded, and there being an excess of water at this period, is it possible for the waterwheel to drive the rotor of the motor above synchronous speed, and thus cause it to act as an "asynchronous generator," and return current to the line, causing variations in line pressure, etc.? If so, please describe methods of prevention.

Answer to No. 698 (*awarded* 10*s.*).—It is, of course, possible that the waterwheel would rise above synchronous speed, and in that case the induction motor would become a generator, and supply a certain amount of current to the line. The effect of this increased speed will, however, make no difference to the frequency, as the frequency depends entirely on the exciting current, which is obviously taken from the generators that have previously supplied current to the motor. In such a machine the effect of increasing the speed above synchronism is to make the rotor conductors cut the alternating field and set up a current in the rotor opposite in direction to when running as a motor. This current in the rotor will induce a current in the stator, which will also be opposite in direction, and thus the machine becomes a generator whose frequency is independent of its speed. It is not at all probable that such a contrivance would make much difference to the line voltage, especially if the plant supplying the power is greatly in excess of the power required for this particular motor. Further, such machines cannot deliver current to the circuit by increasing the speed above a certain point, unless the resistance of the circuit falls, for since the pressure at the stator terminals cannot rise above that of the line if the resistance of the external circuit be kept constant and the speed raised, the stator simply draws a greater wattless current.—E. AUSTIN.

NOTICES OF BOOKS.

Dynamo, Motor, and Switchboard Circuits, by W. R. BOWKER, published by Lockwood and Son; and **Practical Construction of Electric Tramways,** by W. R. BOWKER. Price, 6*s.* E. and F. N. Spon.

We may, perhaps, be allowed to call attention to these books because they are, in every sense of the word, elementary, and the author touches upon subjects which the ordinary text-book treats far more curtly. We think, however, that the time has long since passed when it is necessary to give a chapter in a book on tramways, merely describing the materials and equipment of various undertakings. The student is a student from many points of view. Many study a subject merely to pass an examination, and though that class must buy books, it does very little good otherwise. Another class, by far the more important, is trying to get information in order to utilise that information, the aim being to know what is best under certain conditions Hence, it would be far better to describe carefully the conditions which determine certain materials and equipment rather than to give that information without clearly describing why it was adopted. In both books the information given is fairly accurate, and most of it such as will prove useful. A very valuable feature is the number of illustrations, for in most cases the illustrations show clearly what no amount of words can explain so well. The definitions also are well put, and on the whole the books can be commended.

Transactions of the Junior Institution of Engineers. Vol. XIII. 1902-3. Edited by WALTER T. DUNN. 10*s.* 6*d.*

There are many methods of obtaining the latest information on practical subjects, but perhaps the most important of all is the attending the meetings of associations which deal with the specific subject under consideration. Owing to the great extension of knowledge during the past century, men have to specialise, but before they can do this it is necessary to generalise. Lord Brougham's dictum stands as good now as when it was uttered, and the most promising professional man is he who knows a little of everything and everything of one thing. We have watched with a considerable amount of interest the work and the growth of the Junior Engineers, and consider that they have advanced very rapidly year by year in perfection. The papers read at the meetings are mostly of an exceedingly interesting character, and as a rule are treated in an able way.

We have tried for many years past to impress upon the older and more experienced members of the profession that, so to speak, there are two ends to a professional career, the entry and the exit. Those who are entering the profession have all to learn; many of those who are leaving think there is nothing left for them to learn. The latter is a grave mistake, for he who ceases to learn ceases to be any good in this world. Considering then that those who are entering the profession have all to learn, while others have something to learn, it is not uninteresting or unuseful, but the contrary, to find subjects treated in a more or less elementary manner. Hence the great value of these junior institutions. Many of the papers are certainly of a students' type, while others as certainly appeal to the more experienced. The present volume of *Transactions* contains a number of papers which ought to appeal very strongly to all junior members of the engineering profession, and the papers are very diverse, as will be seen from the titles. Thus, we have "Marine Boilers," by Mr. Roundthwaite; a subject of exceptional interest in these days, when we are in a kind of transition state, hardly knowing what kind of boilers to put in either in the Navy or in the more peaceful ships. We want the best, but they must be the best under all conditions, not under particular conditions. Besides the paper by Mr. Roundthwaite, Mr. Yarrow deals with certain trials in certain water-tube boilers, while Mr. Paterson deals with greasy condensing water as boiler feed.

Then, almost as important is the question of fuel, and Mr. Wernham discusses the "Calorimetry of Gaseous Fuels." Electrical engineering has its place in a paper by Mr. George on "Electric Motors for Factory Work," and a paper of another character which appeals strongly to an enormous number of students is that on the "Effect of Design on Methods of Construction from a Contractor's Point of View," by Mr. Newman.

There is a mass of other information in the volume, but we have said enough to show that certainly this volume is at least the equal, and, we believe, the superior of any other preceding it.

Law of the Telegraph, Telephone, and Submarine Cable. By E. G. M. CARMICHAEL. Knight and Co.

The law relating to telegraphy is practically modern, as will be seen from the following. The year 1836 saw the grant of letters patent to Messrs. Cook and Wheatstone for a certain invention described as "improvements in giving signals and sounding alarums in distant places by means of electric currents transmitted through metallic currents." Subsidiary patents were from time to time granted to inventors throughout the United Kingdom up to 1845. So far as regards telegraphy and telephony, it has been legally held that the latter is a branch of the former. Unfortunately, we have in this kingdom conflicting interests, and the law relating to the subject must necessarily be closely considered during any attempt to get rid of the opposition parties. The question of the submarine cable may also become a delicate one in the face of aerial telegraphy. The latter, being a newcomer, finds legislative enactment, some of which may have to be changed before it can gain a free hand. This book will assist those who desire to learn the law on the subject.

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Supplement to "The Electrical Engineer,"
JULY 15, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

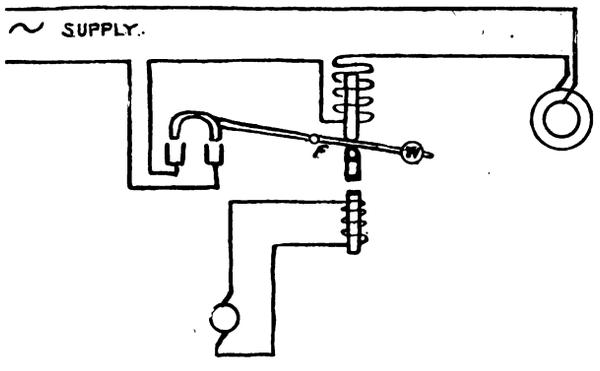
706. In testing a six-pole, 200-kw., 500-volt machine for a faulty (?) armature coil, the following methods were adopted: The brush leads were connected together, with an ammeter in circuit, and the field was separately excited off the 'bus bars, in series with incandescent lamps, with a current of ·6 ampere. The machine was run at about half speed (200 to 230 revolutions per minute), and a current of 400 to 600 amperes was maintained. When the machine slowed up with any drop in steam pressure the amperage rose. The lamps in series with the field continually waxed and waned whilst the machine was running, and in switching off these lamps at the end of the run, the last one switched off, thereby breaking the field circuit, became intensely luminous at the instant of switching off. Explain these phenomena.—A.

707. Describe the process of determining the permeability of a specimen of iron in the shape of an anchor ring for a given magnetising force.—VINCENT.

ANSWERS.

[The following answer was inadvertently omitted from our last issue.—ED. *E. E.*]

Answer to No. 698 (*awarded* 10*s.*).—A method as shown in the accompanying sketch will be found to give satisfactory results. One of the mains to induction motor passes round a laminated core, the core being fastened to a lever which works rounds the fulcrum, F. One end of this lever carries an adjustable weight, W, the other a U-piece of copper to make and break connection with the two mercury-cups. Below the lever is another solenoid, the core of which acts on a piece of iron fixed to underside of lever. This lower solenoid is energised from a small direct-current dynamo, which is driven from the axis of the water-wheel. The arrangement is therefore differential.



Suppose the waterwheel and motor are running together, and that, owing to extra flow of water or reduction in load, there is an increase in the number of revolutions of the combination per minute. It is a property of the induction motor that as the speed of the rotor increases the current falls off, owing to the reduction in "slip." Consequently, as the speed of the combination increases the current drawn from supply mains decreases. The solenoid in the alternating-current circuit may then be adjusted by means of the weight, W, to cut the motor out of circuit at any desired speed. Unless sufficient current is passing, the pull of solenoid will not be enough to keep the copper U-piece in the mercury-cups. The water wheel may now be considered to be taking all the load with the motor cut out of circuit. Should occasion arise for help from the motor, the lower solenoid becomes weaker, and allows the lever to fall over and close the motor circuit. The fall in speed of water wheel causes a proportionate drop in volts of the direct-current dynamo, and, therefore, a weaker current round the lower solenoid. If thought desirable, both cores could be attached to the lever, but it is generally advisable to make moving parts of such apparatus as light as possible. With this arrangement there need be no fear as to the motor acting as a generator.—M. M.

Question No. 699.—Show how to determine the percentage of oil in exhaust steam, samples of steam being taken from the inlet and outlet branches of an exhaust steam oil separator.

Best Answer to No. 699 (*awarded* 10*s.*).—To determine with any degree of accuracy the percentage of oil in the exhaust steam, it is first necessary to condense the steam. Certain precautions must, therefore, be taken to ensure that in the condensation the whole of the oil contained in the steam is left, so to speak, in the water, and that a fair sample of the steam is obtained. In the subjoined sketch (Fig. 1) S represents a steam separator with inlet on top

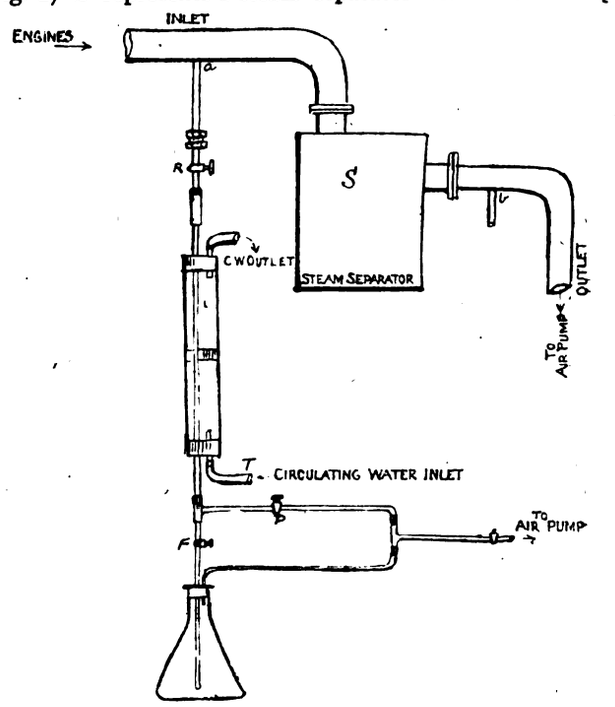


FIG. 1.

and outlet at the side. In the horizontal limb (preferably) at the points *a* in the inlet and *b* in the outlet a ⅜in. hole may be tapped, and a copper or iron tube screwed in so that the tube may be moved vertically across the section of the pipe. The sketch shows the arrangement for the inlet pipe, and it will be seen that the ⅜in. pipe is connected, through a stopcock, to a condenser—one of glass is quite good enough—consisting of two concentric glass tubes, through the outer of which water may be circulated. The inner tube is connected to the ⅜in. pipe, and is carried down into a glass flask. If the engines cannot be run on the atmosphere, through the separator, the inner tube should run close to the bottom of the flask, which should be corked and a small tube connected to some convenient part of the system under vacuum—maybe to the air-pump inlet. To ensure a fair sample, steam must be allowed to flow through the tubes for some time; the method of doing this is shown, for by shutting the cock F and opening P and R steam flows direct down the ⅜in. pipe through the inner tube of the condenser and along the branch through P to the air-pump or atmosphere. The circulating water should then be run through the outer tube—the town supply connected to the bottom inlet, T, will serve well—the cock, P, shut and F opened. The condensed steam collects in the flask, and by screwing the ⅜in. tube up and down a very fair sample of steam is

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obtained. About half a pint of water should be collected. To estimate the oil, pour about 100 cubic centimetres (·176 pint) of the condensed water into a shaking flask (Fig. 2) of about quarter-pint capacity, and pour in about five cubic centimetres of ether. Shake up well, and allow to stand for a minute. Pour in another five cubic centimetres of ether, and repeat the operation. The ether dissolves the oil and separates off from the water. Probably about 25 cubic centimetres of ether will suffice to dissolve out all the oil quickly, and after settling, the water should be tapped off into another shaking flask, 10 cubic centimetres more of ether added to it, and separated as before.

FIG. 2.

The two ethereal solutions should be mixed into a weighed flask and the ether distilled off, either through a Liebig condenser, or, if the accuracy of the result is not required to be absolute, over a water-bath. The residue must be carefully dried and weighed, the difference between the weights of the flask giving the weight of oil in 100 grm. of water, and thus the percentage sought. A sample must also be taken from *b*, and thus the required percentages of oil in inlet and outlet found.—S. E. T.

Answer to No. 699 (*awarded* 7*s.* 6*d.*).—This is not a very simple matter. Different classes of grease and oil are used for lubricating pistons, and these different classes behave differently—*e.g.*, vegetable or animal grease would be decomposed by the hot steam, and so (I have found) are also some of the so-called mineral oils with steam of 50lb. pressure, although, of course, pure mineral oils would not be. Some time ago I put an iron plate about 3ft. square in front of the exhaust pipe of a steam-engine, so that the steam, etc., had to go through about 3ft. to 4ft. of air before impinging upon the surface of the iron plate. The result was instructive, for the plate became covered with a thick coating of grease from the cylinders even when fair quality black cylinder oil (mineral) was used exclusively in the engines, and although all the oil was liquid enough to pass when cold through sight-feed lubricators drop by drop. The grease was very adhesive and remained sticking to the plate for weeks. This simple experiment makes me think that merely taking a sample of steam from the side of the exhaust pipe would either give no result at all or else be misleading. I would, therefore, advise that the best way to ascertain the percentage of grease in the exhaust steam would be to run the machinery as usual but to note the amount of steam condensed, and then to draw off the oil from the separator, when the ratio of one to the other would give the percentage of oil or grease in the exhaust steam either by weight or measure as desired. Another method would be to note the amount of oil put into the cylinders, and to note the amount of exhaust steam condensed, when the ratio of the weight of oil used and weight of water condensed would give the percentage of oil in the exhaust steam almost exactly, because it is obvious that as no grease accumulates in the cylinders and none drops from the piston rod and gland, it must all pass out except the very small amount which is usually found inside the cylinders and steam-chest, but which amounts to practically nothing. In this last method no allowance would have to be made for decomposition of the vegetable or animal fat which might be present.

If it is really necessary to ascertain the percentage of grease in the exhaust steam—*i.e.*, incorporated with the steam—then a specially constructed exhaust box must be provided so that the steam blows straight against a baffle plate, which stands up from the bottom of the box, and allows any lumps of grease passing out with the steam to trickle down its surface and lie quietly and safely at the bottom of the box out of the way of the steam. This baffle plate should be corrugated vertically, so that grease when once on it cannot be blown off again by the passing steam. The exit of the steam would be past the two sides and over the top of this corrugated baffle plate, and so out at a hole in the middle of the opposite side of the box into a pipe, which should be surrounded with cold water like a Liebig's condenser, and long enough to condense all the steam to water, which must be caught in a tank and allowed time to settle, when the grease actually incorporated with the steam would be found floating on the surface of the water, and could be collected and measured or weighed. The oil collected by the corrugated baffle plate would be allowed to run out by the opening of a tap placed at the bottom of the oil-well, and would show the quantity and quality of the grease blown out in drops or lumps, and would probably be considered grease used in excess of actual requirements, if not entirely, at least in large proportion; but this would have to be considered with reference to local circumstances, such as steam pressure and the quality of oil used. Some oil merchants say that the oil is "atomised" and passes along the pipes—*i.e.*, incorporated with the steam—but I am not disposed to believe this statement, at all events, in the case of vegetable, animal, and the heavy mineral oils used in steam-cylinders. I would rather say that the heat renders the heavy mineral oil very liquid and mobile, and consequently greatly facilitates its already great capillary or creeping action. The vegetable and animal oils would be decomposed into glycerine and a fatty acid by the action of much heated steam.—F. G. A.

Question No. 700.—In an engine which is governed by a throttle valve, does the loss of pressure in the valve represent a *corresponding* loss of efficiency in the engine? In other words, would the heat generated by the fluid friction in the valve (which heat would presumably be carried forward by the steam) be to any extent converted into useful work in the engine?

Answer to No. 700 (*awarded* 10*s.*).—This question appears to be one which must be approached cautiously, or it might easily be misunderstood. In fact, several constructions could be put on the wording of the question. When I read the first part of the question, I immediately had in my mind's eye a comparison between an engine fitted with a throttle governor and the same engine fitted with an automatic cut-off governor. Looking at it from this point of view, I should have no hesitation in saying that, theoretically, the engine when fitted with an automatic cut-off governor should be more economical than when fitted with a throttle-valve governor; but when I finished reading the question it seemed to bring other conditions into consideration—in fact, conditions seldom met in practice.

Let us take an engine in our mind's eye, and follow the steam through the various stages. First, when fitted with an automatic cut-off governor, the steam would be admitted to the valve chest at boiler pressure (neglecting losses in connections) and, providing it does not pass through a superheater, would be ordinary saturated steam. This steam is carried at initial pressure until the point of cut-off, when it is expanded to the extent desirable. This would, of course, be our ideal of practical efficiency. But let us now follow the steam when the engine is fitted with a throttle governor. The condition of the steam at full load would be similar to that in the first case, but at light loads the throttle valve would be partly closed, so that the steam would be wire-drawn and supplied to the slide valve at a reduced pressure. Now consider the state of the steam under these varying conditions. Two cases must be taken for this purpose—first, when the engine is working on light loads for very long periods; second, when the intervals on light loads occur frequently and are of short duration. Taking the latter case, the conditions would be as follows: Steam would be supplied at the slide valve alternately with high and low pressures and temperatures, consequently the average temperature of the valve casing would be something between the highest and lowest temperatures of the steam admitted. The effect of this would be that when on full load condensation would take place between the throttle and slide valves, and when on light loads superheating would take place. If full load working is of shorter duration than light-load, there would be more condensation than superheating taking place; on the other hand, if light-load working be of shorter duration than full-load working, more superheating will take place, so that we see on light loads we should have, instead of "fluid friction," what we might term "superheat friction."

Taking the other case, with very long periods on light load, there would be considerable condensation taking place

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due to the change in pressure, and, consequently, temperature, and here we should get "fluid friction," and the question now is, "Would the heat generated by the fluid friction in the valve (which heat would presumably be carried forward by the steam) be to any extent converted into useful work in the engine?" My answer to this question is, "No."

If I admit that fluid due to condensation by reason of the use of the throttle valve caused additional friction, and put more work on the valve rods, additional work must be done by the piston to overcome this friction, and the heat generated by reason of friction cannot be again converted into work without loss, therefore it is not possible for useful work to be got out of any engine by reason of the heat generated by friction of any kind. Personally, I am of opinion that moisture in the steam reduces friction. I have run triple-expansion engines of 6,000 h.p., month in and month out, without putting a drop of oil in the cylinders, except that which crept in when swabing the rods, depending entirely on the saturated steam for lubrication.—A. C.

Answer to No. 700 (*awarded* 10*s.*).—When steam is wire-drawn in passing through a throttle valve, the steam expands without doing useful work; its expansive energy is then mostly employed in increasing the velocity of the steam particles. The kinetic energy so produced will ultimately be transformed to heat by fluid friction in the steam. This heat will, if the steam originally contained moisture, evaporate some, or all, of it, and perhaps superheat the steam. The useful work obtainable from the steam is less after this unbalanced expansion than before, but the resulting loss is less than the direct loss due to fall in pressure. Thus if steam, in passing through the valve, has its pressure reduced by d P, and the mean specific volume be V, loss in thermal units per pound of steam will be $\frac{d\,P\,V}{5{\cdot}36}$. For example: If dry steam fall in pressure from 100lb. to 90lb. per square inch, taking the mean specific volume as 4·39 cubic feet, the loss

$$= \frac{10 \times 4{\cdot}39}{5{\cdot}36} = 8{\cdot}1 \text{ thermal units.}$$

The loss due to wire-drawing—the engine in which the steam does work being otherwise perfect—will be given by the formula

$$T_0 \left(\frac{1}{T_2} - \frac{1}{T_1}\right) L_1,$$

where T_1, T_2, T_0 are the absolute temperatures of the steam at 100lb., 90lb., and exhaust respectively, and L_1 the latent heat of the steam at temperature T_1. The loss in this case, therefore,

$$= 563 \left(\frac{1}{781} - \frac{1}{789}\right) 883{\cdot}6 = 6{\cdot}4 \text{ thermal units,}$$

T_0 being taken as 563, or 102deg. F. The difference between the two results, of 1·7 units, is due to the drying or superheating effect of wire-drawing.

The formulæ from which the foregoing results are deduced are based on certain assumptions not realised in practice. The steam does work in an engine supposed to be perfect, except for the wire-drawing of the steam from 100lb. to 90lb., all the heat generated by friction against the valve being supposed to pass into the steam. If the valve be raised to a higher temperature than the metal forming the casing, heat will be conducted from the valve to the latter. The temperature to which the valve is raised depends upon the relative rates at which heat is generated in, and given up by, the valve, the last depending upon the state of the steam as regards dryness and temperature, and also the flow of steam over the heated surface. It is not improbable, therefore, in practice that some of the heat generated in the valve is lost, and the remainder given up to the steam.

In reference to the value of the heat passed to the steam from the valve, as regards its bearing on engine efficiency, the maximum work obtainable from it will depend upon the temperature of the steam that receives it. Although a quantity of heat has a mechanical equivalent, its mechanical value depends upon the temperatures between which it may be utilised. Suppose that each pound of the steam, absolute temperature T_1, supplied to an engine (in which the only imperfection is wire-drawing) loses a quantity of heat, K, in friction against the valve, and that this quantity is passed to the steam back from the valve at temperature T_2, corresponding to the reduced pressure. Then, if T_0 be the exhaust temperature, the greatest amount of work obtainable from K at the initial pressure will be

$$K \frac{T_1 - T_0}{T_1} \text{ thermal units;}$$

and at the reduced pressure

$$K \frac{T_2 - T_0}{T_2} \text{ thermal units.}$$

In the case above the first will be

$$K \frac{789 - 563}{789} = {\cdot}286\ K,$$

and the last $$K \frac{781 - 563}{781} = {\cdot}279\ K.$$

Thus the loss is ·007 K thermal units, whereas if the heat, K, were not returned to the steam, the loss per pound of steam would be ·279 K for an engine working between the absolute temperatures 789deg. and 563deg.—H. J. W.

Answer to No. 700 (*awarded* 10*s.*).—This question may be best answered by dealing with a particular case and estimating the comparative economy. Before doing so it will be as well to recall Prof Peabody's throttling calorimeter, which within its limits is known to give accurate results. As the name implies, the steam to be tested for dryness is throttled at its inlet to the calorimeter and the pressure reduced to nearly atmospheric pressure. The heat units represented by the difference in the total heat of the steam at the higher and lower pressure, are then available at the calorimeter to first re-evaporate any moisture in the steam and then to superheat it, or, if, as is very unlikely, the steam is dry, the heat units would be expended in superheating alone. Now, the use of this calorimeter is one instance of throttling through an exceptional range, and, if, as the question suggests, fluid friction resulted in the production of heat at the throttle valves, its effect would be noticeable. It has, however, been found actually that the superheating effect is only that to be expected from the heat units liberated by the fall in pressure and no more, and, as a result, the use of this calorimeter is limited to cases in which the steam is dry enough to allow some superheating to be observed. Steam containing more than 3 per cent. of water does not liberate sufficient heat to do more than re-evaporate moisture, unless the degree of throttling or the fall of pressure is such as to be beyond practical working conditions. As an actual example of the loss due to throttling the following case may be stated. Steam pressure at the engine, 145lb., supplied in the first instance to the engine steam-chest at this pressure, and in the second instance at 125lb. gauge pressure, or throttle reduced 20lb. The engines tested under these conditions at full load showed steam consumptions of 22lb. and 25lb. per indicated horse-power hour respectively, or a difference of 12 per cent. The engines were of precisely the same design, the difference between them consisting alone in the use of suitable cylinders and points of cut-off at the valves to allow the same powers to be developed at the different pressures stated. As there are essential differences in any particular type of engine, the 12 per cent. economy may be taken as representing the practical gain, which might be a little more or less in other engines of different size and construction. As it is comparative economy that is being considered, it is, of course, necessary that results from the same design and size of engine should be given. Considered from the standpoint of absolute thermal efficiency the gain would be 7½ per cent., but there are so many conflicting conditions that modify the theoretical conceptions that space will not permit of its being entered into here. The "drying action" at the throttle valve is inseparable from throttling, but its probable effect may be calculated in the following way. Taking the total heats of the steam at the same pressures as already considered, the difference is 1,192·8 −1,189·5 = 3·3 heat units. The specific heat of steam at constant pressure is, according to Regnault, 0·4805, and the same authority gives the same figure for superheated

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steam. Hence the 3·3 heat units would be capable of superheating dry steam 3·3 ÷ 0·4805 = 6 86deg. F. This degree of superheat would not result in more than 1½ per cent. gain in economy—that is, the gain in economy by using steam at 145lb. pressure, throttled to 125, would not be more than 1½ per cent.—assuming that the steam is dry saturated steam before throttling, and as compared with the same quality of steam used without throttling, and supplied at 125lb. pressure.—E. G. B.

Answer to No. 700 (*awarded* 10*s.*).—In the various experiments which have been conducted from time to time, the method of governing an engine by a throttle valve does not seem the most efficient. In considering this question, it is necessary to look up the law of expansion of gases, which is: "That if a gas expands without doing external work, there is no loss of molecular efficiency." Now, seeing that the throttle valve has the effect of reducing the pressure of the steam, there must necessarily be (under ordinary conditions) a corresponding increase in volume and a reduction in temperature. Now, assuming that the molecular action on the valve face has the effect of slightly increasing the temperature of the steam, it is quite clear that this is attained at the expense of the kinetic energy or velocity of the steam, so that it is reasonable to assume that there would be no loss of efficiency due to the change of form of effects. We can see, then, that the effect of reducing the pressure of the steam means a corresponding increase in volume but with a reduction in temperature, and simply means that the engine would require a larger volume of steam than it would require if the pressure was higher.

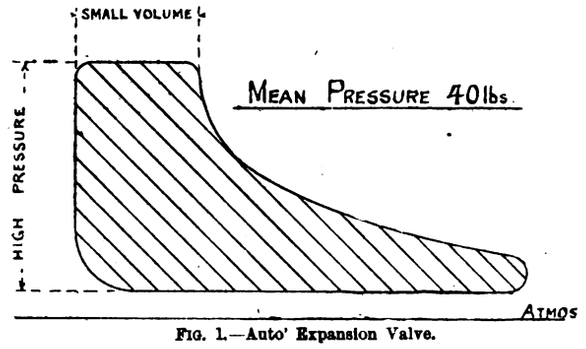


FIG. 1.—Auto' Expansion Valve.

In Figs. 1 and 2 are shown indicator diagrams, taken off similar engines and working under similar loads. Fig. 1 shows the effects which are produced when the engine is controlled by an automatic expansion valve, which varies the amount of cut-off. The boiler pressure is maintained in the cylinder, and the expansion is varied according to the load. Fig. 2 shows the effects which are produced

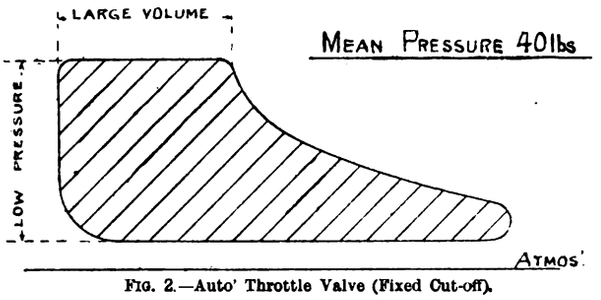


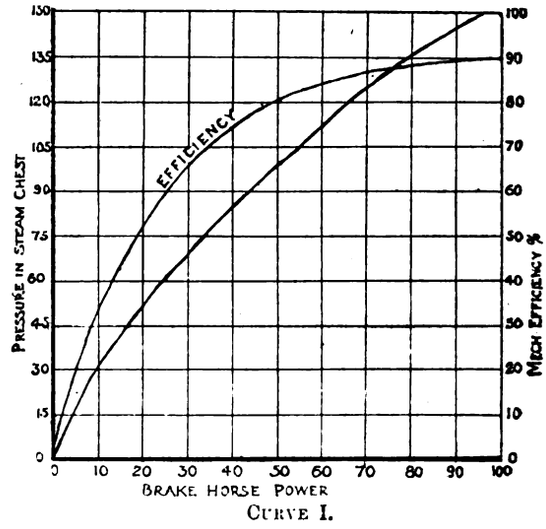
FIG. 2.—Auto' Throttle Valve (Fixed Cut-off).

when the engine is governed by a throttle valve. The expansion is fixed, but the throttle valve varies the pressure of the steam according to the load applied. The same mean effective pressure is obtained in both cases, and are simply different methods of obtaining the same end. In Fig. 1 there is a higher pressure of steam with a small volume. In Fig. 2 there is a lower pressure of steam, but with a large volume. Thus, there is no reason to assume that because the steam has suffered a drop in pressure that there is a corresponding loss in efficiency—what it loses in pressure it gains in volume. The pressure, volume, and temperature of steam is determined by a certain law, and should any one of these be affected it must of necessity affect each of the others.

If it is reasonable to assume that heat is generated by fluid friction in the valve, it is clear that this must have the effect of increasing either the pressure of the steam, if the volume is kept constant, or increasing the volume if the pressure is kept constant, but this effect could not be distinguished from the ordinary effects which accompany steam.

To sum up, there does not appear to be any reason why there should be a decrease in the efficiency of the steam because of the throttling effect. In other words, the gas being self-contained, an alteration in the form of effects does not make any difference in the intrinsic value. It might be well to quote the well-known "law of Charles" for steam, which is: "Under constant pressure equal volume of different gases expand equally for the same increment of temperature, and the volume changes proportionally to the absolute temperature."—JAMES W. TUNSTALL.

Answer to No. 700 (*awarded* 7*s.* 6*d.*).—In an engine governed by a throttle valve, the loss of pressure in the valve does not represent a corresponding loss of efficiency in the engine. When the efficiency of an engine is spoken of, the mechanical efficiency is usually meant—*i.e.*, the ratio of brake horse-power to indicated horse-power. That this ratio does not decrease at the same rate as the steam pressure is made clear in taking a practical case. Suppose the efficiency of a 100-b.h.p. engine at full load with 150lb. steam pressure is 90 per cent., and at half load 80 per cent., and that there is no throttling at full load and 90lb. initial pressure at half load. Now the steam pressure has dropped 60 per cent, and if there was a corresponding drop in the mechanical efficiency this would be only 54 per cent., whereas it is really 80 per cent. The mechanical efficiency of an engine, of course, falls with the load, until at no load it becomes zero; but it does not correspond in any way with the loss of pressure in the valve, as will be seen by Curve I. If it did, the curves would be parallel with each other.



CURVE I.

As regards the heat generated by the fluid friction in the valve, this is of some account in raising the *thermal* efficiency of an engine and in counteracting the causes tending to lower it at light load—for instance, the greater initial condensation due to the lower temperature of the throttled steam. That it has some effect is proved by the Willans straight-line law, which is that in an engine governed by a throttle valve with fixed cut-off the curve of steam consumption per hour and indicated horse-power, when plotted on squared paper, lie in a straight line. A throttle valve has the effect of drying and, under favourable conditions, slightly superheating the steam.—A. B. S.

[Other replies to Question No. 700 will be given in our next issue.—ED. *E. E.*]

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JULY 22, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

708. On a four-pole, 200-ampere, 500-volt B.T.H. three-phase rotary converter, the attendant when running the machine up as a direct-current motor left the shunt field switch open, and machine ran up as a series motor, but in the opposite direction to that in which it runs as a shunt machine. Are the shunt and series windings connected up properly? If not, what is the best method to find out which way the coils are wound without uncovering the windings, and how should they be connected up? P.S.—The shunt coils are joined up two in series.—HERIONS.

709. The proprietors of a boarding-house have a small hand-worked lift for elevating and bringing down dinners, etc. It is desired to work the lift electrically. What would be the best method of doing so, so as to obtain the following conditions: The switching gear must be of the simplest, and be easily understood by the servants, and, of course, be fool-proof. It must be actuated from either top or bottom. The lift is balanced, and it is required to take up at full load about 1cwt. of utensils, etc.; silent working is specially desired. Capital cost to be kept as low as possible. Skilled labour is available to do the whole of the erecting and wiring, but not to supervise after the job has been set to work. A supply of energy at 230 volts is available, and there is an electric bell service from top to bottom of lift.—W. T. W.

710. Controller required for a three-phase motor, 6 h.p., 100 volts; ratio of turns, 2:3; periodicity, 60. Work out diagram of connections and main dimensions of controller, supposing it were for lifting purposes on a crane.—H. E.

ANSWERS.

Question No. 709.—In an engine which is governed by a throttle valve, does the loss of pressure in the valve represent a *corresponding* loss of efficiency in the engine? In other words, would the heat generated by the fluid friction in the valve (which heat would presumably be carried forward by the steam) be to any extent converted into useful work in the engine?

Answer to No. 700 (*awarded 7s. 6d.*).—To govern an engine by means of a throttle valve is inefficient by reason of reducing the pressure. High-pressure steam, as is well known, contains very little more heat than steam at low pressures; but its expansive properties being far superior, it is obviously economical to work at high pressure at all loads, and regulate by altering the cut-off. Taking steam at 200lb. per square inch absolute and applying Regnault's formula to find the total heat, we have $1{,}082 + {\cdot}3\,t$, where t is the temperature of the steam; $1{,}082 + {\cdot}3 \times 381{\cdot}8 = 1{,}196{\cdot}5$ British thermal units. Now, suppose this steam to be throttled, so that its pressure falls to 100lb. per square inch. Applying the above formula, we have $1{,}082 + {\cdot}3 \times 327{\cdot}7 = 1{,}180$ British thermal units. Thus it will be seen that although the pressure has been reduced to one-half, the loss in British thermal units is only about 1½ per cent. of the original number. If, however, we come to compare the work done by a given weight of steam at these pressures, it will be found that by taking advantage of the expansive properties of the high-pressure steam we can obtain a considerable increase in efficiency. This may be proved by drawing a theoretical diagram for each of the pressures, with cut-off taking place at that part of the stroke that will allow the steam to expand down to the back pressure. This point can be found by

$$\frac{\text{Initial pressure}}{\text{Total back pressure}}.$$

Another easier method, although perhaps not quite so convincing, is to find the mean theoretical effective pressure by the formula

$$\text{M.E.P.} = \frac{P_1 + \text{hyp. log } R}{R} - \text{back pressure},$$

where P = initial pressure,
R = range of expansion.

Taking the first case, with steam at 200lb. per square inch absolute, and a back pressure of 17lb., and for convenience we will assume that it is expanded down to 20lb. per square inch, so that the number of expansions is 10. Applying the above formula,

$$\text{M.E.P.} = \frac{200 \times 1 + 3\,302}{10} - 17 = 49\text{lb.}$$

Again applying the formula to the low-pressure steam, in this case the number of expansions will be $\frac{100}{20} = 5$.

$$\text{M.E.P.} = \frac{100 \times 1 + 1\,6}{5} - 17 = 35\text{lb.}$$

From this calculation it will be seen that although only half the volume is used per stroke in the case of the high-pressure steam, yet the mean effective pressure is 14lb. per square inch more. But to compare the efficiency it is necessary to know the weight of steam used per stroke. Now, the weight of steam varies approximately as the pressure—that is to say, that a cubic foot of steam at 200lb. per square inch will have, roughly, twice the weight of a cubic foot at 100lb. Therefore, since there is twice the volume used when working with the low pressure, the weight used per stroke may be taken as the same, and the increase in efficiency will be due to the increase in the mean effective pressure, which is 14 per cent. greater than the original pressure. Hence the loss in a steam-engine due to governing with a throttle valve is brought about by not taking advantage of the expansive properties of the high-pressure steam, and the heat lost by the reduction of pressure is really a minor quantity, and cannot be called upon to compensate to any great extent for the loss. Turning now to the question which asks would the heat generated by the fluid friction be to any extent converted into useful work in the engine, the answer is obviously only to a very small extent, for it is well known that if steam passes through a throttle valve it becomes heated and consequently drier, and if the steam contains little moisture it becomes superheated. Hence cylinder condensation will be reduced and efficiency increased, but, as already explained, only slightly. E. AUSTIN.

Answer to No. 700 (*awarded 7s. 6d.*).—Bearing in mind the fact that no heat is lost in passing steam through a valve, then the total heat on one side of the valve is equal to the total heat on the other side, and the heat generated by the fluid friction will go towards converting some of the saturated steam into dry steam, or, expressed in another way, in improving the dryness of the steam, and is given by the following equation:

$$S_1 + x_1 L_1 = S_2 + x_2 L_2,$$

where S = sensible heat, L = latent heat, and x the dryness fraction of the steam.

Taking the corresponding temperatures of the two pressures—*i.e.*, before and after throttling—as T_1 and T_2, then

$$S_1 + x_1 L_1 = (T_1 - 32) + x_1 \{966{\cdot}6 - {\cdot}7(T_1 - 212)\}$$

and $$S_2 + x_2 L_2 = (T_2 - 32) + x_2 \{966{\cdot}6 - {\cdot}7(T_2 - 212)\}.$$

For example, take steam at 160lb. per square inch absolute pressure, and dryness fraction ·9, reduced to 100lb. per square inch. Their respective temperatures are 363·3deg. F. and 327·6deg. F. Then

$$(363{\cdot}3 - 32) + {\cdot}9\,\{966{\cdot}6 - {\cdot}7\,(363\,3 - 212)\} = (327\,6 - 32) - x\,\{327{\cdot}6 - {\cdot}7\,(327{\cdot}6 - 212)\}.$$

$$\therefore\ x = {\cdot}915,$$

being an increase in dryness of 1·5 per cent.

By increasing the dryness fraction, a greater proportion of the steam is in the form of dry steam and less in the form of moisture, and so there is more dry steam per pound of feed after reduction of pressure than before, and therefore the drop in efficiency in the engine is more gradual than the drop in pressure.

If the steam is dry to commence with, then the effect of reducing its pressure will be to add heat to it, which will increase its temperature above the normal at that pressure, and this will lessen the amount of cylinder condensation there would be with the throttle valve open.—E. L.

Answer to No. 700 (*awarded 5s.*).—There are two general methods of governing steam-engines: by varying

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the ratio of expansion with alteration in the point of cut-off, and by throttling with a constant ratio of expansion. The engine described in the query, being governed by a throttle valve, has, therefore, the ratio of expansion in the cylinder constant. The steam supplied to the cylinder at each stroke will be of approximately the same volume, but when throttling takes place will be at a lower pressure. Now, there is no advantage in using a high pressure unless a corresponding higher ratio of expansion is employed. With the engine under consideration the ratio of expansion is constant; therefore there will practically be no difference in the efficiency of the engine. Without throttling, steam enters the cylinder at a higher pressure and temperature, but the exhaust will have a proportionately higher pressure. With throttling, although the entering steam is at a lower pressure as the ratio of expansion is constant, there will also be a corresponding lower pressure at the exhaust. The whole question of throttling *versus* expansion is one of great interest to the engineer. Expansion may easily be carried to excess; with throttling there is the very great advantage of re-evaporation on the low-pressure side of throttle valve. This re-evaporation dries the steam. Any heating of the valve and piping would assist in this re-evaporation on low-pressure side. The losses due to radiation and conduction by the pipes would, of course, depend on the insulating material with which they were covered.—M. M.

Answer to No. 700 (*awarded* 5*s.*).—In governing an engine by a throttle valve the loss of pressure in the valve does not represent a corresponding loss of efficiency in the engine. Steam when expanded without doing work has its temperature raised, assuming that heat is neither received from nor given to external surroundings. Thus dry steam passing from the steam-pipe to the steam-chest through the throttle valve is superheated; if the steam be wet, it is to some extent dried. This is due to the fact that the total heat of steam decreases as the pressure decreases, and the pressure in the above case is less on the steam-chest side. The constricted openings of the throttle valve causes the formation of eddies, and the energy expended is converted into heat on the steam-chest side. Allowing for the minute loss of heat through conduction to and through valve walls, etc., the energy is nearly all used again, as it were, in a useful form. For although the pressure is lowered, the temperature of the steam is increased, or the steam is dried, and, consequently, the efficiency of the engine is little, if any, deteriorated. It is a matter of contention, for it is ofttimes stated that throttle governing is as efficient as expansive; in certain cases and at certain loads this is so. A simple relation holds by which the dryness fraction (determining the degree of saturation of the steam) of the steam on each side of the valve: If f_1 and f_2 represent the dryness fractions, L_1 and L_2 the latent heats of steam at the respective pressures, and h_1 and h_2 the heat of the liquid at these pressures, then

$$f_1 L_1 + h_1 = f_2 L_2 + h_2$$

and thus it can be seen that f_2 is greater than f_1.—S. E. T.

Question No. 701.—A few weeks ago I was staying with a friend, when I dropped across something new (to me). He said he had an appointment with a friend, and would I care to accompany him. I consented. It turned out they were experimenting with wireless telephony, one of them worked an ordinary spark coil, giving about an eighth spark. The rest at that end I was not privileged to see, but we got on our cycles and rode to the local club, taking an ordinary receiver of a telephone with us. We connected one wire to the water tap and the other to the gas bracket, and could hear every word that was said at "the other end," about two miles away. Has anyone else seen or heard of anything similar? if so, perhaps the transmitting apparatus would be interesting.

Best Answer to No. 701 (*awarded* 10*s.*).—Personally I have not heard of anything similar, but having experimented with wireless telegraphy, I will give two diagrams, with a possible explanation of them. The first diagram (Fig. 1) is a probable solution to the wireless telephony (so-called) which took place between two parties over a distance of two miles. I doubt if the receiving instrument was so simple as stated, and, as regarding the transmitter, we are not told whether the ⅛in. spark actually sparked when the messages were being sent. T is the telephone with microphonic carbon contacts to enable a strong pulsating current to be used to work the coil; C is the induction coil without the contact breaker being used; C¹ is the induction coil at receiving end; B, the battery; T_1, the receiving telephone. The diagram does not look very wireless; and what would be done if there were no gas or water mains?

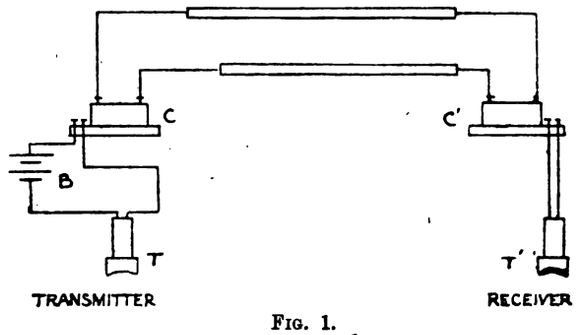

FIG. 1.

Fig. 2 gives the diagram minus the convenient pipes. The secondary wires are taken insulated to two respective points a certain distance apart and earthed. This arrangement works probably owing to some of the stray current from A, in finding its way through the earth back to B, passes through C D. It may also work through a small amount of self-induction between A B and C D. As I have not tried this experiment, I could not say how far this would work with only an ⅛in. sparking coil.

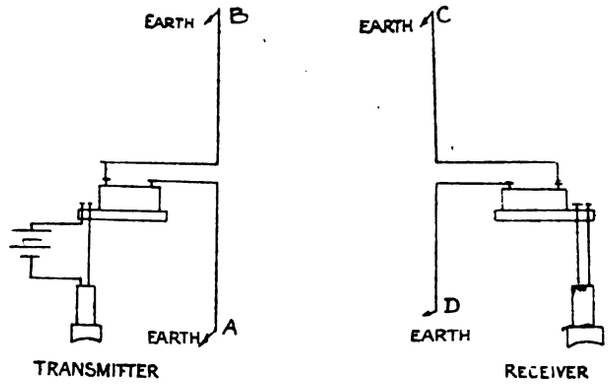

FIG. 2.

In both Figs. 1 and 2 I have not shown a spark-gap, as I doubt if there would be a sufficient variation of current in the primary to produce a susceptible spark in the secondary. According to Kelvin's sparking distance in air, ⅛in. would represent 13,000 volts. A spark-gap would greatly improve matters, owing to the voltage being able to rise till it jumps the gap. Now, this gap might interfere with the articulation of the telephone (1) owing to the higher notes giving a great rate of variation of current, and a consequent long spark in the secondary, whilst the lower notes (2) would give a shorter spark. From the above reasoning, the gap would have to be adjusted to the smallest jumping spark, or the low notes would be lost.

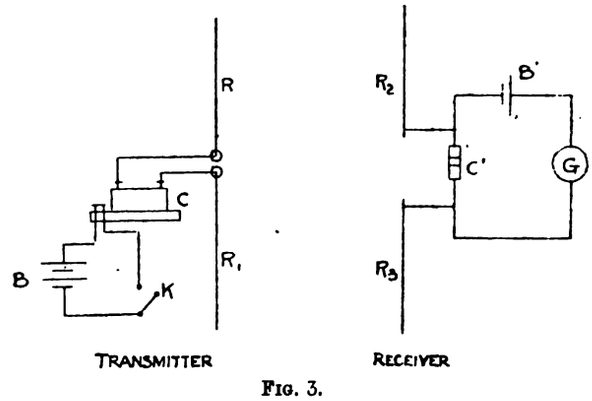

FIG. 3.

Fig. 3 represents a diagram of Marconi's arrangement for wireless telegraphy for a coil only giving ⅛in. spark. Transmitter: C is a coil with contact breaker; B, the battery; K, the key; S and S_1, the sparking balls; R and R_1, the radiators or oscillators (each 2ft. long and supported on insulators). Receiver: R_2 and R_3, the oscillators (same

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as R and R_1); C, coherer, consisting of brass or iron filings between metal plugs in a glass tube; G, a galvanometer or electric bell, the hammer to be arranged to tap the coherer. In practice it is better to arrange a relay in the receiver, only one cell being used to work the coherer, as only a small E.M.F. is needed. The spark balls can be made to give a more sudden spark by placing them in oil or thick grease. With this arrangement and with the very crudest adjustment one can telegraph 100ft.

Now to refer back to Fig. 1. The oscillations in the pipes no doubt short-circuit through the soil, but owing to the high frequency and voltage the oscillations set up in the pipes can be detected by the telephone. If these vibrations are hardly audible, microphonic contacts on the diaphragm of the telephone, closing a circuit containing another telephone and a battery, would make it more audible. Now, Mr. Marconi does not depend for his telegraphy on currents or oscillations through stray gas-pipes, etc., but purely from the radiation of energy which takes place in the oscillators.—J. ARNOLD.

Answer to No. 701 (*awarded* 5*s.*).—The following may be of interest to "Brackley-Liamena." I take it verbatim from the current number of *Knowledge*: "In a recent issue of *La Energia Eléctrica*, Madrid, May 25, 1904, Mr. G. J. de Guillén Garcia records some interesting experiments made by him in conjunction with his son. In connection with some wireless telegraph researches the son of the author happened to note that in the telephone of the Tommasi coherer located at the receiving station there was a 'sound difference' which varied in accordance with the air-gap in the interrupter of the Ruhmkorff apparatus. This suggested that a similar apparatus would be capable of transmitting the human voice without the agency of a wire. The experiments had to be put off for some time because of the lack of a suitable outfit, but the author was eventually enabled to carry out his idea. The experimental arrangement is a rather simple one. At the transmitting station there is a Ruhmkorff apparatus, 3cm. in spark length, as well as the necessary oscillator, a small antennæ, and an earthed conductor. Between the transformer—*i.e.*, the Ruhmkorff coil—and a small battery of Grenet cells there is a special microphone acting both as manipulator and as interrupter. The automatic interrupter of the induction coil is stopped, while the condenser is used for enforcing the oscillator spark. At the receiving station there is a Tommasi coherer connected to the receiving antennæ and the earthed conductor. In a telephone receiver the noise produced by the Hertzian waves on traversing the coherer is noted. On approaching the mouth of the microphone and singing or speaking, every sound vibration will be attended by an interruption in the passage of the electric current through the primary circuit of the transformer, the number of sparks in the oscillator thus being varied. The underlying principle, therefore, shows some analogy with the mechanism in an ordinary telephone. Any results so far obtained in the reproduction of singing are said to be quite satisfactory, whereas the rendering of language leaves much to be desired. The feeble point seems to be the difficulty of designing a microphone of sufficient intensity. Mr. Garcia, it is true, has remedied the imperfections of his apparatus to a certain extent by using a condenser and augmenting the potential difference. This, however, could not be driven too far, lest electric arcs be formed."—P. Q.

Question No. 702.—On a 500-kw. Parsons turbo-generator the two brushes on both poles nearest armature wear down to a knife edge on a 10-hour run; the others doing 40 hours, have changed brushes, and found all contacts to be good. I should be glad if any of your readers can explain this, also give remedy for the same.

Best Answer to No. 702 (*awarded* 10*s.*).—The most probable cause is that the armature is out of balance. With such high speeds as are usual with this class of machine any slight want of balance becomes a really serious matter. This will be at once apparent from an examination of the formula for centrifugal force, $M v^2/r$. For twice the speed, therefore, the pull due to want of mechanical balance is increased four times. The stress due to this pull has to be borne by that portion of the shaft between the bearings. With a speed of several thousand revolutions per minute an amount of out of balance hardly noticeable with ordinary speeds becomes a source of trouble, if not danger. It would be well to first examine the bearings. These must be a good fit, but not too tight. If the bearings are too loose, there will be vibration; if too tight, they will run hot. Should the armature be out of balance, it may be loaded; this is a troublesome operation, and requires a large amount of skill.

Another cause may be that oil creeps over from the bearing on to face of commutator, causing an increase in the resistance between the outer brushes and the face of the commutator. Thus the greater part of the current passing by the inner brushes, these are worn away more quickly. This might be remedied by having a dished washer between commutator nuts to throw oil clear of the commutator. To give a larger brush contact area, commutators on these high-speed dynamos are sometimes grooved, so that with a given length of commutator there is a maximum of collecting area for the brushes. For mechanical reasons, with these dynamos the sizes of commutator are kept down to as low a figure as possible; therefore this device of grooving makes up, in a degree, for a small commutator.

Generally, each brush should have a connection to main conductor, not depend on frictional contact between holder and brush spindle. Also, to secure good running with these machines, the commutators must be kept in first-class condition; any inequality sets up chattering and intermittent contact at the brushes, by which an undesirable state of affairs is quickly aggravated.—M. M.

Answer to No. 702 (*awarded* 7*s.* 6*d.*).—The probable cause of this trouble is the raising or partial raising of the brushes in question off the commutator by mechanical vibration, and the consequent sparking. The least want of balance in the armature core or winding would, at the high speeds employed, cause an appreciable whip in the spindle. The amount of this whip would be a maximum midway between the dynamo bearings, so that, naturally, the end of the commutator nearest the armature would be most subject to the vibration, and the brushes nearest that end would be more vibrated than the others, and would, therefore, spark more and wear away more quickly. This would more particularly occur with carbon brushes, but even with wire ones might easily account for the difference between 40 hours and 10 hours in the lasting power.

The question of cure is a difficult one, as the reduction of the vibration might involve the rebuilding of the core or the replacing of the present spindle by a stiffer one, and in any case is a matter for the makers to deal with. It may be found possible to work satisfactorily with the brushes nearest the armature removed altogether, perhaps increasing the thickness of the remaining ones somewhat. In any case this should be tried, and, as an alternative, the pressure on the unsatisfactory brushes might be increased.—Q.

Answer to No. 702 (*awarded* 5*s.*).—With regard to this question, I have reason to believe that the cause of the two brushes wearing away so much quicker than the others is due to sparking, caused by them not being kept diametrically opposite. It is usual to feed turbo brushes forward whilst running to allow for the shortening of brush due to the wearing away. It is a good plan to have a gauge to set length of brushes in holder exactly showing length to put through, this being done while running. I had a similar trouble with a 300-kw. machine, and found it to be of great advantage to only strip about $\frac{1}{2}$in. of the gauze cover off the brushes that wore away the quickest, as this kept the brush more solid, and it is less liable to spray, as is the case when stripped the usual distance (1in.). Keep the V in commutator very clean and smooth. This will improve commutation very much.—S. H. LEE.

Answer to No. 702 (*awarded* 5*s.*).—There appear to be only three possible reasons for the rapid wear of these brushes. In the first case, it might be due to variation in the brush material. As, however, the question states that the brushes have been changed, this is evidently not the cause. Secondly, it might be due to excessive sparking, but as no sparking is mentioned, we may also reject this. Thirdly, it may be due to excessive pressure of brushes on commu-

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tator. If this pressure were due to ordinary causes, we may take it for granted that the questioner would have noticed and removed same. The following explanation seems feasible. If the natural period of vibration of the brushes happens to coincide with that of the turbine, they would tend to press heavily on the commutator at recurrent intervals, and so wear away rapidly. To determine this, increase or decrease the counterweights on the brush-holders, which will have the effect of changing their period of vibration, and so stopping the excessive wear.—H. B.

Question No. 703.—In calculating the cable losses for a certain high-voltage long-distance polyphase transmission scheme with underground cables, an addition was made on account of "dielectric hysteresis." Can this be found in ergs per cubic centimetre as with magnetic hysteresis, and, if so, what are reliable figures for different classes of cable? In the vector diagram, should the current taken by this loss be plotted with the watt-current or the capacity-current?

Best Answer to No. 703 (*awarded* 10*s.*).—It is unusual, when estimating the losses in high-tension transmission mains, to make any allowance on account of dielectric hysteresis, for the loss is, as a rule, so small as to be difficult to ascertain, and is therefore negligible. In an electromagnetic alternating field, energy is consumed in hysteresis due to the molecular friction—that is, instead of the exciting current lagging 90deg. behind the impressed volts, it lags by an angle somewhat less than 90deg. Thus the exciting current consists of an energy component—the hysteresis energy current and a wattless component called the magnetising current. Similarly, energy is also consumed in an alternating electrostatic field. The loss is in the dielectric, and is what is referred to in the question; but, unlike the magnetic hysteresis, the laws and magnitude of the electrostatic hysteresis are but little understood. Experiments tend to show that there are two different components of loss—the one proportional to the frequency, and which, like magnetic hysteresis, is a fixed loss per cycle, independent of the frequency; and one proportional to the square of the frequency, like the eddy currents in iron, and therefore a loss per cycle which varies with the frequency. The loss in watts per cycle in each case can be found per cubic centimetre of volume. The former component is, as stated, independent of the frequency, but is proportional to the 1·6th power of the field strength—it follows the same law as magnetic hysteresis—that is, watts consumed $W = \eta \beta^{1\cdot6}$. Here η is a constant peculiar to the dielectric, and β is the field strength. This is the true hysteresis. The other component varies as the square of the electrostatic field strength, and therefore as the square of the E.M.F. The loss per cycle per cubic centimetre is represented by $W = K N \beta^2$. Here K is another constant, and N is the frequency of supply.

It may be stated at once that for paraffined paper and all dielectrics used in modern practice, the latter component of loss, small even as it is, obscures the former or true hysteresis loss. It should be noted that, taking account only of the latter loss, since it is that lost in the condenser resistance and is constant, and since the capacity or condenser reactance is also a constant for all pressures within the limits of practical work, it follows that the angle of dielectric hysteresis lag is a constant. To find this angle. The capacity current is known, and also the power consumed in the dielectric. The power consumed $= I_c \sin a E$, where a is the angle the value of which is required. In the vector diagram, then, instead of setting off the capacity current 90deg. in advance of the impressed volts, draw it $(90 - a)$ degrees in advance, thus introducing the energy component. Here a different state of things obtain than for the electromagnetic field, for there the permeability of the iron or the magnetic inductance varies, and so the magnetic hysteresis angle of advance is not a constant. From the foregoing it will be seen that while capacity consumes current in quadrature with the E.M.F., which current is, therefore, wattless, dielectric hysteresis consumes current in phase with the E.M.F., and is a power current. Dielectric hysteresis, therefore, appears in the circuit as the energy component of the capacity current.

The writer regrets that he has no reliable values at hand for the constants appearing in the equations given, never having met with any in his everyday work. Concentric cables working under extra high potentials are the only ones likely to be a source of considerable loss, for here the electrostatic gradient is somewhat large; three-core cables, however, are almost invariably the ones employed in power schemes.—T. H. H.

Answer to No. 703 (*awarded* 7*s.* 6*d.*).—It has been observed that high-tension alternating cables become appreciably warm on light loads, much in excess of the rise in temperature corresponding to the $C^2 R$ loss, the extra rise in temperature being due to the loss of energy caused by the insulating material being subjected to rapidly repeated and violent electric strains. This loss by "dielectric hysteresis" closely resembles magnetic hysteresis, but, unlike it, shows no saturation effect, it varying in proportion to some power of the voltage, usually 2 for cable dielectrics. By increasing the thickness of the insulation—*i.e.*, reducing the strain—or by using a dielectric of low specific capacity and working at a low frequency, this loss may be lessened; it also varies greatly in different specimens of the same dielectric, depending on the amount of air and moisture present.

I know of no figures giving the loss in ergs per cubic centimetre of any class of dielectric, but if the capacity per mile and the power factor for any class of cable is known, the hysteresis loss can be approximately determined as follows:

If V = voltage;
n = frequency;
K = capacity per mile in microfarads;
A = capacity current;

then
$$A = \frac{2 \pi n K V}{10^6}.$$

$A \times V$ = apparent watts,

$\therefore A \times V \times$ power factor = true watts.

Then, assuming that the $C^2 R$ loss and the leakage loss are negligible, these true watts will be the loss due to dielectric hysteresis per mile.

A convenient method of determining the power factor of any cable is described by Mr. Mather in the discussion on Mr. Mordey's paper, "Capacity in Alternate-Current Working," read before the Institution of Electrical Engineers. He uses an ironless choker of inductance suitable for bringing the current as nearly as possible in phase with the voltage, and measures the power used in the choker and cable by a wattmeter. The loss in the choker, which is wound with fine wire, is practically equal to C R, the difference between this and the wattmeter reading giving the power lost in the cable.

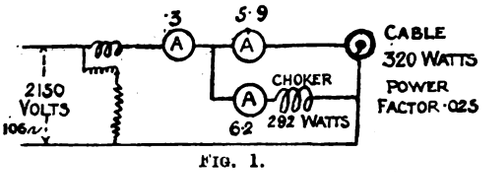

FIG. 1.

Fig. 1 gives a diagram of the arrangement, which speaks for itself.

The apparent watts = 5·9 × 2,150.

True watts taken by cable = 320.

$$\text{Power factor} = \frac{320}{5\cdot9 \times 2{,}150} = \cdot025.$$

In the above test it is essential that the wave-form of the alternator should be a sine curve as near as possible on account of the capacity current varying greatly with the shape of the impressed voltage curve, currents greatly in excess of the theoretical value being obtainable with distorted curves. Below is given a table showing power factor of various classes of cables:

Material.	Voltage.	Frequency.	Power factor.
Oiled paper	2,017	100	·024
Jute	2,030	71·5	·027
Indiarubber	2,000	105	·028

—C. L. S.

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JULY 29, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

711. Give a clear description and example of a method of ascertaining core loss on a direct-current machine by observing the time taken to shut down from its normal speed with field on; secondly, with field off. Given the weights off the moving parts.—E. S. C.

712. Explain the necessity of reactance on the alternate-current side of a rotary converter.—E. S. C.

713. Describe what you consider the best method of truing up large commutators, say from 5ft. diameter upwards.—H. B.

ANSWERS.

Question No. 704.—How would you calculate a blow-out magnet for a controller, given horse-power and voltage. Give the respective advantages and disadvantages of the different designs.

Best Answer to No. 704 (*awarded* 10*s.*).—In the designing of blow-out magnets for controllers a large amount of

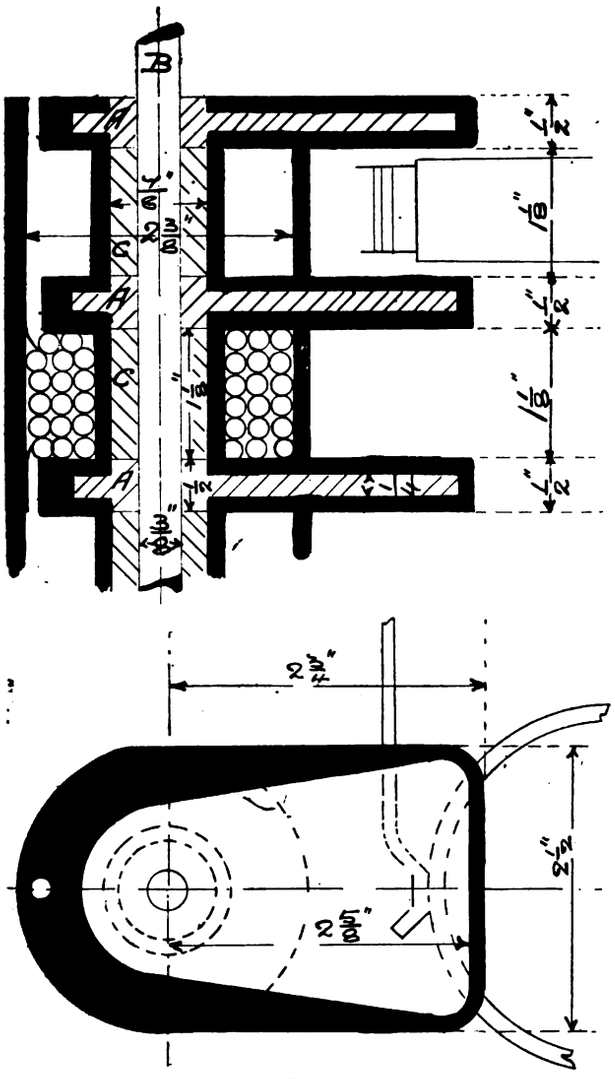

FIG. 1.

experimenting is necessary to first find the most suitable arrangement of the blow-out plates, etc., on which are based the future calculations, the chief point being to get as strong a magnetic field as possible for the circuit to be broken in. The blow-outs used for intermittent working, such as cranes, etc., are so arranged that the amount of watts lost in the coil is higher than if the blow-out was used in a controller made for continuous working. It is generally taken not more than 1½ watts per square inch for intermittent working and ·75 watt per square inch for continuous working.

It has been found that the following arrangement was suitable for use in connection with a 30 e.h.p. 500-volt crane controller, as shown in Fig. 1. The blow-out plates are constructed of wrought-iron drop forgings, marked A, mounted on a wrought-iron centre spindle, B, separated by wrought-iron distance pieces, C. The distance pieces and blow-out plates, also the outside of the winding on the blow-outs, are insulated by means of specially moulded fireproof insulating material, as shown. The distance between each pair of blow-out plates is wound with a suitable size of tape or wire, tape being only used for very large current.

The full-load current of a 30-e.h.p. 500-volt motor being 45 amperes, the winding in this case consisted of four layers of No. 9 S.W.G. S.C.C. wire, each layer having eight turns, making 32 turns for each blow-out. Mean length of each turn equals $1\frac{5}{8}$in. × 3·1416 = 5·105in.; total length of wire per coil = 32 × 5·105 = 13ft.; resistance per yard of No. 9 S.W.G. from Glover's list is ·001476 ohm; resistance of winding on each blow = $\frac{\cdot001476 \times 13}{3}$; watts loss per coil = $C^2 \times R = \frac{\cdot001476 \times 13 \times 45 \times 45}{3} = 12\cdot95$; area of surface equals outside circumference × length = $2\frac{5}{8} \times 3\cdot1416 \times 1\cdot125 = 9\cdot3$ square inches; maximum amount of watts loss allowable per coil = 9·3 × 1·5 = 13·95; and the amount of watts we are losing is 12·95, so that we are on the

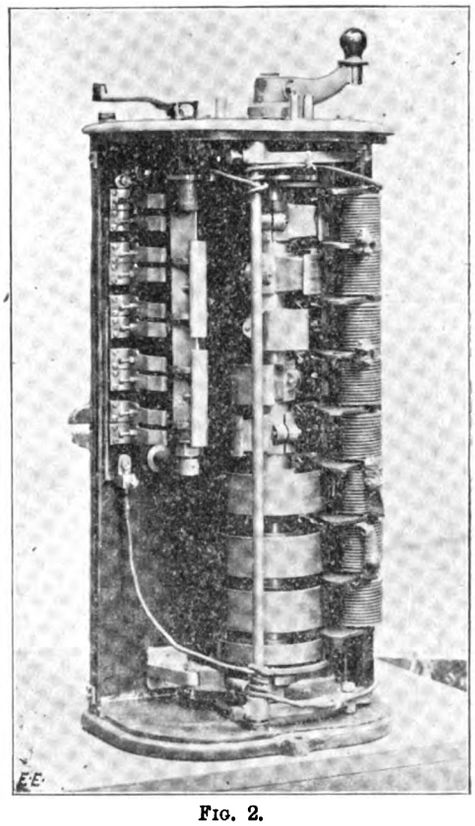

FIG. 2.

safe side. Fig. 2 shows a similar type of blow-out made by Messrs. Royce, Limited, Manchester. The figure in this case shows the blow-out coils before the outer layer of insulation has been put on.

There is only one true blow-out on the market, and that is the type described above. The types consisting of one coil fixed at the bottom of the controller, using the case as part of the magnetic system, are not very efficient.—C. G.

Question No. 705.—What is the most practical method of preventing oil being thrown from the connecting rods and discs of horizontal engines running at 95 revolutions per minute, and having a 3ft. stroke. The engines are fitted with ordinary "Hood" splashguards, but these do not prevent the oil from being thrown out at the sides on to the floor and the frames of engine.

Answer to No. 705 (*awarded* 7*s.* 6*d.*).—Where oil is used for the lubrication of crankpins and cross-head pins and slides, there is only one way of effectually preventing drippings from being thrown, and that is to case in the motion work of engine completely. This practice has been adopted by several of the leading American engine builders,

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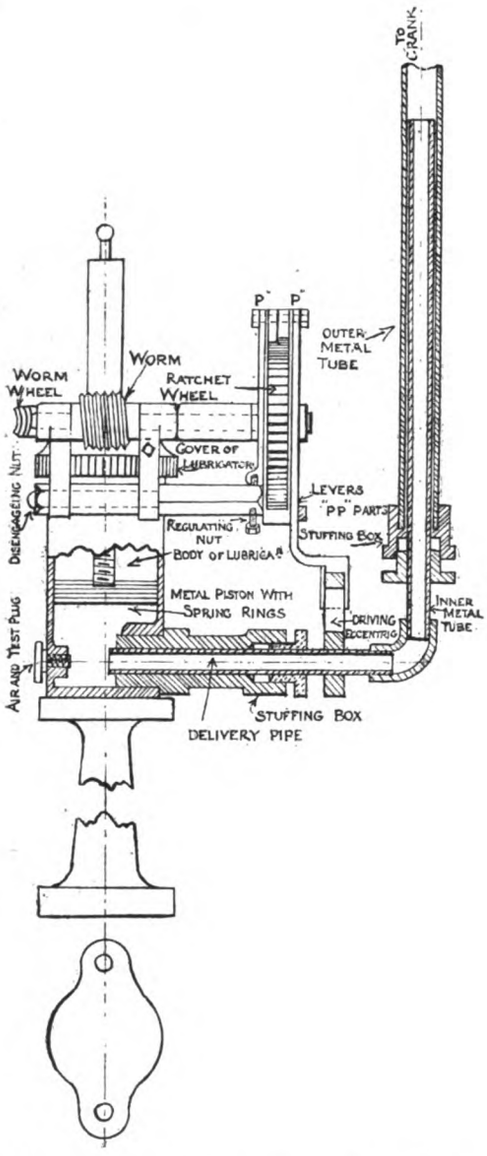
and while, no doubt, being a very efficient method, it possesses obvious disadvantages. Suitable hand and sight holes are provided, and the whole casing (usually made of planished sheet steel) being fitted together in sections can



be taken down to allow of inspection and repair to engine. An excellent method where cleanliness is a desideratum is to use a solid lubricant for crankpins and cross-head motions. The lubricant is delivered under pressure by means of a special lubricator. This system is much favoured by many

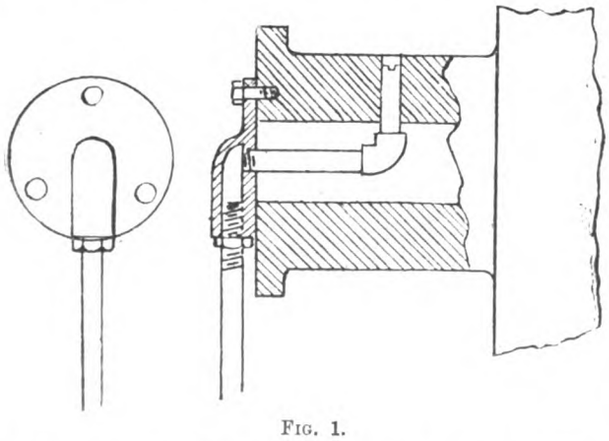


FIG. 1.

engineers in Lancashire and Yorkshire, and is extensively used on large slow-speed engines in the cotton and woollen mills of these counties.

There are many makes of this type of lubricator on the market, one of best being the "Berwal," this particular make possessing the advantage of being of rather simple construction. A sketch of this is given, which may, perhaps, prove self-explanatory. Figs. 1, 2, 3, and 4 show the various methods of drilling crankpins and attaching flanges thereto. A large triple-expansion mill engine lubri-

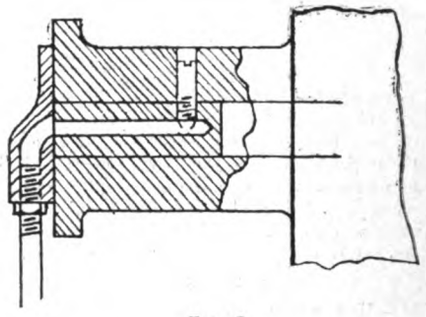


FIG 2.

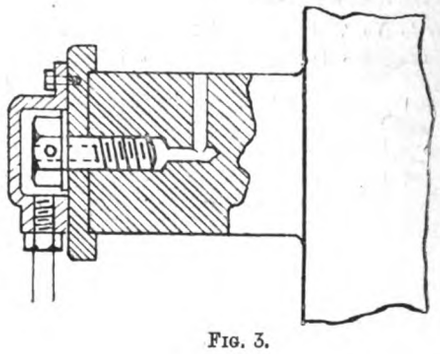


FIG. 3.

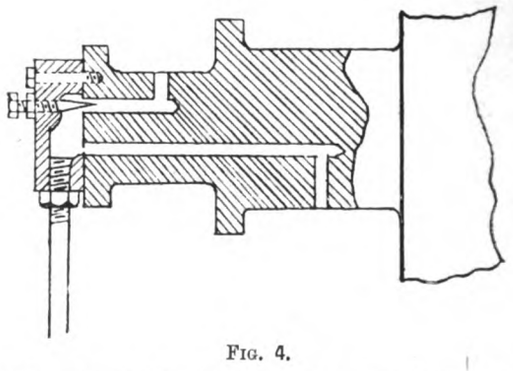
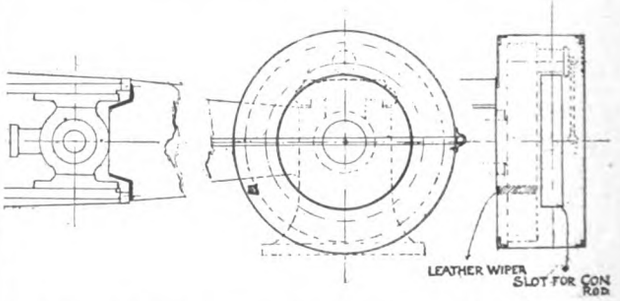


FIG. 4.

cated throughout with this system of automatic lubrication ran for 2½ years continuously (no stoppage for meal hours), the lubrication giving entire satisfaction.—S. L.

Answer to No. 705 (*awarded* 7*s.* 6*d.*).—The question of oil throwing from the moving parts of horizontal engines is an important one, though often neglected. Ample provision is usually made for conveying oil to the bearings, but often no provision is made to prevent it throwing out anywhere and everywhere.

A very simple and effective method of preventing oil splashing from the discs is to have a pad of leather rubbing against the outer edge of the disc, the leather being secured to a piece of flat iron bent to a right angle and screwed to



the bed. For the connecting-rod large end, which is the greatest trouble, a circular blue steel guard built on an angle-iron frame is the most effective. The guard should be as close to the brass as it is possible to get it, and should be as deep as the inner surface of the crank-pin. If provision is made in the design, a cast-iron guard can be fitted

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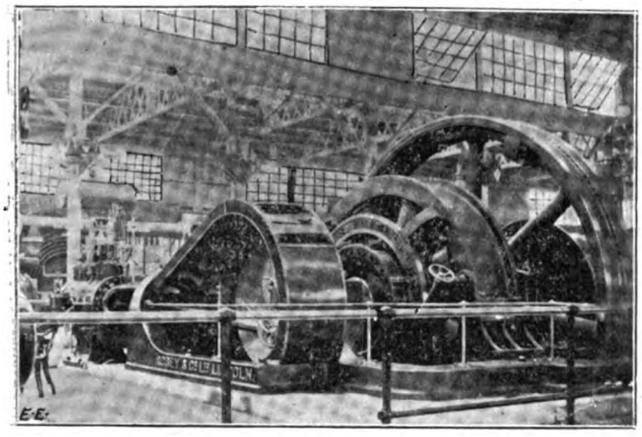
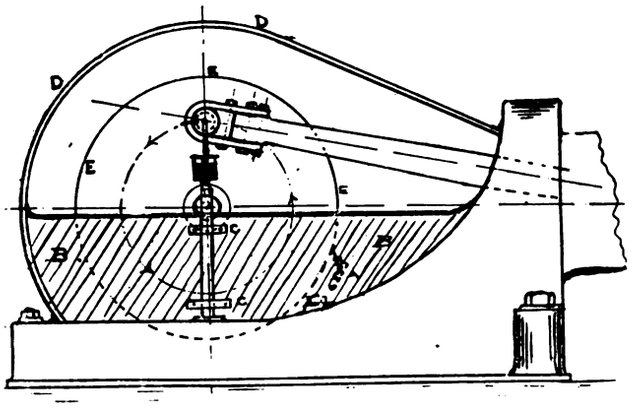
much the same shape as the steel one. This type of guard also catches the oil from the main bearings. Oil is sometimes splashed up by the cross-head at the end of the stroke, and a good way to stop this is to fasten a cone-shaped casting or thin steel plate up to the guide end as in sketch. This also allows a well of oil to form and lubricate the guides. Of recent years the Allis type of bed has come into prominence, and as this has the bottom cast in it



is easy to make an effective guard, as shown in the illustration.—A. B. S.

Answer to No. 705 (*awarded* 7*s.* 6*d.*).—The question of preventing the oil which is thrown off from the discs and rods splashing the floor of engine-room and the engine frames is one upon which a considerable amount of thought and ingenuity has been expended, and in some cases the connecting-rod ends themselves have been fitted with oil guards or "catchers" of varying designs and sizes, with,



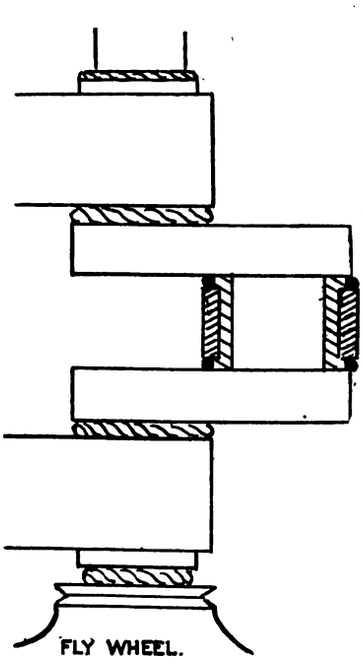
A, Angle Iron Knee, with leather scraper attached; B, Thin Sheet-Steel Screen (shaded), with beaded top; C, Clamps to secure Screen to Oil Standard; D, Hood or Splash Guard; E, Disc.

however, a very small measure of success. The throwing off of the oil from the discs may be almost entirely prevented by fitting oil scrapes, consisting of pieces of leather wide enough to go across the face of the discs fastened on to angle-iron knees, the leather bearing upon the periphery of the disc on the side nearest the cylinder, and the knees bolted to the frame of the engine inside the crankpit (see sketch).

The cause of the splashing seems to be that as the rod-ends describe their circle, the oil which is fed into them, and which works out through the sides, is thrown off at a tangent, some of the drops naturally going upwards, and these, falling again, strike the rapidly-moving rods, and are thrown off again at an angle, and so clear of the hoods, which *can* only stop that oil which is thrown off within their limit. The only practical way of catching this seems to be by fitting a kind of "screen" or "splash plate" right across the crankpit on about a level with the centre of the disc, after style of sketch, and if this be painted in harmony with the rest of the engine and fitted with a neat brass beading, it is an ornament rather than an eyesore, does not prevent free access of air to the moving parts, and is an additional safeguard against accident.—MAFUTA.

Answer to No. 705 (*awarded* 5*s.*).—The best way to deal with the trouble of oil throwing from the big end and crank disc is to fit a sheet steel cover to the open side of the ordinary splashguard. The ordinary guard will deal with all oil thrown off in a longitudinal direction, and the cover, if properly fitted, will prevent any oil being thrown out sideways. The cover should make a tight joint with the existing guard, and should be so fitted as to be easily removed and put up again when it is necessary to make any adjustments to the big end. A good-sized hinged door must be made and fitted in the cover, and should be placed in the path of the crankpin, and where it will be most convenient for feeling the crankpin brasses whilst running, or for nipping up the brasses when the engine is at rest. The post carrying the crankpin lubricator should, of course, be kept outside the casing to allow the lubricator to be filled and adjusted with as little trouble as possible. This method will form a closed crank chamber, and although the big end may run a little warmer, there is no danger of hot ends, provided the connecting rod is properly made and adjusted; whilst the advantages of saving the amount of oil which has previously been wasted, and the keeping of the crankpit free from the dust and dirt which are always attracted to an open crankpit, are well worth having, to say nothing of the saving in labour due to a cleaner engine-room floor and frames. A sketch has not been given, as the arrangement of the ordinary splash-guards on the particular engines will suggest the best shape and extent of the cover.—W. T. W.

Answer to No. 705 (*awarded* 5*s.*).—Although it is practically impossible to completely prevent this trouble, it can, with a little care, be reduced to a minimum. When oil for lubrication is supplied under pressure, stuffing boxes are often provided; these with ordinary attention give good results. Some drivers cut down the supply of oil so that very little is left to be thrown off. This, however, appears to be a dangerous policy. It is better to use oil freely, and after filtering use again on bearings that are not likely to be troublesome. Unless hoods and shields are of an unwieldly size, they do not prevent oil flying off into undesirable places. One of the best, and at the same time one of the simplest, methods is to have a ring of a number of strands of "Berlin" wool round the outside of each bearing. This ring is made up in a similar manner to a "grummet." The accompanying sketch will make matters clear. In the section of connecting-rod strap and brasses, the sections of the wool rings are shown as black dots. Rings are also shown in position round the main bearings. This is a very cheap remedy, is easily applied and renewed, and is not much of an eye-sore. A groove is shown on boss of flywheel; this is a well-known method often used on quick-running machinery. In any case a great deal can be done by wiping down after each run; oil will "creep," and will do much more quickly over a wet than over a dry surface.—M. M.



Question No. 706.—In testing a six-pole, 200-kw., 500-volt machine for a faulty (?) armature coil, the following methods were adopted: The brush leads were connected together, with an ammeter in circuit, and the field was separately excited off the 'bus bars, in series with incandescent lamps, with a current of 6 ampere The machine was run at about half speed (200 to 230 revolutions per minute), and a current of 400 to 600 amperes was maintained. When the machine slowed up with any drop in steam pressure the amperage rose. The lamps in series with the field continually waxed and waned whilst the machine was running, and in switching off these lamps at the end of the run, the last one switched off, thereby breaking the field circuit, became intensely luminous at the instant of switching off. Explain these phenomena.

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Best Answer to No. 706 (*awarded* 10*s.*). — These phenomena seem very curious at first sight, particularly that the amperage should rise, when the speed decreases, as one of the first rules we learn is that the E M.F. generated in a dynamo armature is directly proportional to the speed when the machine is separately excited. However, in thinking over the problem, we must continually bear in mind that the conditions are not the normal running conditions of the machine; but that, though we are taking more than full-load current from the machine, and, therefore, have a very strong armature reaction and demagnetisation, we have only an exceedingly weak field, the exciting current being probably not more than one-tenth of the normal. The machine is also a "multipolar," there being probably three armature circuits in parallel, and as the machine is only 200 kw., no equalising rings connecting these circuits. Also, the engine is doing very little work, but the rotating armature and the flywheel combined store a good deal of energy, and it is under these conditions that "hunting" or oscillations in the speed of an engine are most easily set up and maintained. Probably other engines are running off the same steam-mains, and these will set up periodic oscillations in the steam pressure, which oscillations will, therefore, be transmitted to the engine under consideration; and even if this were not the case, we can easily conceive the engine speed to be periodically varying from a maximum to a minimum and *vice versâ*, the period of these oscillations being a few seconds probably.

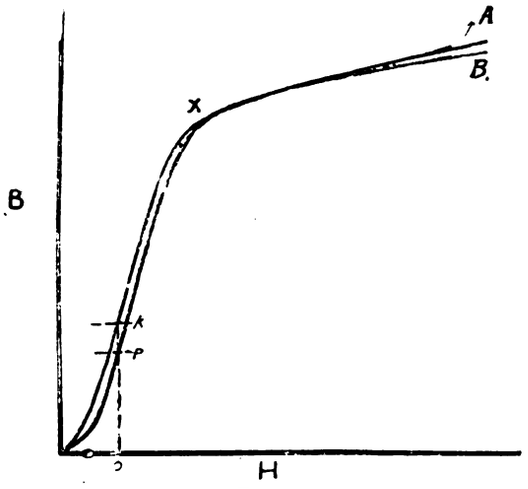

Fig. 1.

Now, let us consider the electrical side of the case. The field magnets of a dynamo are never all of exactly the same quality of iron, and probably if we had a B H curve for two of the field magnets we should find them something like A and B in Fig. 1. If, then, the magnets are excited fully, as, say, at the point X, the percentage difference in the inductions of the two fields is small; but if they are only partially excited, the induction in A may be O P and in B it is O K, the difference in induction P K being quite a large percentage of the total. We see, therefore, that with fields weakly excited the poles vary in strength much more than if the fields are all "stiff" The three armature circuits which are in parallel will then have varying E.M.F.'s developed in them, and we shall, therefore, have cross-currents round the armature, which do not pass through the ammeter, but simply round the brush connecting rings, and these will have a considerable action on the weakly magnetised poles of the generator, alternately demagnetising and magnetising, and thus causing the flux in them to alter, and causing first back, then forward, E.M.F.'s in the field coils themselves, therefore variations in current in the field coils, and waxing and waning of the lamps in series with them. These cross-currents in the armature coils have been noticed particularly in large tramway generators when sudden changes of load occur, the currents being found to grow to a maximum, then die away again, grow again, and so surge from a maximum to a minimum, giving rise to sparking at the brushes every few seconds, the action being known as "bucking."

It is probable that when the machine is running at half speed these electrical surgings are of the same periodic time, or some multiple of the mechanical oscillations of speed, and they therefore assist each other, and we have large cross-currents; whilst when the speed falls, due to falling in steam pressure, the oscillations are no longer of the same period, and therefore check one another, and we have less cross-currents. There will then be less C^2 R loss in the armature and potential drop due to these currents, and, therefore, though the speed be a little less, the current in the ammeter circuit will rise. The reason the lamp grew intensely luminous at switching off is

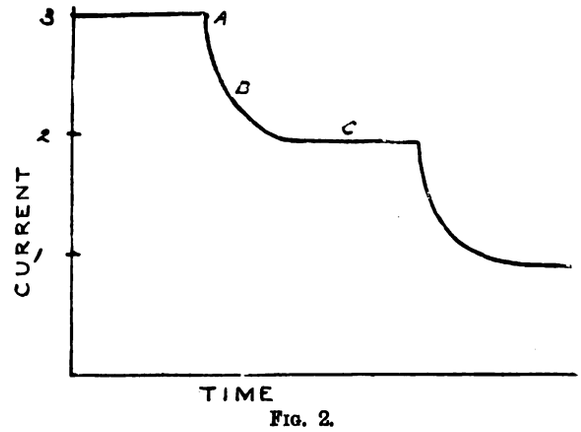

Fig. 2.

because the current has a large inductance, or magnetic inertia, which resists sudden changes of current, and, therefore, tends to keep the current through the lamp and field constant when switching off. If we had only one lamp in series with the field, then on switching off we should have a large spark at the break, but the lamp would not glow more brightly, since it cannot do this without an increase of current, and the inertia of the magnetism tends to prevent an increase of current just as it tends to prevent a decrease. The reason is that we have, probably, three lamps in parallel, and then are switched off one after another quickly, not allowing the current time to decrease. Fig. 2 shows how the current would fall off as the lamps are switched off. At A one of the lamps is switched off, and the current then falls to the value at C, corresponding to the steady current for two lamps, but it does not do this instantly, but at a point, say B, we have a larger current through the two lamps than the normal current at C, and, therefore, the lamps are glowing more brightly than the normal. The same happens in a greater degree when the last lamp but one is switched off, then nearly twice the previous current passes through the last lamp for an instant.

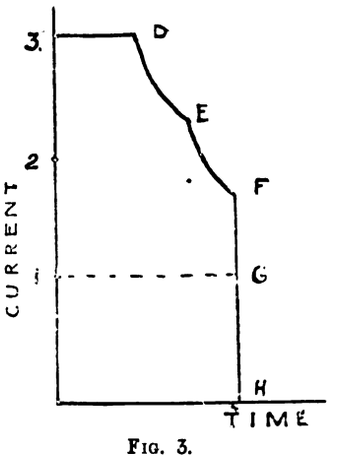

Fig. 3.

Fig. 3 shows how the same results are intensified if the switches are pulled out more quickly, one after another. At D we switch off one lamp, and before the current has reached a steady state we switch off another at E: then, on switching off the last lamp at F, the current through it is H F, whilst the normal current for the lamp is H G.—W. S. P.

[Other replies to Question No. 706 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"

AUGUST 5, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

714. Give, with sketch, what you consider the best method for testing car axles; also the remedy for crystallisation, which has been found to take place just at the boss of wheel. All axles have been found broken at the same point, just inside the hub.—HIERONS.

715. Explain the principle underlying and give sketch showing the connections of starters for single and two phase alternate-current motors from 4 h.p. to 30 h.p. I do not refer to liquid starters, but to those made by the E.C.C., which have a two-way marked "start" and "load," and appear to be some sort of transformer device.—DIRECT CURRENT.

716. In inspecting Lancashire boilers, what are the chief places to watch for defects?—H. B.

ANSWERS.

Question No. 706.—In testing a six-pole, 200-kw., 500-volt machine for a faulty (?) armature coil, the following methods were adopted: The brush leads were connected together, with an ammeter in circuit, and the field was separately excited off the 'bus bars, in series with incandescent lamps, with a current of ·6 ampere The machine was run at about half speed (200 to 230 revolutions per minute), and a current of 400 to 600 amperes was maintained. When the machine slowed up with any drop in steam pressure the amperage rose. The lamps in series with the field continually waxed and waned whilst the machine was running, and in switching off these lamps at the end of the run, the last one switched off, thereby breaking the field circuit, became intensely luminous at the instant of switching off. Explain these phenomena.

Answer to No. 706 (*awarded 7s. 6d.*).—To answer this question we will assume that the fault consists of one or

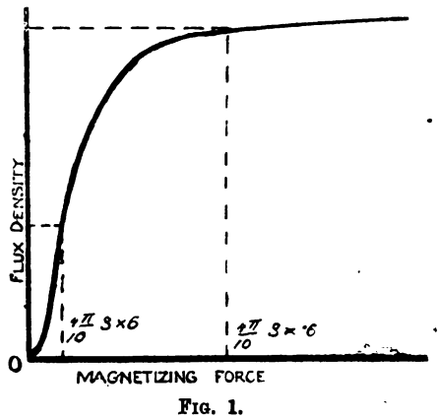

FIG. 1.

more short-circuited coils, and we will see how this would account for the effects noted. The current taken by the shunt winding of a machine of this size would be about six amperes, this corresponding to 1½ per cent. of the full-load output, and as it is stated that by means of lamps connected in series with the shunt winding the current is reduced to ·6 ampere, the field magnetism will be very weak, a small change in the magnetising force therefore causing a considerable change in the flux density (see Fig. 1). As the short-circuited coil revolves, passing poles of opposite polarity, an alternating E.M.F. will be induced in it, causing a current to circulate, which, if the coil is "dead shorted," will lag by nearly 90deg. This will be seen to be the case, since $\tan \alpha = \frac{p L}{R}$.

where α = angle of lag;

$p = 2\pi$ times the frequency;

L = coefficient of self-induction of the coil;

R = resistance of coil and fault, which in the above case is very small.

Consider the coil in the position shown (Fig. 2). The E.M.F. induced in it will be at its maximum, but the current, owing to it lagging, will have just passed through its zero value, and will be flowing in such a direction round the coil as to demagnetise the magnet pole which it is

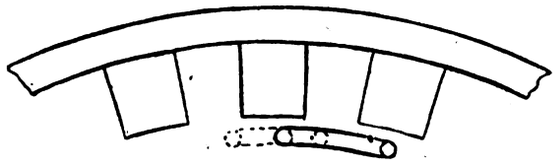

FIG. 2.

approaching. As the coil moves forward the current in it increases, and will pass through its maximum when the centres of the coil and pole nearly coincide (depending on the angle of lag), in which position it has the greatest demagnetising effect. During this movement of the coil the flux through the magnet core will be increasing, inducing an E.M.F. in the field coil which tends to oppose this change. This E.M.F. will, therefore, act in the same direction as the 'bus-bar voltage, thus causing more current to flow through the coils and lamps. Consequently the lamps increase in brightness. Again, as the coil moves from this latter position (shown dotted in diagram) its demagnetising action on the magnet core will decrease, thus allowing the magnetism in the pole to attain its original value, which change in flux will induce an E.M.F. in the field coils opposing the 'bus-bar voltage. The current through the field coils and lamps will, therefore, be decreased, causing the lamps to become dim. As this effect occurs every times the coil passes a pole, the lamps will wax and wane, as stated in the question.

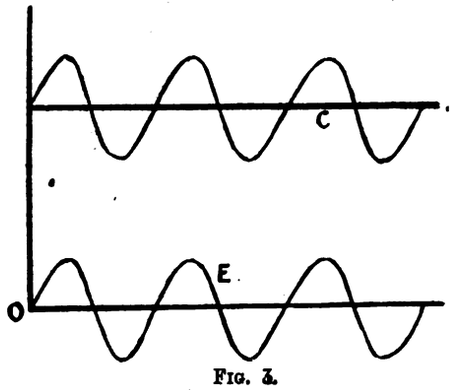

FIG. 3.

It is seen from the above that the current through the field coils, and consequently the magnetism in the poles, is pulsating between certain maximum and minimum values, causing two E.M.F.'s to be induced in the armature conductors—viz., a pulsating one in phase with the field, due to the armature's rotation; and an alternating one at right angles to the field, due to the armature acting as a secondary

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of a transformer. This latter E.M.F. we may neglect, since the current it produces is small, depending on the lead of the brushes, and would be nothing if the brushes were in their neutral position.

The pulsating E.M.F. due to rotation may be resolved into two components, a steady E M.F. (C) and an alternating E M.F. (E), as shown in sketch (Fig. 3) This alternating E.M.F. generates a current which will lag considerably (as explained above), consequently demagnetising the fields. When the speed of the machine falls, the current through the short-circuited coil will remain practically unaltered, but the rate of demagnetising the fields will be decreased. The E.M.F. induced in the field coils will therefore be less, causing the current, and therefore the magnetism, to pulsate between smaller values. The combined effect of this and the speed falling is that the alternating component of the above E M.F., and consequently the current, is reduced, also the angle of lag, thus reducing the demagnetising action on the fields. Should the voltage induced by the increased strength of fields be greater than that corresponding to the drop in speed, the current through the armature will increase, which seems to be the case for the machine in question. The increase in brightness of the last lamp on breaking the shunt field is caused by the collapsing field inducing a large E.M.F. in the field coils, and sending a current through the lamp, and a non-inductive resistance, which is evidently connected in circuit across the field coils at the moment of disconnecting them from the 'bus bars.—C. L. S.

Answer to No. 706 (*awarded* 5*s.*).—The following will perhaps be one explanation of the phenomena described by "A." in Question 706. The engine being run at approximately half speed, the governors would not regulate the steam supply so satisfactorily as under the normal speed for which they were set, consequently the speed of the engine will vary. If the speed rises, a greater E.M.F. will be maintained at the brush terminals of armature, and as the brushes are simply connected through an ammeter (the resistance, leaving out heating effect, unaltering), a greater current will flow and the engine will slow down. The current, as stated in the question, rises from 400 to 600 amperes. The dynamo being but a 200-kw. machine, allows a normal capacity of 400 amperes, hence it is seen that at times the current is too much in excess, and consequently brings about armature reactions, which tend to distort and weaken the field magnets. This fluctuation in the field causes a variation in the lines of force, which are produced by the exciting current This variation is felt directly by the coils surrounding the magnet cores, and as the lamps are in series with the field coils, they also vary accordingly. When the field magnets become weaker owing to armature reaction, the armature generates less E.M.F. for a given speed, consequently the current is again diminished, and less is the torque demanded of the engine; hence the engine again rises in speed, and the above cycle is once more gone through. The rises in amperes cannot be due to the slowing of the engine, as stated by "A." for this would be producing greater torque corresponding to a fall of steam pressure, which is not so. The most probable reason is that the greater current generated demands a greater supply of steam, hence the pressure falls.

Concerning the switching out of the lamps. ("A." does not say whether they are in parallel or in series with one another before being connected in series with the field.) In any case when the exciting circuit is broken, either through the switching out of one lamp when in series or the last when in parallel, an induced current is set up, caused by the collapsing of the field lines across the coils. This induced current flows in the same direction as the original current, and the increased voltage causes the increased luminosity of the said lamp. In switching out field coils, it is usual to have specially provided switching gear, which cannot be entered into here. A little more detail concerning the armature, number of brushes, winding, etc., might have been helpful.—WILLIAM BEARD.

Question No. 707.—Describe the process of determining the permeability of a specimen of iron in the shape of an anchor ring for a given magnetising force.

Best Answer to No. 707 (*awarded* 10*s.*).—I have recently carried out a large number of permeability tests by the ring method, and I will therefore describe exactly the apparatus I used, and the method of carrying out the test. Where a number of samples are to be tested, it is advisable to have the rings of uniform size in every particular, and this can be obtained with certainty if the rings are of rectangular cross-section. In order to reduce the calculations to a minimum, every ring was wound alike, and the number of turns on the primary calculated so as to give the value of H as a simple multiple of the value of the current in amperes. The ballistic galvanometer was calibrated so that the value of the swing, θ, multiplied by a constant, K_g,

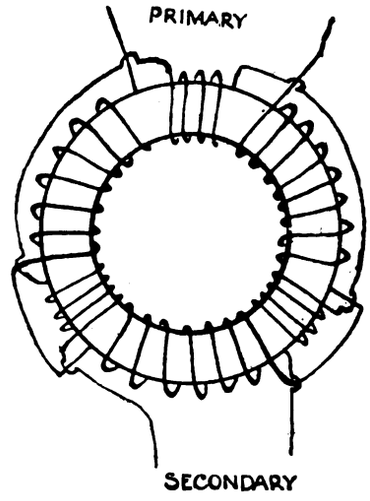

FIG. 1.

was equal to the change of B in the iron ring. The rings were first carefully measured by means of vernier gauges. They were then wrapped with a layer of thin tape. (The tape should not be wider than $\frac{1}{4}$in., or it cannot be laid tightly on the iron.) They were then wound with a primary and secondary winding, as in Fig. 1. The primary was divided in three sections, and the secondary into three sections, and wound so that they did not overlap, as shown in the figure, and then the respective sections connected in series The wire on the primary was 16 S W.G. copper, double cotton covered, and on the secondary 36 S.W.G. copper, double cotton covered. By thus dividing the windings, the secondary coil can be wound directly next to the iron, and at the same time wound *after* the primary, thus eliminating the danger of damage to the secondary by winding the primary on top of it. Moreover, the labour of winding is considerably lessened. The number of turns, etc, will be considered later.

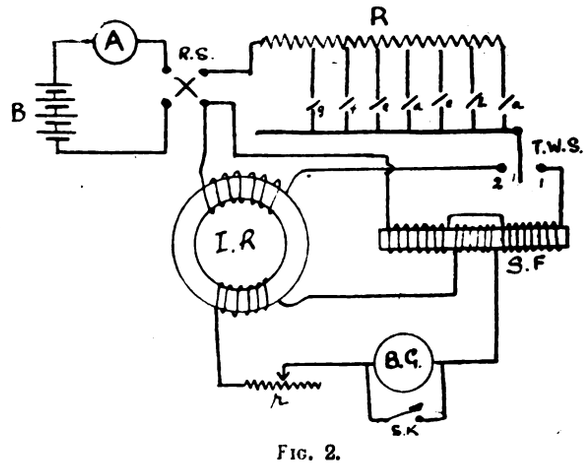

FIG. 2.

The apparatus employed is illustrated diagrammatically in Fig. 2, and is as follows: I R, iron ring under test; B G, ballistic mirror galvanometer of the moving-coil type; r, box of resistance coils in the galvanometer circuit; S F, standard solenoid for calibrating B G (a Hibbert's standard magnetic field may be used instead of S F if desired); R, rheostat in the primary circuit, and is made so that the

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current may be altered *quickly* and *definitely*; B, four or five secondary batteries, capable of maintaining a steady current of about 30 amperes; R S, reversing switch; A, ammeter of the moving-coil type, scale divided into not less than 150 divisions; T W S, two-way switch; S K, spring key for short-circuiting the coil of the galvanometer to bring it quickly to rest.

In order to be certain that the windings on the rings have not been short-circuited or damaged by the edges of the iron, it is a good plan to determine either by trial or calculation the length of wire necessary for each section, and then determine its resistance, first before it is wound and then after winding. It is also necessary to be certain that the sections of the primary form a continuous solenoid and also those of the secondary.

Method of Testing.—The apparatus was connected up as in Fig. 2, with all switches open, and T W S arranged on contact 2. The resistance, r, was increased until the damping effect on the galvanometer coil was of a negligible amount—that is to say, so that the galvanometer was acting truly as a ballistic one. Then trials were made. The spot of light was brought to rest at 0 on the scale, by means of S K. Then switch a was closed, and the deflection of spot noted. The spot was again brought to rest, and switch b closed, and so on, increasing r if necessary, so that in no case the spot of light was deflected off the scale. All switches were now opened and the ring demagnetised. This was done by connecting the primary winding to a motor-driven alternator, whose field was excited so that the armature gave about eight or ten volts. The machine was run up to speed and then the motor switched off, thus allowing the machine to come slowly to rest. Another method of demagnetising is to use the reversing switch, R S, and then, commencing with a current sufficient to overcome the residual magnetism, to gradually diminish the current through the circuit to a very small value, say 0·01 ampere. The ring was then replaced as in the sketch, T W S was put on contact 1, and current switched on to the primary of the standard solenoid, the magnitude of the first swing of the spot of light and the current in amperes being noted.

This procedure was repeated with several values of the current and a mean of the results obtained (see table). N.B.—The spot of light was brought to rest after each swing. All switches were now opened and T W S moved to contact 2. (Care is now necessary, as an error in one reading will necessitate demagnetising the ring and commencing again.) Switch a was then closed and θ and A noted. Switches b, c, d, etc, are then successively closed, each time noting θ and the corresponding current, and the observations tabulated as below. After reaching the maximum current the switches were opened, and a check test made by demagnetising the ring and repeating the test with the current reversed, so as to magnetise the ring in the reverse direction.

Calculations, etc: Particulars of Standard Solenoid.—Number of turns on primary, 464; ditto secondary, 100; length of primary, 150 cm.; mean area of secondary, 186·5 square centimetres. Secondary wound under primary and about the middle, on a wood cylinder.

Particulars of Iron Ring and Winding.—Material, cast iron; external diameter, 5in. = 12·7 cm.; mean diameter, $4\frac{5}{8}$in. = 11·62 cm; mean circumference = length of magnetic path = 36·9 cm.; width of iron = $\frac{3}{4}$in. = area of cross-section = $\frac{9}{32}$ square inch = 1·81 square centimetres; number of turns primary, 147; ditto secondary, 100. Since the core of the standard solenoid is practically air, and therefore of unit permeability, the relation between N, the total flux embraced by the secondary, and A, the current in amperes flowing through the primary, can be determined and expressed as K . A.

$$\text{where } K = \frac{\cdot 4\pi \times \text{turns primary} \times \text{area . secondary}}{\text{length . primary}}$$

$$\therefore K = \frac{\cdot 4\pi \times 464 \times 186\cdot 5}{150}$$

$$\therefore N = 725 \times \text{amperes.}$$

Now, also, for each ring $\frac{\cdot 4\pi \times \text{primary turns}}{\text{length of path}}$ is a constant, and therefor H for the ring may be expressed as $K_1 A$, and by calculation the number of turns required to make $K_1 = 5$ were determined; hence H for ring = 5 × amperes.

In calibrating the galvanometer, θ (the magnitude of the first deflection), is proportional to the number of lines cut by the secondary coils. Hence $\frac{K A}{\theta}$ = the number of lines cut to produce one division deflection, and since the number of turns (secondary) on the solenoid and ring is the same, they do not come in the calculation. If now $\frac{K A}{\theta}$ be divided by a, the area of cross-section of the iron, then $\frac{K A}{\theta a}$ = change of B in the iron represented by one division deflection. If, however, the number of secondary turns on the ring be not the same as that on the solenoid, then change of B in the iron represented by one division

$$= \frac{K A}{\theta a} \times \frac{\text{number of turns on standard}}{\text{number of turns on ring}}$$

This may be called K_g, and is the constant of the galvanometer; and thus when measurements are taken on the ring, $K_g \times \theta$ = the change of B in the ring.

From the accompanying tables of observations a B-H curve can be plotted, and the permeability of the iron for any value of H interpolated.

Calibration of Galvanometer.

Amperes.	θ	K_g.
1·06	45	9·43
2·12	91	9·33
1·5	64	9·4

Mean K_g = 9·39.

Observations on Ring.

Amperes.	H	θ	Total θ	B	μ
0·68	3·4	30·5	30·5	280	82·4
1·34	6·7	61	91·5	841	125·5
2·0	10·0	111	202	1.857	185·7
2·6	13·0	106	308	2,835	218
3·26	16·3	92	400	3,680	226
3·7	18·5	51	451	4,150	224
4·16	20·8	47	498	4,580	220
8·14	40·7	250	748	6.880	169
11·6	58·0	110	858	7.900	136
14·56	74·8	70	928	8.530	114
18·1	90·5	50	978	9.000	99·5
20·74	103·7	36	1,014	9,330	90

In order to convert the values of H and B to inch measure, it is only necessary to multiply them by $2\cdot54^2$. Obviously, then, if a number of rings are to be tested, and they are of uniform size, etc., it is only necessary to work out the constants for one ring, and the calculations for the whole of the rings become of the most elementary character.

Thus $H = K_1 A = 5$ A in this case.
$B = K_g \theta = 9\cdot39\ \theta$ „ „ —M. S. T.

Answer to No. 707 (awarded 7s. 6d).—General.—It is a well-known fact that a magnetic field exists in the neighbourhood of a conductor carrying an electric current. The direction in which this field acts can be readily determined. It is also a matter of common knowledge that some substances offer greater facilities than others for the propagation of these lines of force. The relative power for conducting these lines is termed the permeability. In order to be able to definitely compare this property in various substances, some standard must be adopted; for this purpose the permeability of a vacuum is taken as unity, but that of air is almost exactly the same, and is a more convenient standard. Hence the permeability of any substance might be estimated by dividing the number of lines of force which pass through by the number which pass through the same space when the substance is removed, the magnetising force being the same in both cases. There is, unfortunately, no method available for determining the actual number of lines of force pervading any particular space or substance. The nearest approach we can get to this is to measure the strengths of the resulting electromagnetic fields, which, as might be supposed, are proportional to the number of lines. These field strengths are easily compared by comparing the magnitude of the various phenomena which can be made to take place in them. Fig. 1 shows a simple arrangement of apparatus for

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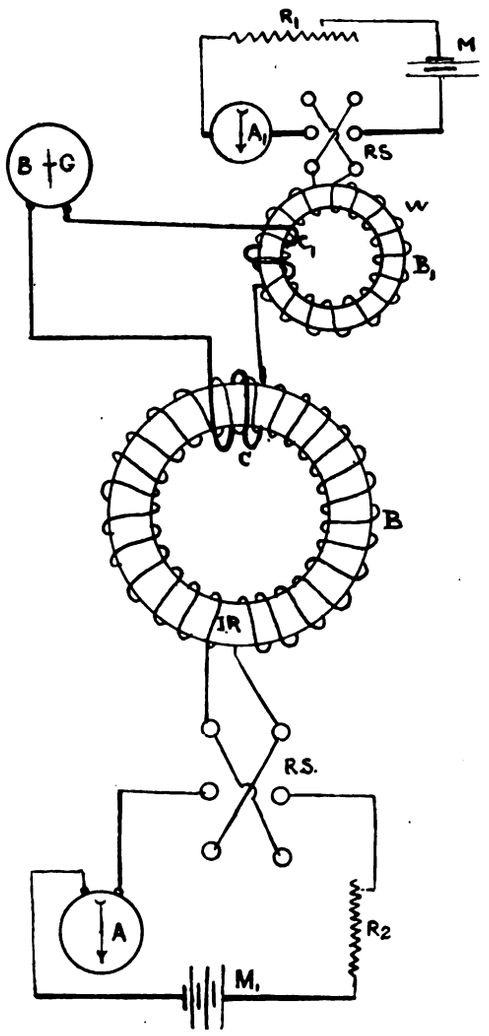
performing these operations with an anchor or continuous iron ring.

Description of Apparatus.—The magnetising coil, B, is wound uniformly over the whole ring, I R, and is connected in series with a battery, M_1, an adjustable resistance, R_2, for varying the currents strength, an ammeter, A_1, for measuring the current, and a reversing switch, R S. The other circuit consists of a small coil, c, in series with the test coil, c_1, of a wooden cored coil (for calibration), and a ballistic galvanometer, B G. This small coil, c, should, if possible, be wound next the ring, so as only to embrace lines actually passing through the iron. A ballistic galvanometer consists essentially of a galvanometer having a somewhat massive needle. The reason for using a galvanometer of this type is that, the inertia of the moving parts being



I R, Ring under test; B G, Ballistic Galvanometer; A A, Ammeters; M M, Batteries; R S, Reversing Switches; R1 R2, Adjustable Resistances; C C1, Test Coils; B B, Magnetising Coils.

great, the whole of the transient current will have passed through the galvanometer before it has moved appreciably from its mid position. Thus the needle receives the whole of the impulse while in the most sensitive position, and therefore the deflection will be proportional to the total quantity of electricity passed independent of any variation in the time element.

Explanation: Definitions.—The number of lines passing through a square centimetre is called the magnetic induction, and is denoted by the symbol B. The intensity of the magnetising force, denoted by H, is in air equal to magnetic induction B, as the permeability of air is unity. The permeability of a substance, usually denoted by μ, $= \frac{B}{H}$.

To Find the Intensity of the Magnetising Force (H).—The magneto-motive force for any magnetic circuit is proportional to the product of the number of convolutions, N, in the solenoid and the currents strength, c—that is, the M.M.F. $= k$ N C and the intensity of the magnetising force $= k\ n\ c$, where n = number of convolutions per unit length. The factor k actually equals $\frac{4\pi}{10}$, the 4π being due to the definition of unit current and the 1/10 to the fact that the C.G.S. unit of current = 10 amperes, therefore $H = \frac{4\pi nc}{10}$.

To Measure the Magnetic Induction (B).—To compare the strengths of different fields, use is made of the fact that when a conductor cuts lines of force an E M.F. is induced in it, and if it forms part of a complete electrical circuit, a current will flow. For instance, supposed we placed in a certain magnetic field a small coil just one square centimetre in area and at right angles to the lines of force, this coil will embrace a number of lines equal to B If we suddenly remove the coil from this field, the resulting current will be proportional to this number. By placing the same coil in another field and removing it just as quickly, a second current will be obtained proportional to the second field. Of course, the resistance of the circuit and the other conditions must be maintained the same in both cases. Hence, knowing the strength of one field, we can calculate the value of the other. But instead of using a coil one square centimetre, we may use a larger one and obtain B by dividing the total flux by the effective area of the coil; also instead of removing the coil from the field, we may turn it through a right angle: it will then be parallel to the lines of force and enclose none, or we may turn it through 180deg. and cut the lines twice. Or, better still, instead of moving the coil, we may take away the lines in force or reverse them; the latter is the method adopted of this experiment.

Calibration of Galvanometer.—The calibration is accomplished by means of the wooden cored coil shown as w. The coil merely consists of two windings, one connected through an ammeter, A, and variable resistance, R, to a battery, M (magnetising coil), and the other a test coil connected to the galvanometer, both wound on a wooden core. The object of using a wooden (non-magnetic) core is that its permeability being unity the magnetic induction equals the magnetising force, and as we have seen that the intensity of the magnetising force $= \frac{4\pi nc}{10}$, hence, if we observe the number of convolutions per unit length of magnetic path, n, and the current, C, we can calculate the induction, B. By varying the resistance, R_1, we shall obtain different values of c, and hence of B; and by observing the throw of the galvanometer occasioned by throwing over the reversing switch, R S, in each case, it will be possible to obtain a curve co-ordinating B with galvanometer deflection. With a Kelvin galvanometer (the time of oscillation being made great, by causing the needle to move in a very weak field, by opposing the permanent magnets to the earth's field), calibrated by the writer for this purpose, the curve obtained was practically a straight line.

Instructions.—We are now ready to proceed to the actual test of the ring. Adjust R_2 to give the current required for the given magnetising force. Note the value of the current as given by ammeter, A, throw over the reversing switch and note the throw of the galvanometer. It should be noted here, as well as above, that the lines of force have been made to vanish and to reappear in the opposite direction, hence the throw will be proportional to 2 B. Then calculating H from the formula $H = \frac{4\pi nc}{10}$, and observing B from the calibration curve found above, we can easily find μ from the equation $\mu = \frac{B}{H}$. This should be repeated two or three times, and if any variation occurs, a mean should be taken.—H. E. H.

[Other replies to Question No. 707 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
AUGUST 12, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

ANSWERS.

Question No. 707.—Describe the process of determining the permeability of a specimen of iron in the shape of an anchor ring for a given magnetising force.

Answer to No. 707 (*awarded* 7*s.* 6*d.*).—The permeability of a substance is the ratio of the magnetic induction in the substance to the magnetising force, or $\mu = \frac{B}{H}$. Now the value of H produced in a given coil can be calculated when we know the current flowing in the coil and the number of turns per unit length of the coil. We have, therefore, to determine experimentally the value of B for various applied values of H, or obtain a B-H curve for the iron, and we can then readily calculate the permeability.

The first thing to be done, then, is to carefully measure the size of the anchor ring with a pair of callipers, measuring (in Fig 1) the dimensions *d*, D, and *w* in centimetres. Then the mean length of the magnetic circuit is

$$\pi\left(\frac{D+w}{2}\right) \text{ centimetres,}$$

and the cross-sectional area is equal to

$$\frac{\pi \cdot d^2}{4} \text{ square centimetres.}$$

We have now to wind a magnetising coil round the ring. Probably a double layer of No. 20 S.W.G. will be sufficient,

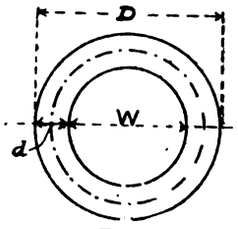

FIG 1.

and this should be wound evenly round the whole ring, and the total number of turns counted. Let it be *n* turns. Then the number of turns per centimetre will be

$$\frac{n}{\text{mean length of path}} = \frac{n}{\pi\left(\frac{D+w}{2}\right)}.$$

Call this S. Then, if we pass a current of C amperes through the coil, the magnetising force in the ring is

$$\frac{4\pi}{10} S C = H.$$

We now require to be able to measure the values of B produced when various values of H are applied. To do this, we require a ballistic galvanometer—that is, a galvanometer whose suspension has a large moment of inertia, but very small damping action. This galvanometer has to be standardised, either by rotating a large coil of many turns through 180deg., cutting the earth's horizontal field, the galvanometer being in series with the coil, the rotation being performed very quickly, and the maximum deflection of the galvanometer noted. Or a better, and more usual, method is to use a standard solenoid having an exploring coil at its centre in series with the galvanometer, and to note the deflection produced on the galvanometer, when a current of one ampere is suddenly reversed in direction through the solenoid. In order to avoid having to apply connections for the ends of the solenoid, it should be at least 12 diameters long. (The error introduced by the ends will then be only about 1 part in 300, and may, therefore, usually be neglected.)

A good form is to wind a uniform layer of about No. 20 S.W.G. copper on a split brass tube, say, 2½in. diameter. The exploring coil is then wound of fine wire—say No. 36 silk-covered copper—on a light split brass bobbin which will just slide in the brass tube of the solenoid. We may have about 200 turns on this bobbin, and the leads leading away from it should be twisted together. Fig. 2 shows part of a section through the centre of the solenoid, showing the bobbin and fine-wire coil in the centre. The number of turns on this bobbin should be noted, and also the mean diameter, *a*, of the turns. Then we know that the flux

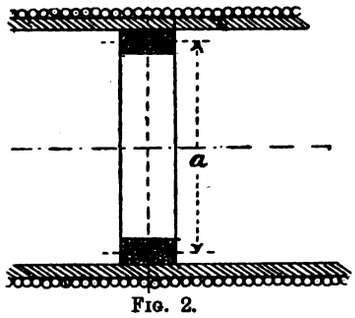

FIG. 2.

passing through the exploring coil for current, C, in solenoid is equal to

$$\frac{4\pi}{10} S C \times \frac{\pi a^2}{4} = H \times \text{area.}$$

Therefore, if current is suddenly reversed in direction, the flux cut will be

$$2 \times \frac{4\pi}{10} S C \times \frac{\pi a^2}{4}.$$

Thus, knowing S and *a*, we may standardise our galvanometer by having it in series with our exploring coil, and noting the deflection when a current, C, is reversed in the solenoid.

We now need an exploring coil on our ring specimen. The number of turns necessary will depend on the size of the ring and the sensitivity of our galvanometer; perhaps 10 turns will suffice. The connections have now to be made as in Fig. 3. The galvanometer should be connected up in series with the two exploring coils, and a resistance if necessary, and this circuit should not be altered at all during the experiment, as we wish to keep the "damping" of the galvanometer constant.

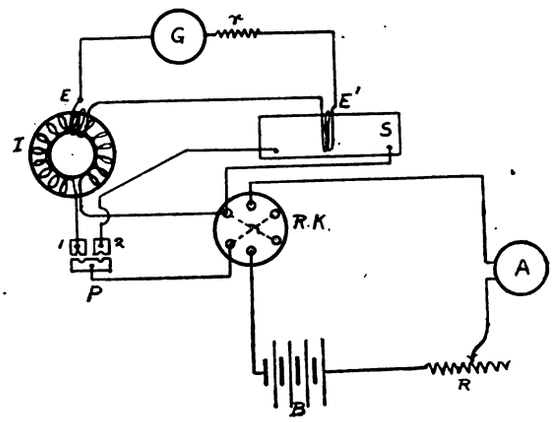

FIG. 3.—B, Battery of Accumulators; A, Ammeter; R, Adjustable Resistance; R.K, Mercury Cup Reversing Key; P, Two-way Plug Key; S, Solenoid; I, Iron Specimen; G, Galvanometer; E E', Exploring Coils.

To conduct the experiment, start with plug, P, in 2. Adjust current to a convenient value and reverse, noting throw of galvanometer. Repeat once or twice, and take a mean of the results. Now put plug in 1, and adjust current to such a value that H in the ring is the maximum we require. We may find this by comparing with other B-H curves of iron similar to ours. Reverse current several times, then take a reading of throw of galvanometer on reversing. Repeat this with a lower current, and so on, taking about a dozen points on the curve, and reversing current once or twice each time before taking the reading.

We have seen how to calculate the value of the flux N', which on being reversed in the solenoid gives a deflection *d'*; therefore, if we obtain a deflection, *d*, for reversing a flux, N, in the iron specimen, we know that

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$$N = N' \times \frac{d}{d'} \times \frac{200}{10},$$

if, as we assumed, E' has 200 turns and E has 10 turns. Therefore B, which equals $\frac{N}{\frac{\pi d^2}{4}}$, can be calculated for any reversal of current, C, or for any value of H, since $H = \frac{4\pi}{10} \cdot SC$, and we may therefore plot a B-H curve. From this, knowing $\mu = \frac{B}{H}$, we may calculate the permeability and plot a permeability curve.

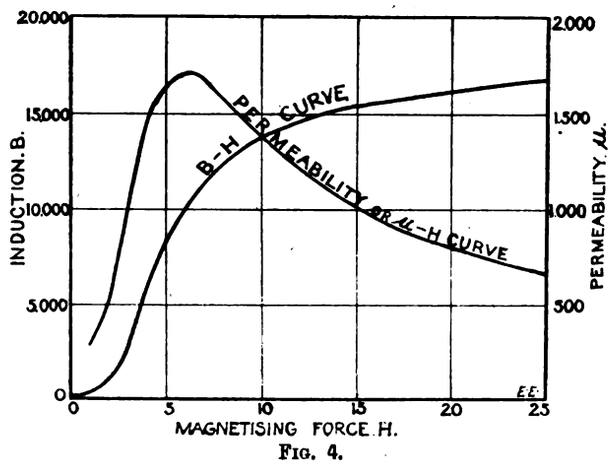

Fig. 4.

Fig. 4 shows curves of permeability and induction for a soft-iron ring.—W. S. P.

Answer to No. 707 (*awarded* 7*s.* 6*d.*).—The permeability of a sample of iron or steel in the form of a ring is measured in the following manner: A solenoid, S (Fig. 1), of known mean cross-section and length, and uniformly wound with

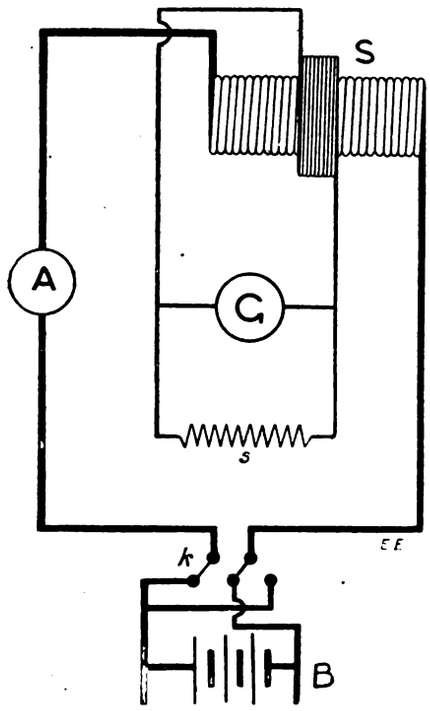

Fig. 1.

a known number of turns, is excited by a current from a battery, B, or other source. This current can be accurately measured by an ammeter, A, in the exciting circuit. Midway along this solenoid is wound an exploring coil whose turns are in series with a ballistic galvanometer, G; *s* is the galvanometer shunt. If the solenoid be excited and the exciting current suddenly reversed by means of the switch, *k*, the current induced in the exploring coil causes the galvanometer to give a deflection. Now, the deflection of the galvanometer will be proportional to the current induced in the exploring coil. This current is proportional to the E.M F. induced, which in turn is proportional to the number of lines of force linked with the exploring coil. Thus the galvanometer deflection is a measure of the number of lines of force linked with the exploring coil.

Let H = magneto-motive force required to produce a flux of one line per square centimetre in air;
N = number of turns in the exciting coil;
c = current in the exciting coil;
L = length of solenoid;
a = mean cross-section of exciting coil in square centimetres.

Then $H = \frac{4\pi N c}{10 L}$ = C.G.S. lines per square centimetre at the middle section of the solenoid, and

$\frac{4\pi N c a}{10 L}$ = total lines at middle section of the solenoid.

Now, if the number of turns in the exploring coil be *n* turns, then the lines of force linked with the galvanometer circuit will be

$$\frac{4\pi N c a n}{10 L} \text{ C.G.S. lines.}$$

The effect upon the galvanometer of reversing $\frac{4\pi N c a n}{10 L}$ lines is equivalent to creating $\frac{2(4\pi N c a n)}{L\,10}$ lines.

Let the deflection corresponding to this flux = θ degrees. Let R = ohms resistance in the entire secondary circuit; K = number of lines per degree deflection of the galvanometer, with *r* ohms resistance in the secondary circuit. Then

$$K = \frac{\frac{2(4\pi N c a n)}{10 L}}{\theta \times \frac{R}{r}}.$$ Let this = Y lines.

The galvanometer having been thus calibrated, we are in a position to measure the permeability of the ring sample under investigation. The ring is wound all over with an exciting coil of a known number of turns, N', its cross-section, *a'*, and mean circumference, L', having been previously ascertained. An exploring coil, Q (see Fig. 2),

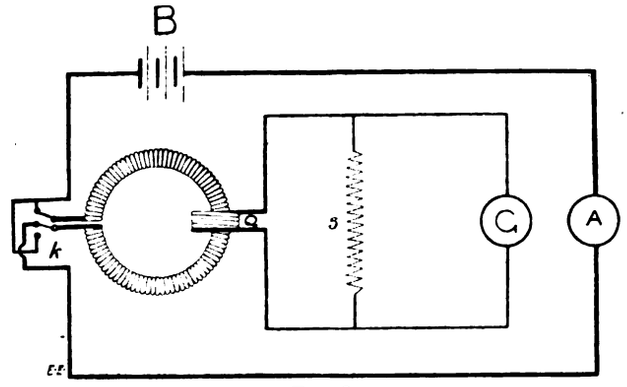

Fig. 2.

of known number of turns, *n'*, is then wound on it. The exciting current, *c'*, is measured by an ammeter, A.

Again, $$H = \frac{4\pi N' c}{10 L'}.$$

Let the total resistance of the secondary circuit = R'. Now let the current in the exciting coil be reversed and the deflection of the galvanometer noted. Let this deflection be θ' degrees. Now if the total resistance of the secondary circuit had been *r* ohms, and if there had been only one turn in the exploring coil, and if the flux had been simply created instead of reversed, we should have a deflection = $\frac{R' \times \theta'}{2 \times r \times n'}$. Let this equal D degrees. Consequently, since Y lines correspond to 1deg. deflection of the galvanometer, the flux reversed in the sample was D × Y C.G.S. lines. Since the cross-section of the ring is *a'* square centimetre, the density per square centimetre is

$$B = \frac{D \times Y}{a'}.$$

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Let the permeability be represented by the Greek letter μ. Then

$$\mu = \frac{B}{H} = \frac{\frac{D \times Y}{a'}}{\frac{4\pi N' c'}{10 L}} = \frac{D \times Y \times 10 L'}{4\pi N' c' a'}.$$

For practical purposes the density is generally expressed in lines per square inch. Lines per square inch = 6·45 × lines per square centimetre. Ampere-turns per centimetre of length $= \frac{10 H}{4\pi}$. Ampere-turns per inch of length = 2·02 H.

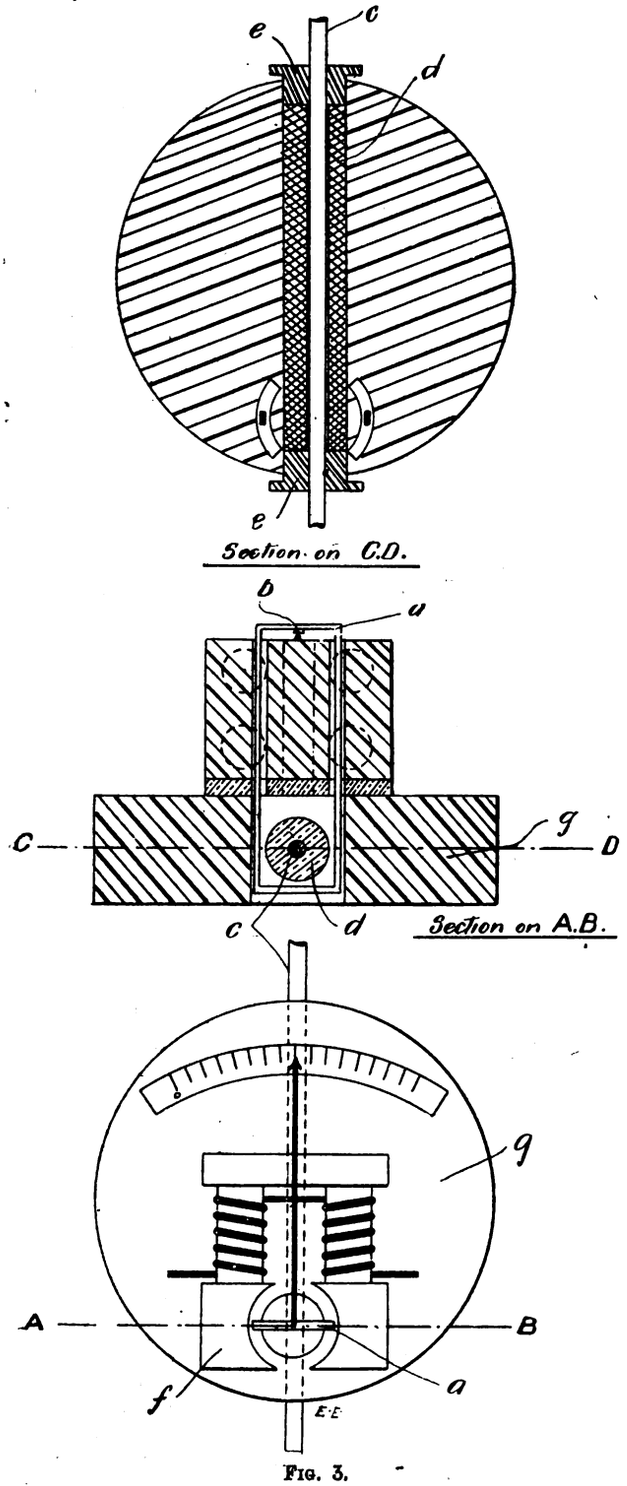

FIG. 3.

The foregoing method, although giving results of great accuracy, is a very lengthy and tedious process, owing to the necessity for winding the exciting and exploring coils afresh on each sample to be tested.

Permeability tests can be carried out much more expeditiously and with quite sufficient accuracy for all practical purposes by means of the instrument designed by Mr. Frank Holden. The general idea of this instrument is shown by Fig. 3. On a circular wrought-iron block, *g*, is mounted a magnet, *f*, constantly excited from any convenient source of current. Through the block, *g*, at right angles to its axis, passes a hole. In this hole a coil, *d*, is placed which surrounds the sample, *c*. Magnetic contact between the block and the sample is only made at the ends by means of iron plugs, which accurately fit the block. The sample is accurately turned to fit the holes in the plugs, *e e*. Suspended at *b* is a coil, *a*, consisting of one turn of copper wire. This coil surrounds the sample, *c*, and is free to move in the field set up by the constant magnet, *f*.

A sample is tested in the following manner. First the instrument is calibrated by inserting a standard bar whose permeability is known with precision; the pointer attached to the coil, *a*, is set to zero. The current in coil *d* is reversed, and the reversal of the flux through the bar, *c*, being interlinked with the coil, *a*, induces a current in it, and as the coil is at this moment lying obliquely across the field of *f*, it will deflect through a certain angle. This angle of deflection is directly proportional to the flux reversed. Let this deflection = θ degrees. The sample to be tested is now placed in the instrument, and a second deflection is obtained by reversing the current in *d*. Let this second deflection = θ'. Then, if deflection θ be known to correspond to flux N, then flux in sample under investigation is

$$= \frac{\theta' N}{\theta}.$$

If sectional area of sample is A square centimetres, then

$$B = \frac{\theta' N}{\theta \times A}.$$

The instrument is usually so arranged that H is a known multiple of the amperes in the coil, *d*. Let this constant = K. Let current in *d* = C. Then

$$H = CK,$$

and

$$\text{permeability} = \frac{\theta' \times N}{\theta \times A \times CK}.$$

In the above manner samples of iron or steel can be tested for permeability with a minimum of preparation of the sample, and with a high degree of accuracy and celerity. One excellent feature of Mr. Holden's instrument is that it is entirely unaffected by any external stray field.—T. E. G.

Question No. 708.—On a four-pole, 200-ampere, 500-volt B.T.H. three-phase rotary converter, the attendant when running the machine up as a direct-current motor left the shunt field switch open, and machine ran up as a series motor, but in the opposite direction to that in which it runs as a shunt machine. Are the shunt and series windings connected up properly? If not, what is the best method to find out which way the coils are wound without uncovering the windings, and how should they be connected up? P.S.—The shunt coils are joined up two in series.

Best Answer to No. 708 (*awarded* 10*s.*).—The shunt and series windings on the machine in question are connected up quite correctly, and the attendant was lucky not to have had a nasty accident due to the series winding being also cut out. It is evident from the data given that the machine is intended to run as a shunt motor and as a compound-wound generator. The explanation which "Herions" seeks is best found by considering the machine in its different aspects—as a shunt generator or motor, and as a series generator or motor. In dealing with motors, there are one or two points which, if borne in mind, will give a simple solution to apparently intricate problems. When a conductor carrying a current is placed in a magnetic field and is free to move in that field, it will be impelled in such a direction that the E.M.F. induced in it by this motion will oppose the flow of the original current in the conductor. Now consider the machine in question as a shunt generator. Referring to Fig. 1, it will be seen that when running as a shunt generator the machine sends a current from B+ (positive brush) to terminal, T+, round the outside circuit, and back through terminal, T−, to machine by the negative brush, B−. Part of the current also goes from terminal, T+, through shunt resistance, S R, and field switch, F S, through the shunt field winding, Sh. F, to D, and back to machine at B−, the field thus shunting some of the armature current. Now, without altering any connections, consider the machine as a shunt motor. Current now *enters* at

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T+, and flows through B+, through armature, A, and back to the mains *viâ* B− and T−. Part of the current also flows from T+, as before, through S R and F S, through shunt field, Sh. F, to D, and back to mains, *viâ* T− (*i.e*, the current in the field flows in the same direction). Now the machine is running as motor, as it did when the machine was running as a generator, the difference being that the field now shunts some of the line current. Obviously, if the law stated above is to be obeyed, the machine must run in the same direction as a motor as it did as a generator, in order that the E.M.F. induced in the armature conductors by their motion shall oppose the flow of the current originally existing in the conductors and entering at T+. Now consider the machine as a series generator. Referring to Diagram 2, when running as a generator current is sent from B+ up through series field, Sr. F, to T+, round outside circuit, and back to the machine, *viâ* T− and B−. Now without altering any connections consider the machine to be running as a motor. Current now *enters* at T+ and flows *down* through series field, Sr. F, into armature, A, *viâ* brush, B+, and back to

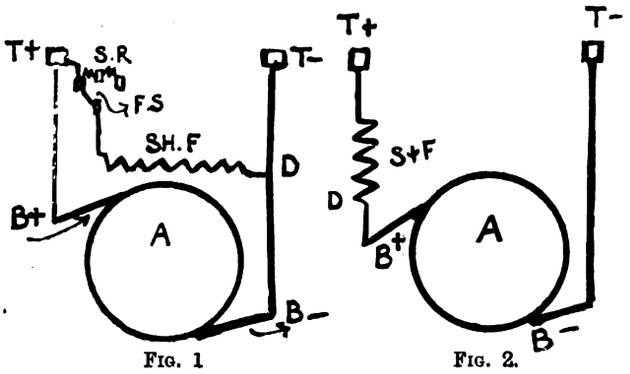
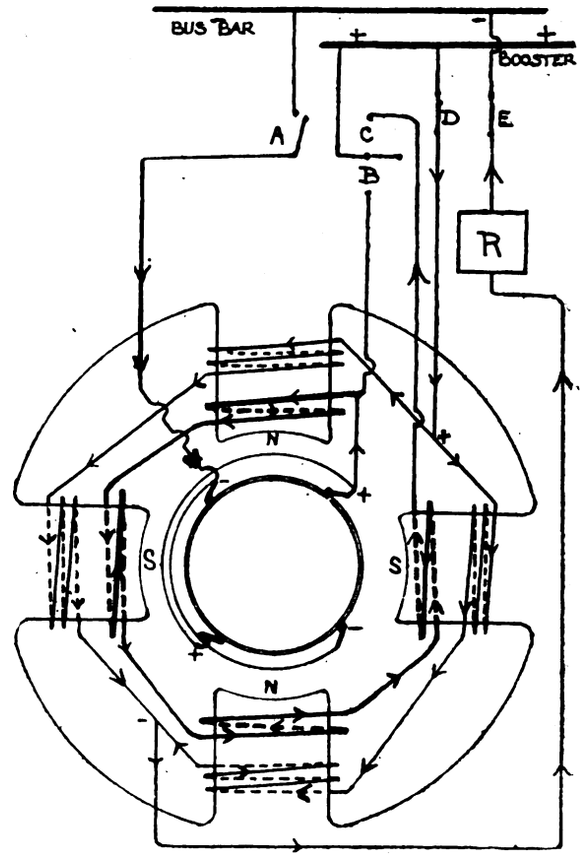


Fig. 1

Fig. 2.

mains by B− and T−. It will be observed that the current through the field is in the reverse direction to when the machine was running as a generator; therefore, in order that the armature conductors may have an E M.F. induced in them by their motion, which will oppose the flow of the current entering at T+ and taking the course described, the machine must revolve in the opposite direction when running as a motor to what it does when running as a generator. This will explain why a shunt machine must (with the connections unaltered) run in the same direction as a generator, or as a motor, and why under similar conditions a series machine will run in the reverse way as a motor to what it does as a generator. The crux of the matter is that, when running as a motor, either type of machine must also generate an E.M.F. which opposes the flow of the entering current. In order to test the direction in which coils are wound, test the coils by means of a couple of dry cells and a galvanometer, put the cells across D and F S, and then put the galvo. leads across the same points and note the direction of the deflection. Now place the cell lead which is on D, 1, on D in Diagram 2, and the other lead from the cells at the top terminal of the series winding. Then treat the galvo. leads in the same way, and if the deflection is the same, then both coils are wound in the same direction.—W. T. W.

Answer to No. 708 (*awarded* 7*s.* 6*d.*).—The accompanying sketch shows the usual method of connecting up a machine such as the one in question. When running as a compound generator (all switches closed except B), the currents in the field windings would flow in the direction of the arrows, and the magnetic fields produced would be as indicated by the letters. Now consider the machine without the shunt windings (switches D and E open) being run up to speed as a series motor. The polarity of the brushes is the same as before, but the current in the field windings (series) being in the opposite direction, produces a reversed field, and consequently the machine runs in the opposite direction. The best method of verifying the field connections is by means of an exploring coil, consisting of two or three turns of wire wrapped round the pole-piece and connected in circuit with a galvanometer. On making the shunt circuit a current will be induced in the exploring coil, causing a kick on the galvanometer. This kick will be to the right, say for one pole, and to the left for the next, and so on, taking the poles in order right round the machine. The series turns may be tested similarly. Connect them across the 'bus bars through a rheostat and a switch, and arrange to pass a fairly large current. Proceeding exactly as with the shunt windings, the kicks should, if the connections are correct, be in the same direction for each pole as those given by the shunt wind-



ings. It will probably be found necessary to increase the turns on the exploring coil when testing the series coils.—W. E. P.

Answer to No. 708 (*awarded* 5*s.*).—Apparently the series winding is properly connected. When the machine is working on load, the function of the series coil is to increase the magnetisation as the load increases—that is, it is wound to give a field similar to the field due to the shunt winding. If the rotary be started as a direct-current motor, the current flowing through the armature and series coil will be in the opposite direction to the normal, therefore it will oppose the field due to the shunt winding. As the starting current is usually small, the magnetisation due to the series coil will be small, and have very little neutralising effect on the main field. If, however, the shunt field switch be left open when starting, the magnetisation passing through the armature will be that due to the series coil, which, being in the opposite direction to the normal, will establish a field passing through the armature in the wrong direction, consequently the machine runs in the wrong direction, taking a very heavy starting current. It is good practice with compound rotaries arranged for starting as direct-current motors to provide a means of cutting out the series coil, thus getting a stronger field; consequently less starting current is required. To ascertain in which direction the field coils are wound, it is only necessary to note the polarity of the particular pole-piece on which any coil is placed, then, looking at the pole-face, the current will flow clockwise if it be a north pole, counter-clockwise if it be a south pole.—H. W.

N.B.—Will F. Kennington, of Leeds, kindly send his full name and address.—[Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
AUGUST 19, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

717. A high-speed lighting set of 200 h.p. when working at full load requires 160lb. steam in steam-chest, but at three-quarter load only 120lb. is registered on the pressure gauge connected to it. The engine is controlled by throttle valve, and runs condensing. Which should be the most economical boiler pressure to use (as regards coal consumption) for continuous runs at three-quarter load—165lb. or 130lb., and why? Does superheating by 100deg. affect the case?—H. G. V.

718. How would you calculate the magnet and winding of a maximum and minimum release and magnetic brake (*a*) for direct current, (*b*) for alternating current.—J. B.

719. In an alternating-current plant with rotaries a bad phase was made when synchronising another alternator with one previously running, and which caused all the rotaries to loose their fields. The same thing has happened when a bad phase has been made in synchronising a rotary. Could anyone explain in full detail exactly what happens to the rotary as to how it looses its field?—F. B.

ANSWERS.

Question No. 709.—The proprietors of a boarding-house have a small hand-worked lift for elevating and bringing down dinners, etc. It is desired to work the lift electrically. What would be the best method of doing so, so as to obtain the following conditions: The switching gear must be of the simplest, and be easily understood by the servants, and, of course, be fool-proof. It must be actuated from either top or bottom. The lift is balanced, and it is required to take up at full load about 1cwt. of utensils, etc.; silent working is specially desired. Capital cost to be kept as low as possible. Skilled labour is available to do the whole of the erecting and wiring, but not to supervise after the job has been set to work. A supply of energy at 230 volts is available, and there is an electric bell service from top to bottom of lift.

Answer to No. 709 (*awarded* 10*s.*).—Dinner lifts worked by electricity, though not common, are in use in a good many places in the country, chiefly, of course, in large buildings and such places where there are a lot of things to bring up for the table. I hardly see the electric bell service which is at present from top to bottom of the lift will be of any use to us, as the insulation on the wires and the method they have probably been run would most certainly not be good enough to stand a pressure of 230 volts. The methods I shall indicate will be quite feasible, but any calculations made can only indicate the methods to be followed, and "W. T. W." must adopt this method to this particular case himself, as he has given no particulars about the lift itself. He says it is to be capable of lifting 1cwt., and it is balanced. Now, the lift itself, to hold 1cwt of goods, must be a fair size, and must be built substantially; and so let us assume the box itself into which the articles are put, together with the metal rings to which the suspension ropes are attached, weighs ½cwt. Now, as to the counterweight, it is not said what weight this is. Is this ½cwt. as well? in which case the lift itself is exactly balanced, and our motor will have to be capable of raising 1cwt.; or is the weight of the counterweight greater? in which case we should never have such a heavy load to elevate. The most economical size of counterweight would be to make this 1cwt. in weight, for then the maximum effective load to be raised cannot be more than ½cwt. This may very easily be seen from the following: It is evident that the greatest load must be when 1cwt. of utensils is being raised, and also when the lift is being dragged down against the action of the counterweight, for in the first case we have the total weight of utensils and lift cage is 1cwt. + ½cwt. = 1½cwt. Against this has to be put the weight of the counterweight, which is 1cwt., and hence the total effective weight to be raised is $1\frac{1}{2} - 1 = \frac{1}{2}$cwt. Similarly, when the lift is being drawn down against the counterweight empty, the weight of the cage alone is ½cwt., and the counterweight is 1cwt. Hence total effective weight to be raised is $1 - \frac{1}{2}$cwt. = ½cwt. From this I think "W. T. W." will see that the most economical weight for the counterweight to be will be 1cwt, as if any other value be taken and similar calculations be made, it will be found that either in one or the other of these cases the total effective load to be raised will be greater than ½cwt., and the rule for the best weight for the counterweight will be readily seen to be equal to the weight of the lift cage plus half the weight of the maximum load. Let us now assume the total lift required is 10ft., and the time to be taken for the complete lift from rest at the bottom to a position of rest at the top is eight seconds, and that it takes the motor three seconds to get up to top speed, three seconds to slow down from this to position of rest, which leaves two seconds for the motor to be running at full speed. Now let us further assume that during the three seconds it takes to get to full speed the speed is one-third full speed at the end of one second and two-thirds full speed at the end of the second second, and that this rate of acceleration is the same when stopping, though, of course, this time it is in the negative direction.

Let x = full speed in feet per second of lift.

Speed at end of one second $= \frac{x}{3}$

" " two seconds $= \frac{2x}{3}$

" " three " $= x$.

Distance travelled in 1st second $= \frac{x}{3 \times 2} = \frac{x}{6}$

" " 2nd " $= \frac{x}{3} + \frac{x}{6} = \frac{x}{2}$

" " 3rd " $= \frac{2x}{3} + \frac{x}{6} = \frac{5x}{6}$

" " 4th " $= x$

" " 5th " $= x$

" " 6th " $= \frac{5x}{6}$

" " 7th " $= \frac{x}{2}$

" " 8th " $= \frac{x}{6}$

} Being same as those during acceleration.

Now the sum of these must be equal to 10ft., the total length of lift. So

$$\frac{x}{6} + \frac{x}{2} + \frac{5x}{6} + x + x + \frac{5x}{6} + \frac{x}{2} + \frac{x}{6} = 10\text{ft.}$$

Hence $x = 2{\cdot}4$ft. per second, which is greatest speed of lift.

Total effective load = ½cwt. = 56lb., with 1cwt. in lift.

Power to raise load of 1cwt. in lift at top speed $= 56 \times 2{\cdot}4 = 134{\cdot}2$ foot-pounds per second = ¼ h.p.

This ¼ h.p. is entirely neglecting friction and the inertia of the whole system, and is only the power required to keep the system in motion after it has been accelerated up to full speed, and does not take into account the power required to accelerate the load from rest up to full speed in three seconds. This power required will be much greater, and I should advise using either a ½-h.p. motor, or, better still, a 1-h.p. motor, the difference in prime cost being only a matter of about £5, and the larger power motor will work far better and will run up to speed quicker. If the balance weight on the lift is only equal to the weight of the cage, it will be absolutely essential to use the 1-h.p. motor.

A small motor of this size will run at a speed of about 1,300 revolutions per minute, and so, of course, this must be geared down. This may best be accomplished by means of a pinion and spur wheel, the latter being on the same shaft as the winding drum. A suitable sized pinion wheel on the motor spindle will be about 2in. diameter, and a suitable sized winding drum will have a diameter of about 6in. It will be necessary to have the drum grooved, so that the rope will wind up on to it easily. A suitable depth would be to make the grooves about as deep as half or three-quarters the diameter of the ropes. The above 6in. diameter of drum means the diameter of the drum and half the thickness of the rope each side, being the diameter of one turn of the rope round the winding drum.

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Now, 6π = length of one turn of rope in inches and $\frac{10 \times 12}{6\pi} = 6{\cdot}36$ = number of turns of drum to wind lift from bottom to top.

There will be three ropes to wind on to this drum, two being for the lift and one for the counterweight, each of which must have a groove cut for it.

Now, going back to the former assumptions, that the speed of the lift, and hence the motor, is $\frac{x}{3}$, $\frac{2x}{3}$, and x in both the first and last three seconds of the run, and knowing the full speed of the motor is $\frac{1{,}300}{60} = 22$ revolutions per second.

Now, total revolutions in 1st second = 3·66 and also in 6th
" " 2nd " = 11 " " 7th
" " 3rd " = 18·33 " " 8th
" " 4th " = 22 " " 5th

Now, summing up the total number of revolutions of the motor armature for the eight seconds' lift, we get 110.

Now, as there is a 2in. pinion wheel on the end of the spindle running 110 revolutions, driving on to a spur wheel running 6·36, the diameter of this spur wheel must be equal to 34·6in. This is certainly very large, and the only way to reduce it, except by another reduction, which would increase the cost and lessen the efficiency, would be to reduce the winding drum diameter to 4in. instead of 6in.

Length of one turn now = 12 6.

Total number of turns for hoist = 9 53.

Then diameter of spur wheel = $\frac{110 \times 2}{9\ 53} = 23$in.

This is a far more practical size, though 4in. diameter for the turns of the rope is certainly very small, and undoubtedly a double reduction would be best.

Now, the method of procedure will be the following: The motor will be placed either at the top or the bottom of the lift well, and will drive by means of the pinion and spur wheel on to a countershaft extending centrally across the well, and holding the winding drum. Lifting ropes will be attached at either end to this drum in the aforementioned grooves, which ropes extend up the sides of the well, over pulleys at the top, down again, fastening into two eye hooks fastened centrally on the top of the lift itself. Another rope will be fastened round another groove placed centrally in the winding drum, go round a pulley at the side of the bottom of the well, up the side to the top, over two other pulleys, across, and down again, the other side fastening on to the counterweight. Of course, it must be arranged that when the lift is at the bottom the counterweight is at top, and sufficient rope must be wound on the drum at the bottom of the well so that when the lift is at the top the rope may have unwound and let the counterweight down to the bottom. Some strong spring buffers should be attached to the sides of the well, both at the bottom and at the top, a little beyond the usual travel of the lift, so that if the lift runs too far it may not have a violent shock in stopping. It is necessary to have a brake so that the lift may stop in any position when required, and not be pulled up by the counterweight when empty, nor down by the load in the cage when full. This should be quite automatic in action, going on when the motor stops and coming off the moment it starts. This can best be accomplished electrically, using a solenoid, which by drawing in its core releases the brake. Fig. 1 shows such a solenoid and brake; its action may be easily seen. The plunger is attached to the junction of two links, which normally incline downwards to this junction. On their other extremities are pivoted two pieces of metal to which the brake blocks are attached, and the other ends of these metal arms are bent inwards and pivoted together. The plunger is coned at its top end and fits into another piece of soft iron, which is permanently fastened inside the solenoid. The object of coning this plunger is double: firstly, by so doing we increase the area of the air-gap and so decrease the reluctance and get more lines through the core; secondly, by doing so we get the effect of having a long pull with only a slightly varying length of air-gap, which would not be the case if the two surfaces were to be flat. When current passes round the solenoid coil the plunger is pulled up, which brings the two links horizontal, and so pushes their other extremities outwards and takes the brake pieces off the drum. This brake drum is keyed on the same shaft as the winding drum. The solenoid is

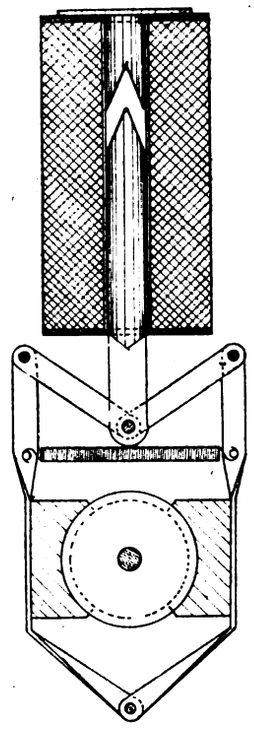

FIG. 1.

connected across the mains as a shunt to the motor, so that when the motor is switched on the solenoid is energised, and takes the brake off the winding drum, so releasing everything and allowing the motor to do its winding freely.

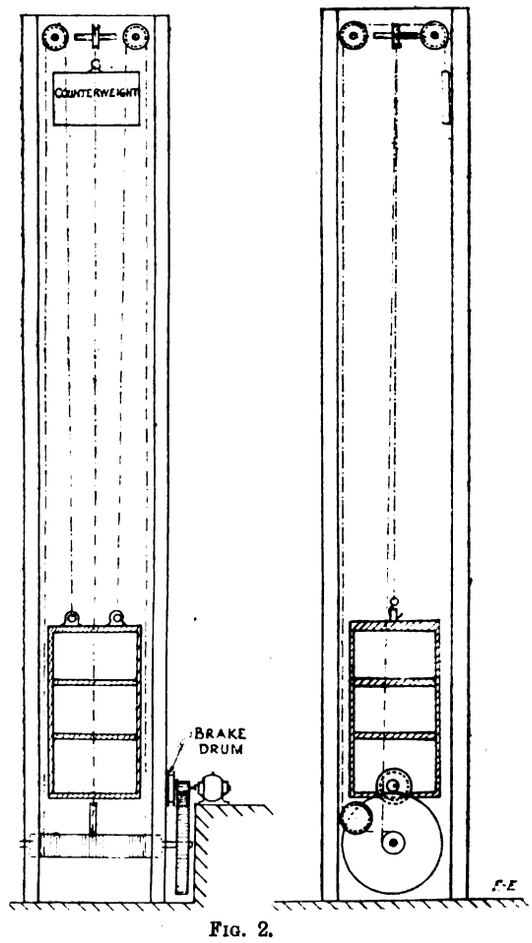

FIG. 2.

Another necessity is to have some means by which a person operating the lift from where they are to the other stage may know when the cage is there, and so may be enabled to switch off and put the brake on at the correct moment.

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This might, of course, be done electrically by having a system of brushes on the lift cage itself, and strip brass contacts on the side of the well running the greater part of the whole distance of travel, but stopping abruptly at the place where current should be switched off. If the main motor current passed through these contacts and brushes, it would automatically be broken at the correct time to stop the lift at the proper position, but I think this electrical method is hardly advisable, owing to the extra cost it would entail, the extra likelihood of something going wrong, and also, probably, the fire insurance people would object to these live unprotected contacts being broken thus. A better method would be to mark the positions of the counterweight on the side of the lift wells at which points it is necessary to switch off, and then when running the lift to watch till the counterweight reached this spot, and then immediately open the circuit. Fig. 2 gives an idea of the general arrangement of the dinner lift, which is fairly self-evident from the aforegoing description of the parts, as I have given two elevation views with the front sides removed in both cases, and in one case the motor not shown in its end

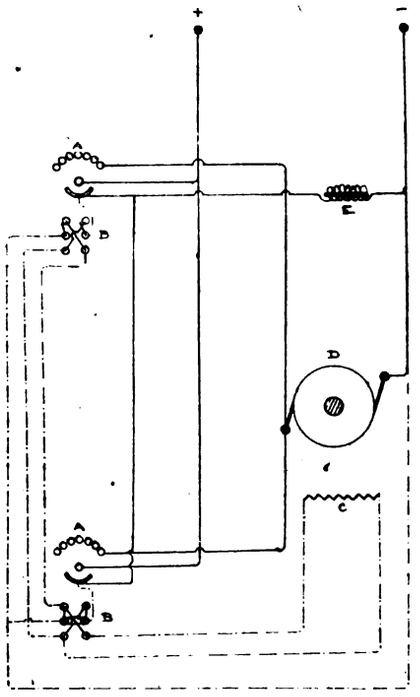

FIG. 3.

view. Fig. 3 gives a diagram of all the necessary connections, where A is a small starting switch suitable for this size of motor, and having a resistance of about 40 ohms when all the contacts are in circuit. Considering the short time the motor is to run, it will be necessary to switch on quickly over all the contacts, only occupying about one second for the whole operation. B is an ordinary double-pole reversing switch, C is the shunt winding of the motor, and D the armature. Of course, a pair of double-pole switches and fuses might be put in across the mains if required. On careful examination of these connections, it will be seen that to work the lift motor it is necessary to first close the reversing switch in either the up or the down positions as required, and so making the shunt circuit, and then on operating the starter, A, the motor will run, as this finally closes both the armature and the field, and finally rapidly switching off at A, so de-energising the brake solenoid and putting the brake on, and then opening the reversing switch. The current enters the starter arm at the point where it is pivoted, the armature current passes through the resistance contacts, and the shunt passes through the back ring, it being arranged that the shunt is not made at this point till just before the lever touches the first contact; this is to prevent the shunt being always on, and it also has it fully magnetised so as to keep up a good torque, and hasn't been arranged to put the armature resistances in the shunt circuit when full on, as is often the case. To reverse a shunt motor, it is only necessary to reverse the direction of the current through the field winding. This is accomplished by throwing over the reversing switch to the other side. The brake solenoid shown diagrammatically at E is also connected across this back ring and the negative wire, so that it is energised and takes off the brake the moment the motor circuit is closed. It is absolutely necessary to open the reversing shunt switch after switching off the motor, as otherwise if it be left in, say, in the up position, the lift will be at the top, and now if someone comes to the bottom and wants it down there they will put their reversing switch in the down position, which will result in a short-circuit and blown fuse, which may readily be traced out. If, however, two persons switch on at the same time, both trying to send the lift in the same direction, it will go, and nothing serious will happen. It is very important to impress on the servants the necessity of always leaving this reversing switch out. Of course, it might be argued that it would have been better to have used a series motor so as to have taken advantage of the greater starting torque, but I hardly think this to be advisable, as if the lift starts too suddenly things are very likely to get spilt; hence the use of a shunt motor, which starts steadier and is steadier running.

Another cheaper method of operating this lift, which, however, I think hardly as good as the one I have described, would be to have the shunt motor running in one direction all the time the lift were likely to be required. Have a very long pulley on the motor driving on to a countershaft with the winding drum on by means of three pulleys, one fast on the shaft with a loose pulley each side, each with a belt on going round the motor pulley, one belt being crossed. Now, striking gear might be operated by ropes running up the side of the lift well, which would pull either the straight or the crossed belt off its loose pulley on to the fast one on the countershaft, and so turning the winding drum. Another kind of brake would have to be devised if this were to be the system used for operating the lift. A simple starting switch is all that is required to run the motor up to speed. I should, however, strongly advise the use of the former method described, and if the pinion wheel be of rawhide, I don't think it should make much noise. Such an electrically-operated lift would require practically no attention except just for lubrication occasionally.—E. R. ALEXANDER.

Answer to No. 709 (*awarded* 5*s.*).—The hoisting gear which would probably best meet the specified conditions—viz., cheap, silent, and fool-proof—is shown diagrammatically in Fig. 1. A compound-wound direct-current motor, *a*, designed to give ¾ h.p. at 400 revolutions per minute is direct connected by means of a coupling, *b*, to a small hauling drum, *c*, 1in. diameter, running in two plummer blocks, *d d*. On the same shaft is a brake wheel, *e*. The hoisting rope is given about half a dozen turns round the drum, *c*, which should give sufficient grip to raise a load of 1cwt. The drum should be merely rough turned, and not polished at all. On the other end of the rope is hung the balance weight, *f*. Thus the rope is always kept tightly coiled round the hauling drum. A quick-break, double-throw, double-pole switch, *g*, provided preferably with carbon break, is fixed in a suitable and accessible position on the side of the lift well. This switch must be designed so as to have a well defined "off" position. Stretched down the lift well is a cord, *h*, kept taut by tension springs, *k k*, at top and bottom anchorings. On this rope are two knurls, *l* l_1. Fixed between two brackets on the side of the cage is a round iron pin about 15in. long. Free to slide up and down this pin is a wooden block, *m*, normally held in approximately a central position by the spiral compression springs, *n n*. In the block is a hole, through which the rope, *h*, passes freely. This rope is rigidly connected to the handle of the switch, *g*, in such a manner that in its normal position (as determined by the springs, *k k*) the switch is in the "off" position. On the drum shaft and beyond the brake wheel is a small centrifugal governor, *o*, so adjusted that at about 100 revolutions per minute it will cause the forked arm, *p*, to dip into the mercury-cups, *q q*, thus short-circuiting a starting resistance, which is placed between the two cups and is in series with the motor armature winding.

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Fig. 2 shows the arrangement of the hand-brake. Round the brake wheel passes a steel band, preferably lined with segmental blocks of hardwood. The ends of this band are attached to the lever, *r*, which is pivoted at *s*, and at the

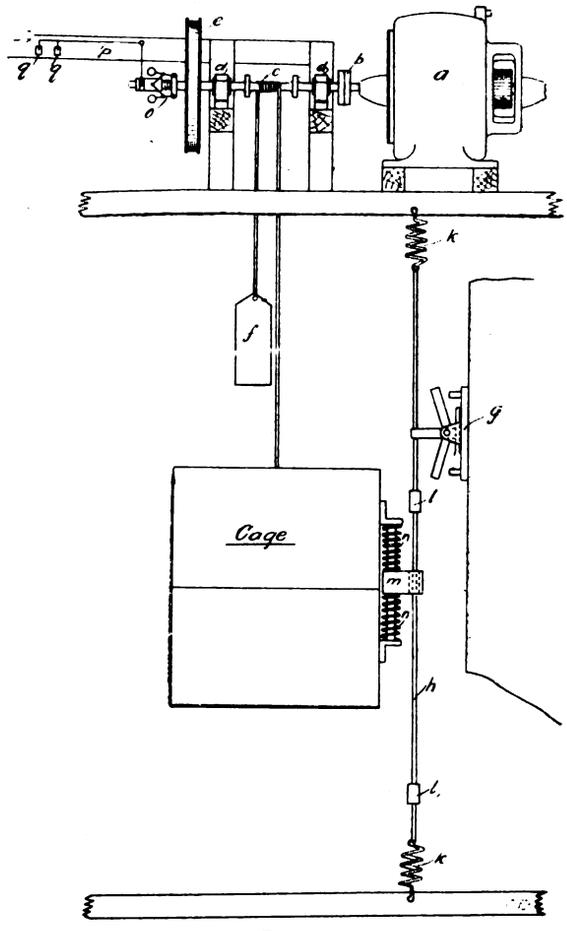

FIG. 1

other end carries a weight, *t*. Immediately over this weight is fixed a pot magnet, *u*, which, when fully excited, has sufficient lifting power to raise the weight, *t*, and so release the brake. The windings of this magnet are arranged in two parts, which are so proportioned that when the current

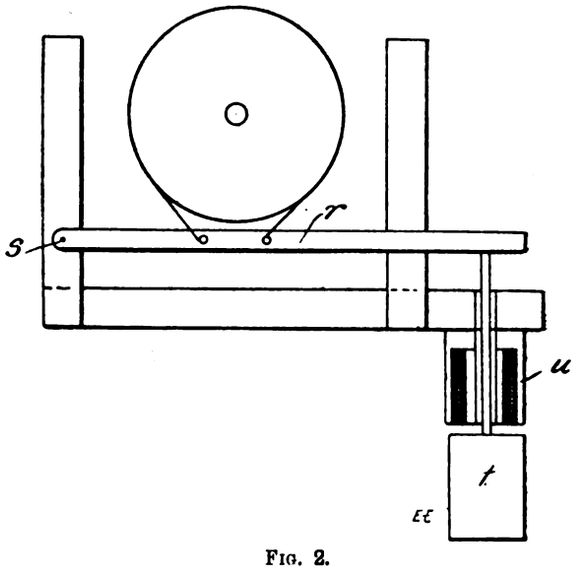

FIG. 2.

in the motor armature is reversed the current in 25 per cent. of the exciting coils is reversed, thus reducing the total excitation and the lifting power of the magnet to approximately one-half of its full strength, which leaves the brake half on when the cage is being lowered, which will prevent it coming down at a dangerous speed.

Fig. 3 is a fairly self-explanatory diagram of the electrical connections. M is the motor armature, S the series field, *s* the shunt field, which need not be more than 30 per cent. of the total ampere-turns, and is only intended to prevent the motor running away on light loads. C C are the two parts of the brake magnet exciting coil, which are always in series with the motor armature winding; *g* is the D.T. D.P. switch, R is the starting resistance, and *q q* are the mercury-cups through which the starting resistance is short-circuited by the action of the centrifugal governor above described; Q is a Thomson magnetic blow-out circuit breaker, provided to take care of overload. The switch, *g*, is so coupled up that pulling down the cord, *h* (Fig. 1), starts the motor in the direction for hauling up the cage, while pulling the cord

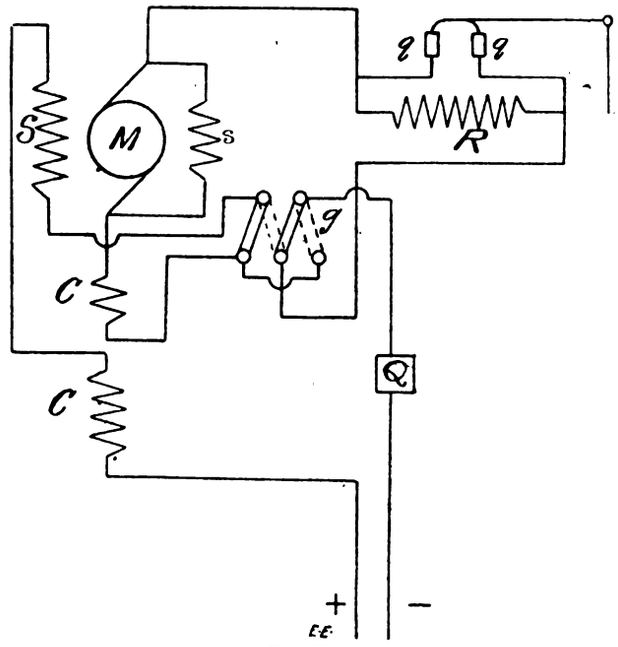

FIG. 3.

upwards causes the cage to descend. This arrangement prevents risk of injury to the operator should he continue to grip the cord until the cage comes right down or up, as the case may be; for his hand will be struck by the block, *m*, and the rope pulled the proper direction to reverse the motor, and so cause the lift to move away from his hand. When the cage is up to the desired height, the block, *m*, engages with the knurl, *l*, pulling up the rope and opening the switch, *g*, cutting off the current from the motor and also from the brake magnet, thus allowing the weight, *t*, to pull the band tight round the brake wheel, bringing the drum to a dead stop. When the cage is descending, the knurl, l_1, is struck and the cage brought to a standstill as above. A very slow-speed motor has been chosen to avoid the need of gearing, thus reducing noise and attendance to a minimum figure. As the duty is very intermittent, a pretty tightly-rated motor can safely be installed, sparking rather than thermal considerations being the limiting factor. Thus, although being very slow speed, its cost will probably be less than that of a higher-speed motor and worm gearing. Toothed gear would be inadmissible on the score of noise.

The equipment described above could probably be all provided and fixed for not more than £40. It is as simple a gear as could safely be installed to do the work, and is as near fool-proof as any electrical apparatus can be, and, moreover, should be absolutely silent. With a winding drum 1in. diameter and running at 400 revolutions per minute, the lifting speed would be about 100ft. per minute. A higher speed than this would be likely to result in culinary compounds being served up which were not originally included in the menu.—T. E. G.

[Other replies to Question No. 709 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
AUGUST 26, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

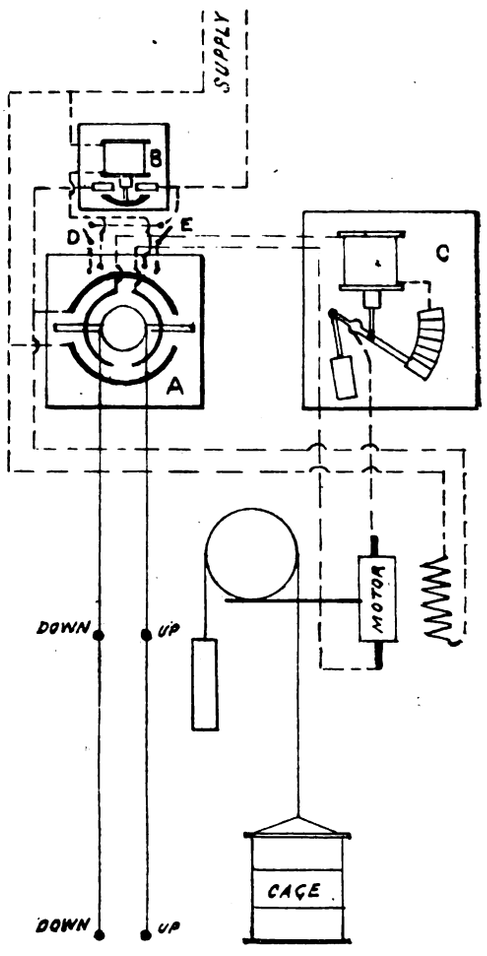
QUESTIONS.

720. In a certain type of coking stoker the bars are subjected at the back end to a very intense heat and soon burn away, resulting very often in serious damage to the stoker, due to them falling. The bars supplied by the makers are of a low-grade cast iron. What should be the composition of the iron in order, as far as possible, to resist the intense heat?

ANSWERS.

Question No. 709.—The proprietors of a boarding-house have a small hand-worked lift for elevating and bringing down dinners, etc. It is desired to work the lift electrically. What would be the best method of doing so, so as to obtain the following conditions: The switching gear must be of the simplest, and be easily understood by the servants, and, of course, be fool-proof. It must be actuated from either top or bottom. The lift is balanced, and it is required to take up at full load about 1cwt. of utensils, etc.; silent working is specially desired. Capital cost to be kept as low as possible. Skilled labour is available to do the whole of the erecting and wiring, but not to supervise after the job has been set to work. A supply of energy at 230 volts is available, and there is an electric bell service from top to bottom of lift.

Answer to No. 709 (*awarded* 5*s.*).—The accompanying sketch shows the necessary switches and connections for



the automatic control of a ½-h.p. reversible shunt-wound motor, operating 1cwt. lift balanced for average load. The method of operation is as follows. The attendant pulls the cord for up or down motion, whichever is desired, and this actuates switch A, which makes the proper connections to armature of motor and then closes solenoid-controlled main switch, B, and the motor commences to revolve, switch C cutting out resistance from armature circuit of motor as it comes up to speed. Switches D and E are geared to motor shaft, so that when it has made the requisite number of turns to bring cage to top or bottom gate, the main switch is opened and motor stops. When the cage is at the top gate switch D is open and E closed, so that the attendant can only start the motor in proper direction for taking cage downwards. The whole of the apparatus can be purchased in a compact form from a number of leading motor-control specialists, and can be erected and put to work by an ordinary wireman. It would be well to have doors for gates actuated by the cage, so as to prevent such an occurrence as attendant looking for cage and getting trapped.—A. T.

Question No. 710.—Controller required for a three-phase motor, 6 h.p., 100 volts; ratio of turns, 2 : 3; periodicity, 60. Work out diagram of connections and main dimensions of controller, supposing it were for lifting purposes on a crane.

Best Answer to No. 710 (*awarded* 10*s.*).—The general diagram of connections of a suitable controller are given in Figs. 1 and 2, in which Fig. 1 gives a development and

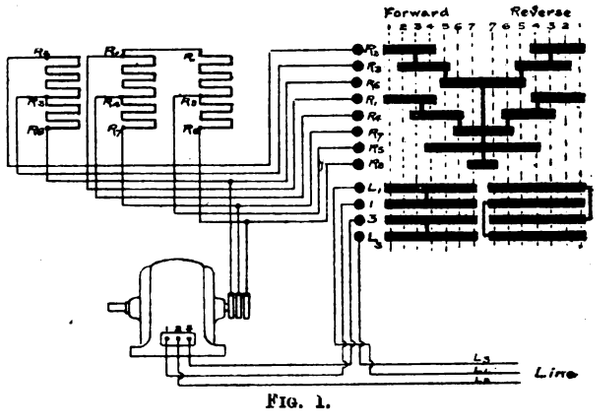


FIG. 1.

controller wiring, while Fig. 2 gives the connections corresponding to each "notch" of Fig. 1. It will be seen that the controller is of the reversing type, with one cylinder, the latter being capable of movement in two directions. This type of controller is to be preferred for controlling

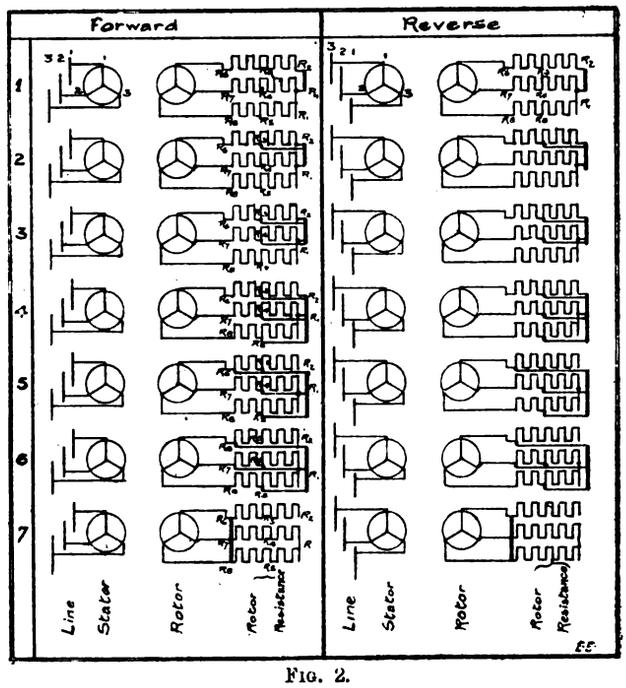


FIG. 2.

cranes, especially if it is worked from the floor level by means of a chain, since extra complication and confusion is involved by the type having the reversing cylinder separate from the main cylinder.

It will be assumed here that the rotor has a Y-connected winding, the rotor resistances likewise being connected in Y. This is the general practice, though for small motors some

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manufacturers use a two-phase winding for the rotor. However, the type of rotor winding can easily be ascertained for the present motor, by open-circuiting the rotor and applying three-phase current to the stator. The voltage across each pair of slip-rings should be measured, and for a three-phase rotor these should be practically equal, while for a two-phase rotor two readings should be equal, and the third approximately $\sqrt{2}$ times each of the other readings. With two-phase rotors it is the general custom to connect one end of both phases together to one slip-ring, the other ends being connected to the remaining two rings. When connecting up resistances they should be joined up in a similar manner, the middle or neutral point going to the slip-ring corresponding to the same point in the rotor winding. Figs. 1 and 2 are drawn out for a three-phase Y-connected rotor, there being in all seven notches, though the resistance per phase is only divided into two steps. This is accomplished by cutting out resistance consecutively in each phase instead of simultaneously. The slight dissymmetry thus introduced occasions no difficulty; in fact, this method has the advantage of reducing the number of contact fingers in the controller to a minimum. The upper portion of the cylinder in Fig. 1 controls the rotor resistances, while the four lower contacts, designated by L_1, 1, 3, L_2 respectively, are for the purposes of reversing, and are connected in the stator circuit. For reversing a two or three phase motor all that is required is the leads of one phase to be changed over, which is accomplished by interconnecting the last-mentioned

FIG. 4. FIG. 5.

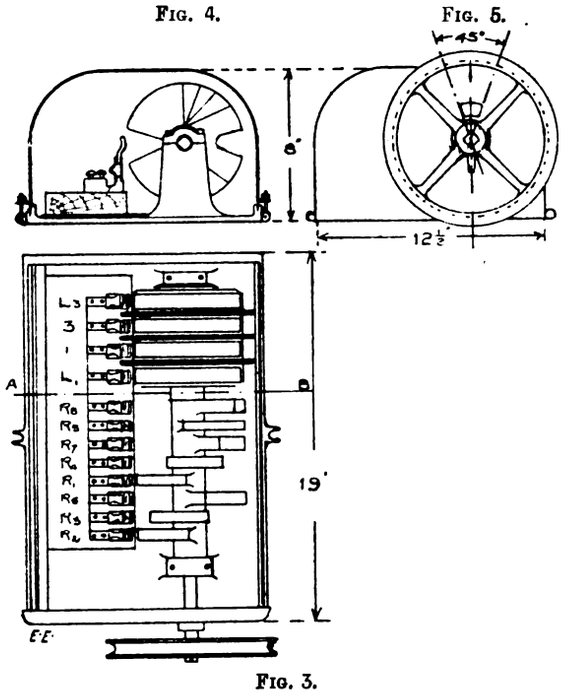

FIG. 3.

contacts as indicated in Fig. 1. Each of these contacts should, of course, be insulated, but the upper contacts must be all connected together. With the help of Fig. 2 all the notches of Fig. 1 can be easily followed.

The general construction of this controller is shown by the sketches in Figs 3 to 6; Fig. 3 being a plan with the cover removed, showing the general assembly; Fig. 4 an end elevation with front end removed; Fig. 5 an end elevation of controller complete; Fig. 6 a sectional elevation, taken on line A B (Fig. 3); and Fig. 6A a detail of the contact fingers. The body for the contacts R_1 to R_8 may be a brass casting, with facings of copper screwed on. In setting out this, the various angles for "off" position, first notch, etc., should be decided on, and the circumference of cylinder developed flat. The contacts, L_1, 1, 3, L_2, may consist of copper strips screwed on the circumference of a cylinder of hard wood, these being interconnected as in Fig. 1. Details of the contact fingers are indicated in Figs. 6 and 6A, and it should be mentioned that the copper connecting the finger to the body of the terminal should be fairly flexible. The dimensions are intended to give approximately the over-all sizes, etc., and will vary slightly with different designs. The mode of operating the controller will depend on circumstances, that shown in Figs. 3 and 5 being by means of a chain and chain wheel, the controller and resistances being mounted on the crane girders. This method is useful for small cranes, but where a cage is used the controller should be provided with a handle and a definite "notch" for each position of the controller. In the former case, a spring should be provided to bring the controller to the "off" position as soon as the chain is released. Definite notches are not required in this case, as the controller should return to the "off" position as soon as the crane-driver releases the chain.

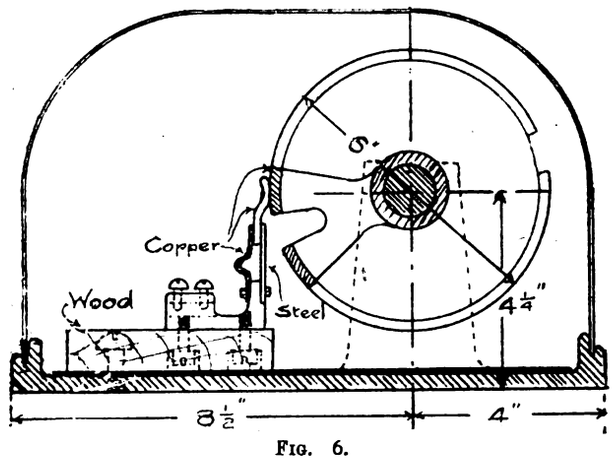

FIG. 6.

The resistances should be of the grid type, and the total resistance per phase should be that recommended by the manufacturer, in order for the motor to give the requisite starting torque. Generally, for a motor of this size a resistance of from about 1·6 to 2·0 ohms per phase will be sufficient. This refers to the resistance between points R_1 and R_8, while that between R_5 and R_8 may be one-third to one-half of this value. The resistance should be designed to carry the full-load rotor current of the motor, which may be obtained by multiplying the full-load stator current by the ratio of transformation, in this case two-thirds, the values, of course, being arranged to correspond to the connections of stator and rotor windings.

The value of the resistance to be inserted in each phase of the rotor for the motor to develop a given starting

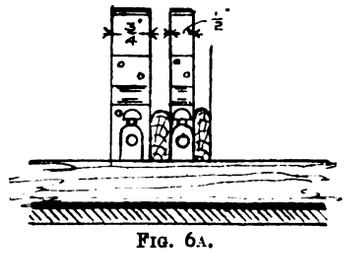

FIG. 6A.

torque with a given starting current may be ascertained by applying the "circle diagram."*—A. D.

Answer to No. 710 (*awarded* 7*s.* 6*d.*).—The motor in question has presumably a "wound" rotor fitted with three slip-rings, and has a ratio of total rotor turns to total stator turns of 2 : 3. Both windings will probably be star connected. Assuming a full-load power factor of ·85, and a full-load efficiency of ·85, the full-load stator current per line (or phase) will be $\frac{6 \times 746}{\sqrt{3} \times \cdot 85 \times \cdot 85 \times 100} = 36$ amperes, and the rotor current per line will be a little less than $36 \times \frac{3}{2} = 54$ amperes, say 52 amperes. Assuming, further, that the slip of the motor at full load is about 5 per cent., the C^2R loss in each rotor phase at full load will be about

$$\frac{6 \times 746}{3} \times \frac{5}{100} = 75 \text{ watts},$$

and the resistance of each rotor phase will be $\frac{75}{(52)^2}$ = ·0275 ohm.

* A very full and practical treatment of the application of the "circle diagram" is given by Mr. H. M. Hobart in his work on "Electric Motors: Their Theory and Construction."

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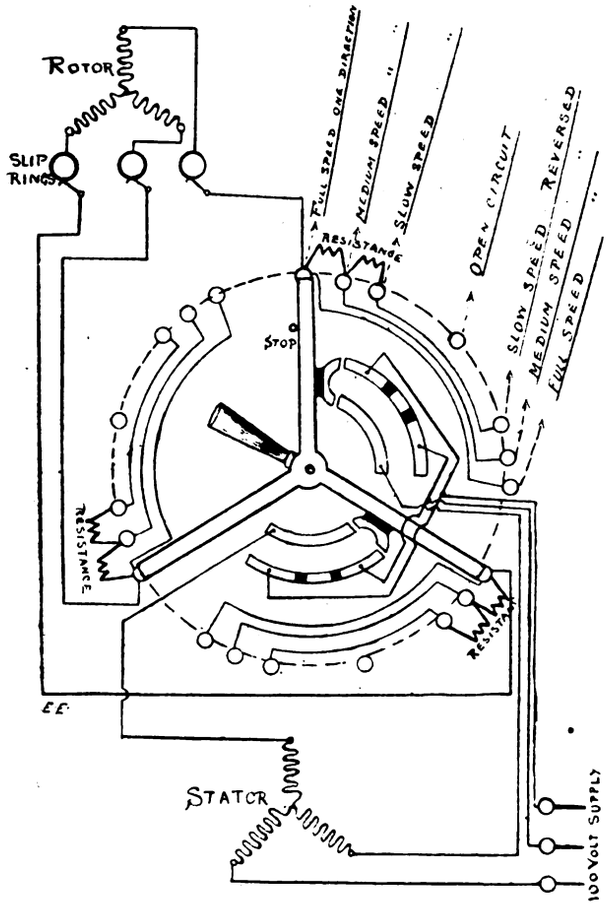
As at least the normal full-load torque will be required at starting, the starting resistance should be proportioned so as to pass about the normal full-load current (52 amperes) when all is in circuit, so that the starting resistance per phase should be made about $\cdot0275 \times \frac{100}{5} = \cdot55$ ohm, divided into three or four steps. The total losses in this resistance at full current will be $(52)^2 \times \cdot55 \times 3 = 4{,}500$ watts for the three phases together. Allowing for a well-ventilated resistance frame, consisting of a number of wire spirals under a perforated cover, the number of watts per square inch of outer surface of frame could probably be safely allowed to reach a value of 6 at the maximum current, provided that the motor is running at full speed with all the resistance cut out for a fair proportion of the time. The outer dimensions of the frame should, therefore, be, roughly, 750 square inches, or, say, about 14in. high by 10in. wide by 10in. deep.

The controller switch might conveniently consist of a three-armed switch arranged on the top of the resistance frame. This switch must control the motor speed by inserting more or less of the resistance into the rotor



phases, finally short-circuiting the slip-rings for full speed, and at the same time must act as a reversing switch—*i.e.*, it must interchange two of the stator supply leads when the motor is on open circuit; then reinsert the whole resistance in the rotor phases, and gradually reduce this resistance until the rotor is short-circuited again and running at full speed in the reverse direction. The necessary connections are shown in Fig. 1.—Q.

Answer to No. 710 (*awarded* 5*s.*). — Supposing the efficiency of the motor is ·8, and the power factor $\cos \phi = \cdot82$, the primary absorbed current will be 40 amperes. Now, the secondary ampere-turns, the primary and the magnetising ampere-turns are represented by the three sides of a triangle having one angle equal to 90deg. $- \phi$. So, if the winding in stator and rotor are of the same kind, and if the magnetising current is 12 amperes, the full-load secondary current will be about 52 amperes (ratio of turns $\frac{2}{3}$), or, say, 55 amperes to allow for the secondary leakage. If 6 per cent. of the output is lost in the rotor winding (or say 270 watts), the resistance of one phase of the rotor is

$$R = \frac{270}{3 \times 57^2} = \cdot03 \text{ ohm.}$$

Supposing, now, we start the motor with the full-load primary current, the secondary starting current will be 55 amperes, and the starting voltage $\frac{100}{\sqrt{3}} \times \frac{2}{3} 0{\cdot}95 = 36$ volts (·95 is to allow for the leakage). The resistance, then, at starting must be $\frac{36}{55} = \cdot65$ ohm per phase. Suppose the controller has five steps per phase, or six studs, we must now divide the ·65 ohm in five parts. If we put the condition that the variation of the current, when the handle is moved from one to the next stud, is equal for all the studs and in the same time a minimum, we get the following formula :

$$\frac{i}{i'} = \sqrt[5]{\frac{36}{55 \times \cdot03}} = \sqrt[5]{21\cdot7} = 1{\cdot}85$$

36 = voltage at starting ;
55 = current at starting ;
·03 = resistance per phase ;
i and i' are the maximum and the minimum currents flowing in the rotor phase when passing from one to another stud.

The resistances in the five steps will be given by :

$$r_1 = \left(\frac{i}{i'} - 1\right) R = \cdot85 \times \cdot03 = \cdot025 \text{ ohm.}$$

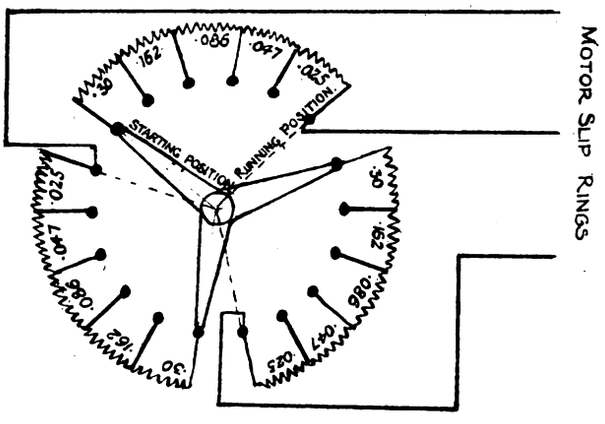
$$r_2 = \frac{i}{i'} \cdot r_1 = 1{\cdot}85 \times \cdot025 = \cdot047 \text{ ohm.}$$

$$r_3 = \frac{i}{i'} \cdot r_2 = 1{\cdot}85 \times \cdot047 = \cdot086 \text{ ohm.}$$

$$r_4 = \frac{i}{i'} \cdot r_3 = 1{\cdot}85 \times \cdot086 = \cdot162 \text{ ohm.}$$

$$r_5 = \frac{i}{i'} \cdot r_4 = 1{\cdot}85 \times \cdot162 = \cdot300 \text{ ohm.}$$

As verification it must be : $r_1 + r_2 + r_3 + r_4 + r_5 + R = \cdot65$. The torque at starting is proportional to the loss in the



rotor copper : $3 \times 55^2 \times \cdot65 = 5{,}900$ watts. It is then about 30 per cent. more than the full-load torque. The diagram of connections is plain enough to be understood without an explanation. If we allow a density of 4,500 amperes per square inch we must use about six steps of Eureka wire, which can be easily put in an open box of 10in. by 10in. by 8in. These dimensions are quite sufficient for allowing the good ventilation necessary in a controller for lift motor.—N.

Question No. 711.—Give a clear description and example of a method of ascertaining core loss on a direct-current machine by observing the time taken to shut down from its normal speed with field on; secondly, with field off. Given the weights off the moving parts.

Answer to No. 711 (*awarded* 10*s.* 0*d.*).—The principle which underlies this method of determining the running losses—that is, the losses which occur all the while the machine is being used — is that when the machine is running at normal speed energy is stored up, and if all external sources of energy are cut off, this energy is gradually dissipated in overcoming the various forces which resist rotation. With an ordinary

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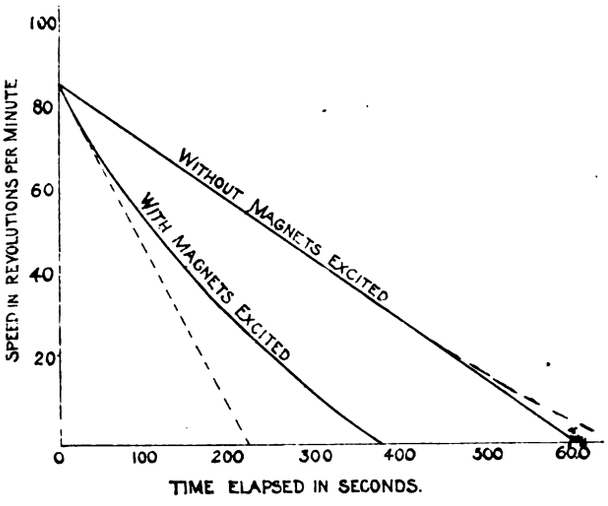
flywheel, these forces consist only of bearing friction and wind resistance, but in the case of an armature revolving under excitation, there are also the magnetic forces set up by eddy currents and hysteresis to resist the rotation. To make the experiment, the machine is run up to speed, and then allowed to run free by taking out the clutch or by cutting off supply of current from both armature and field. As machine slows down readings are taken of the speed in revolutions per minute at the end of known intervals of time. The experiment is then repeated, but this time with the field magnets excited, a similar set of readings being taken. Curves are then plotted, as shown in example,



connecting revolutions per minute and time elapsed in seconds since machine was at its normal speed. The first curve is, it will be found, a practically straight line, while the other starts with a steeper slope, which gradually decreases in value until when the position of rest has been reached, the slope is the same as that of the first curve. Now, as the curves are plotted between revolutions per per minute and time in seconds, the "slope" will give the retardation of the machine in revolutions per minute per second, or multiplying the result by $\frac{2\pi}{60}$, we shall have the angular retardation in radians per second per second. We then apply the formula,

$$\text{Retarding torque} = \frac{\text{moment of inertia}}{32{\cdot}2} \times \text{ang. retardation},$$

and thereby knowing the retarding torque at the particular speed dealt with, we may calculate the watts lost from the well-known rule

$$\frac{T \times 2\pi n}{33{,}000} \times 746 = \text{watts}.$$

In the example, which is of a 450-kw. slow-speed traction generator, the full speed is 85 revolutions per minute, and it took 610 seconds to slow down. Therefore, angular retardation

$$= \frac{85 \times 6{\cdot}25}{60 \times 610} = 0{\cdot}0146 \text{ radian per second per second.}$$

In second curve the tangent at 85 revolutions per minute is A B; therefore, machine starts slowing down at the rate of

$$\frac{85 \times 6{\cdot}28}{60 \times 222} = 0{\cdot}0402 \text{ radian per second per second.}$$

The moment of inertia of the machine has been estimated to be 78,000 (ft.)^2 lb. units.

$\therefore$ Retarding torque in first case $= \frac{78{,}000 \times 0{\cdot}0146}{32{\cdot}2}$, and in second case $= \frac{78{,}000 \times 0{\cdot}0402}{32{\cdot}2}$.

The difference in the torque in two cases is due to iron losses. Therefore, torque due to iron losses

$$= \frac{78{,}000 \times 0{\cdot}0256}{32{\cdot}2}.$$

$$\therefore \text{Iron loss in watts} = \frac{78{,}000 \times 0{\cdot}0256 \times 2\pi \times 85 \times 746}{33{,}000 \times 32{\cdot}2}$$
$$= 7{,}650.$$

Similarly, friction loss at this speed is 4,360 watts.

Some writers on this subject have shown how the eddy-current losses and hysteresis losses may be separated from one another by this method. It will have been noticed that the second curve obtained had not a constant slope all along. This is because the retarding torque due to iron losses is, unlike that due to the friction losses, dependent on the speed. In fact, the hysteresis torque is directly proportional to the speed and the eddy-current loss is proportional to the square of the speed. The expression for the retarding torque in the second case is, therefore, of the form $A + B\,n + C\,n^2$, where n is the speed in revolutions per minute and A, B, and C are unknown constants. It is, therefore, claimed that by taking three points on the curve and proceeding in each case as before, we may solve the equations for A, B, and C, and thus separate the friction, hysteresis, and eddy-current components of the losses. This theory may be applicable in cases where the readings may be taken with extreme accuracy, but for the ordinary cases, owing both to irregularities in the experiment and to difficulty of drawing tangents correctly, it is not practical. Especially is the case with direct-current machines, where the eddy-current losses are generally small compared with the hysteresis loss.

A few remarks must be made on the estimation of I, the moment of inertia. In direct-current machines it is a matter of extreme difficulty to calculate this quantity directly, although in the case of magnet wheels of alternators it may be approximately arrived at by rules given in all treatises on applied mechanics. An experimental method is as follows: The machine is brought up to speed and the number of revolutions made before it comes to rest is noted. A suitable flywheel, whose I is easily calculated, is then attached to the shaft and the process is again repeated, no excitation being on the machine in either case.

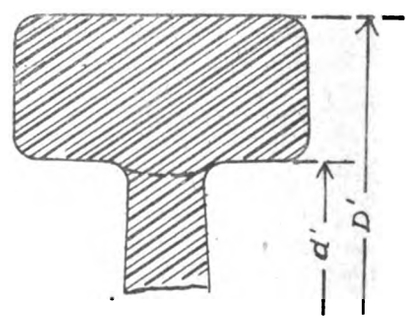
Let I_0 = known I of flywheel;
I_1 = unknown I of dynamo;
n_1 = revolutions made before coming to rest in first case; and
n_2 = revolutions made before coming to rest in second case.

Then $$I_1 = I_0 \left(\frac{n_1}{n_2 - n_1}\right).$$

A very neat expression for the I of flywheel indicated in sketch is

$$\left(\text{Weight of rim (lb.)} + \frac{\text{weight of spokes (lb.)}}{4}\right)\left(\frac{D^2 + d^2}{16}\right)$$

when the diameters are taken in feet.



Finally, in making the experiments as constant conditions must be obtained as possible, the machine being run for some considerable time to ensure that the friction is constant. In the case where the machine is excited, the speed may be accurately taken by reading a voltmeter applied to the terminals, and if the test is one being continually made, a recording voltmeter with a quick-moving drum may be used.—X. Y. Z.

[Other replies to Question No. 711 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
SEPTEMBER 2, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS

721. An ejector condenser coupled close to the exhaust range and about 2ft. below, supplied with water from a centrifugal pump at a pressure of over 20lb. per square inch, will not, either in a vertical or horizontal position, give more than 20in. of vacuum. Explain the reason for this.—E. L.

ANSWERS.

Question No. 711.—Give a clear description and example of a method of ascertaining core loss on a direct-current machine by observing the time taken to shut down from its normal speed with field on; secondly, with field off. Given the weights off the moving parts.

Answer to No. 711 (*awarded* 10*s.*).—The following method is only applicable to machines with armatures of such

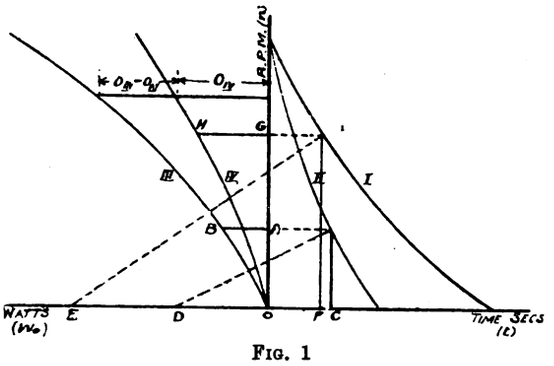

FIG. 1

weight that the time occupied in shutting down with excited field is at least 20 seconds. If the machine be running as a motor, and both supply to the armature and field current be suddenly cut off, then the energy stored in the rotating armature will be consumed solely in overcoming the mechanical losses; the speed will gradually decrease, and the armature will finally come to rest. If in cutting off the armature current the field be left on, additional hysteresis and eddy-current losses will come into play; the time occupied in shutting down will now be of shorter duration. The theoretical side of the question being somewhat involved, it will perhaps be best to treat the mathematics of the case first and then proceed to the actual test. An element of mass a moving at a velocity v per second possesses an energy of

$$E = \frac{a\,v^2}{2}.$$

For a complete body—viz., the armature—

$$E = \Sigma\,\frac{a\,v^2}{2}.$$

If a body revolves around an axis, then an element of mass a of the same at a distance y from the centre has a velocity

$$v = y \times S, \text{ where } S = \frac{2\,\pi \times n}{60} \ (n \text{ standing for R.P.M.}).$$

$$\therefore \Sigma\,\frac{a\,v^2}{2} = \Sigma\,\frac{a\,y^2\,S^2}{2} = \frac{S^2}{2} \times \Sigma\,(a\,y^2).$$

The expression $\Sigma\,(a\,y^2) = I$ is the moment of inertia.

$$\therefore E = \frac{S^2}{2} \times I.$$

In Fig. 1, Curve I. represents the relation between time and speed with field off. Curve II. gives the same relation but with the field excited. For any instant, t, the consumption of energy per second is given by

$$-\frac{d\,E}{dt}\,\frac{d\left(\frac{S^2}{2} \times I\right)}{dt} = \frac{I}{2} \cdot \frac{d\,S^2}{dt} = I \times S\,\frac{d\,S}{dt}.$$

$$\therefore S = \frac{2\,\pi \times n}{60} = \frac{\pi\,n}{30}.$$

$$\therefore -\frac{d\,E}{dt} = I\,\frac{\pi\,n}{30} \cdot \frac{\pi}{30} \cdot \frac{dn}{dt} = I\left(\frac{\pi}{30}\right)^2 n\,\frac{dn}{dt}.$$

$I\left(\frac{\pi}{30}\right)^2$ is a constant value for any particular machine, and represents the subnormal of the n/t curve. $\therefore$ substituting K for $I\left(\frac{\pi}{30}\right)^2$, we have

$$-\frac{d\,E}{dt} = K \times n\,\frac{dn}{dt} \quad \ldots \quad (1)$$

i.e., the watt loss $-\frac{d\,E}{dt}$ per second is proportional to the sub-normal of the corresponding n/t curve. The constant K once known, the loss curve may be deducted from the n/t curve. The value K, however, is awkward to calculate on account of the difficulty of finding the factor I It is possible to ascertain the moment of inertia, I, without the use of higher mathematics by means of a tabular method, as set forth in Alexander and Thompson's "Applied Mechanics," or even by graphical solution (see *Practical Engineer*, Dec. 6, 1895).

A much more direct method of finding K exists, which, furthermore, does not depend on any particulars as to weight or section of the revolving parts being given. To this end plot Curve III. for the excitation at which the losses are to be determined, placing values for speed, n, against total no-load losses, W_0 (see Fig. 1). Then find Curve II. for the same exciting current, and, finally, Curve I. with field off. The value K may be got from Curves II. and III. For by equation (1) watt loss, W_0, of Curve III. for a certain speed, n, is equal to K × sub-normal for the corresponding n on Curve II. Referring to Fig. 1

$$B\,A = K \times D\,C. \quad \therefore K = \frac{B\,A}{D\,C}.$$

Once K is found, the friction loss (Curve IV.) may be deducted from Curve I. For instance, the ordinate H G is determined by the relation

$$H\,G = K \times E\,F.$$

Finally, the difference of any two corresponding ordinates ($O_{III} - O_{IV}$ in Fig. 1) will give the required ordinate of the curve of no-load core losses. It may not be out of place to specially call attention to the fact that the result merely represents the *no-load* core losses. Under load the distribution of the flux is altogether a different one, which necessarily affects the losses very materially.

From the wording of the question one would take it that "E. S. C." merely wishes to ascertain the aggregate core losses. It is but a slight matter to now separate the hysteresis and eddy-current losses, and as this process is

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quite a well-known one it hardly seems necessary to dwell upon the question. Such being the theoretical aspect of the problem, the actual mode of carrying out the test will be somewhat as follows: Connect up as per Fig. 2. Run machine light with the field separately excited, and observe that the exciting current be kept at a constant value throughout the test. The machine had preferably be

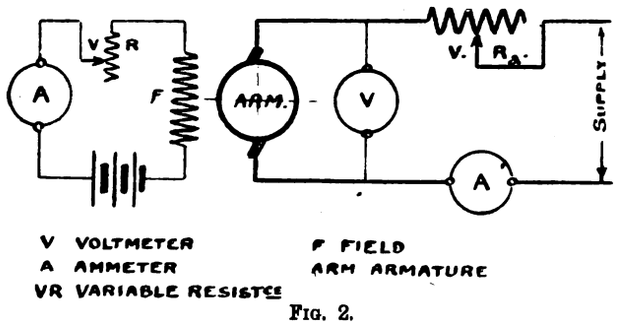

FIG. 2.

had running for some time previous to taking readings to allow the temperature to rise to its normal value. First, determine Curve III., starting at full speed. Take simultaneous readings of voltage and current in armature circuit and speed of machine. Gradually insert resistance, V R_a, and take readings afresh. Plot results as shown in Fig. 3, taking values for n vertically and armature volts × armature current horizontally. Then proceed to take n/t Curves I. and II., again starting from full speed. The speed should be taken by means of a tachometer at intervals

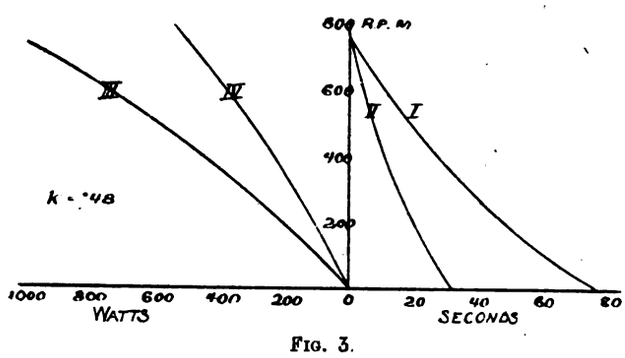

FIG. 3.

of five seconds. The best plan is to get an assistant to mark the time intervals by periodically striking a bell.

All the required readings being now taken, the remainder is done by graphic solution. Determine constant K, which is equal to any ordinate B A of Curve III. divided by the

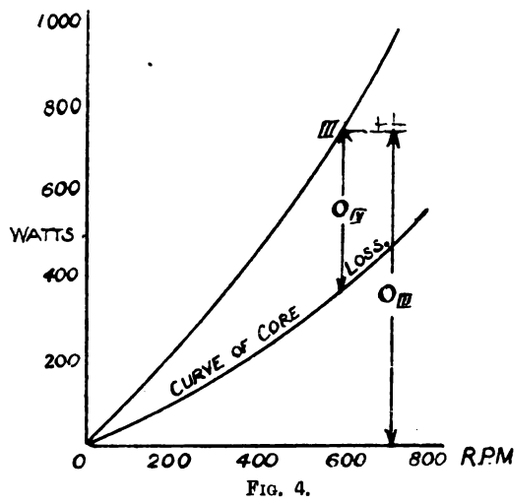

FIG. 4.

corresponding sub-normal D C of the n/t Curve II. As all values got from various points in this manner should yield the same result, the mean value should be adopted. To find any ordinate H G of the friction loss, Curve IV., use the relation H G = K × E F.

For the final result, plot Curve III. as per Fig. 4, and fix several points for the no-load loss curve by deducting any ordinate O_{IV} of the friction loss curve from the corresponding ordinate O_{III}, as per diagram. *Note*.—Figs. 3 and 4 show the actual results obtained on a 15-h.p. machine by Witting Bros., Limited.—R. E. C. IHLEE.

Answer to No. 711 (*awarded* 7*s.* 6*d.*).—To determine the core loss in a machine by the method referred to in the question, a knowledge of the "moment of inertia" of the moving parts is essential. This cannot be calculated unless the weights of the moving parts and their respective radii of gyration are known, but it can be found experimentally by various methods, a convenient one being as follows: The machine is run as a separately excited motor, and the power supplied to the armature accurately measured. Subtracting from this the energy lost in heating the armature coils, we obtain the power actually expended in driving the motor against the resisting forces.

Then if T = retarding torque in C.G.S. units acting on the armature;
w = angular velocity at any instant;
I = moment of inertia of revolving parts;
W = power in watts actually expended in driving motor;

we have $$T = I\frac{dw}{dt} = \frac{-W}{w} \times 10^7.$$

In the above equation both I and $\frac{dw}{dt}$ are unknown, but $\frac{dw}{dt}$ can be determined graphically from a curve connecting w and t, and its value inserted in the above

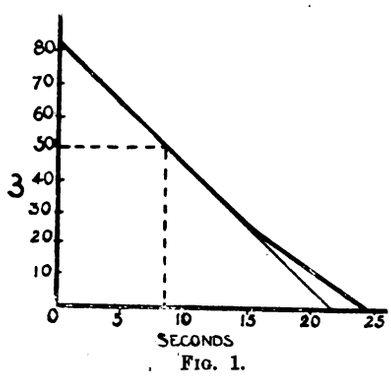

FIG. 1.

formula, thus allowing I to be calculated. The data for plotting this curve is obtained by suddenly cutting off the power from the machine when running on open circuit at any desired speed, and as the armature slows down observing the speed by means of a tachometer at known intervals of time. Fig. 1 represents a curve plotted from readings obtained in this manner. It will be seen that the tangent to the curve is indistinguishable from it for a considerable distance, and can therefore be drawn with great accuracy. For $w = 50$

$$\frac{dw}{dt} = \frac{81}{22} = 3{\cdot}68.$$

Now, consider the motor to be fully excited, and to be running on open circuit at the normal speed. On cutting off the power to the armature, the machine will gradually come to rest under a retarding torque due to the losses on the machine. At any speed, w, this retarding torque has a value

$$T = -I\frac{dw}{dt},$$

and the corresponding power $= Tw = -Iw\frac{dw}{dt} \times 10^{-7}$ watts (the letters having the same meaning as given above). Since I is known and $\frac{dw}{dt}$ can be determined as shown above, the power at any speed can be calculated. This power at any speed, w, is obviously equivalent to the energy dissipated by bearing, brush, and air friction, hysteresis, and eddy currents at that particular speed. If, therefore, we calculate values of the power for various speeds, a curve can be plotted showing how the energy dissipated varies with the speed. Repeat the above experiment, but with the fields cut out, and plot values of

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power and speed, obtained as above, on the same sheet. The difference between the ordinates of the two curves, at any speed, gives the core loss for that speed and excitation (see Fig. 2). To separate the hysteresis and eddy-current losses, plot a curve having values of "energy lost in

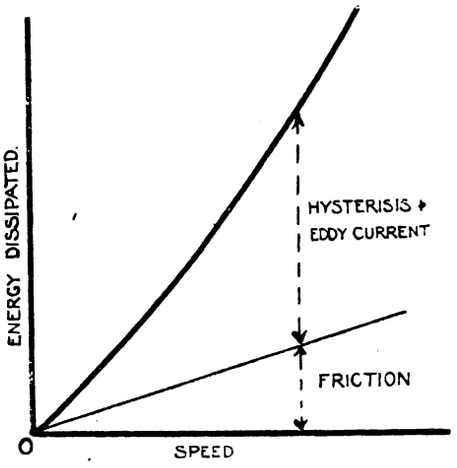

FIG. 2.

hysteresis and eddy currents" ÷ speed for ordinates, and speed for abscissæ. Since the hysteresis loss varies as the speed, while the eddy-current loss varies as the square of the speed, it will be seen that a line drawn parallel to the

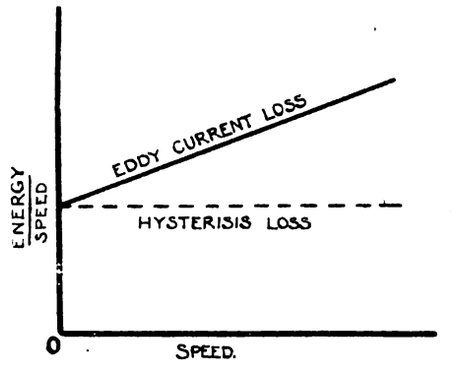

FIG. 3.

abscissa through the point in which the curve cuts the ordinate will separate them (Fig. 3).—C. L. S.

Question No. 712.—Explain the necessity of reactance on the alternate-current side of a rotary converter.

Answer to No. 712 (*awarded* 7*s.* 6*d.*).—One of the many problems connected with the running of rotary converters is that of pressure regulation. The ratio of the E.M.F. between the commutator brushes and that between any two slip-rings is practically constant for any machine, and is independent of the field. It follows, therefore, that to obtain any alteration in the voltage across the brushes a corresponding alteration in the voltage applied to the slip-rings must be made. This variation of the voltage on the alternating-current side can be effected by hand or automatically. In the former case either an "induction regulator" can be used or the ratio of transformation varied (assuming that step-down transformers are used, as is generally the case), while in the latter case the regulation is effected automatically by compounding the rotary, and providing a certain amount of self-induction between the secondary of the transformer and the slip-rings, if not already existing, by inserting small reactance coils in the various leads.

The following is an explanation of its working: Assume the rotary to be working on a fixed load, and that the current is in phase with the volts. On increasing the excitation it will be found that the current through the armature will have increased, and is now leading, while reducing the excitation will also cause the current to increase, but it will now be lagging. If we take readings of the armature current for various excitations, we can plot a curve which will have the shape shown in Fig. 1. At the bottom of the curve, A, the armature current, will be a minimum, and is practically in phase with the volts; any variation in the exciting current now causing the armature current to increase, and to lead or lag, depending whether the excitation is increased or reduced.

Now, in any circuit having inductance a leading or lagging current will cause a rise or fall in voltage respectively. This will readily be seen by an inspection of Fig. 2.

Let O C represent the current taken by the rotary per phase; O L will then represent the E M.F. per phase

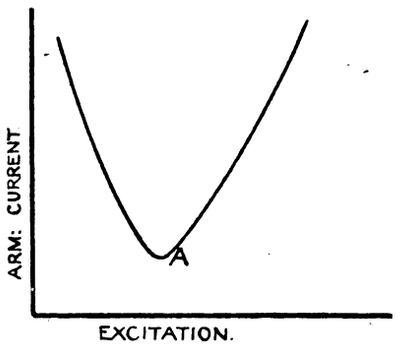

FIG. 1.

required to overcome the back E.M.F. due to self-induction and that required to drive the current through the resistance of the circuit. O E represents the E.M.F. induced in the secondary of the transformer, which may be taken as constant. It will be seen that when the current lags (by the angle D) behind the induced E.M.F. in the secondary, E L will represent the back E.M.F. of the rotary, which, neglecting the drop due to resistance and self-induction,

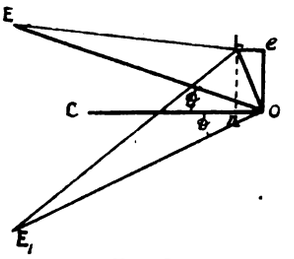

FIG. 2.

may be taken as the E M.F. at the slip-rings. Obviously E L is less than O E Similarly, when the current is leading by the angle D, E_1 L represents the E.M.F. at slip-rings, and is evidently greater than O E_1.

Considering the rotary converter, it will be now obvious that if there is sufficient reactance on the alternating-current side, and the rotary is compounded, the E M.F. across the slip-rings, and, consequently, that across the brushes, will increase as the load increases. In fact, if the shunt excitation is so proportioned that at no load the rotary takes a lagging current about 30 per cent. of the full-load current, due both to under-excitation and reactance, the rotary can be made to regulate perfectly automatically from no load to about 10 per cent. overload.—C. L. S.

Answer to No. 712 (*awarded* 7*s.* 6*d.*).—Reactance is put in series with the alternating-current side of a rotary converter in order to keep the direct-current voltage constant at all loads, or even to increase it as the load increases. The voltage of the D.C. side of a rotary converter is quite independent of the field strength, so that compounding in the ordinary way is out of the question.

At the same time, a rotary converter, considered from the alternating side, behaves exactly like a synchronous alternating motor, and instead of having a fixed input current for each load, the input current varies according to the excitation.

If the machine is excited to give too great an internal voltage to correspond with the supply voltage, a leading current (lagging with respect to the internal back voltage) is drawn from the supply and weakens the field to the required extent by armature reaction, whilst if excited to give too small an internal back voltage, a lagging current

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(leading with respect to the internal back voltage) is taken and serves to strengthen the field.

If, therefore, a rotary converter is fitted with a compound field winding on the D.C. side and with a definite amount of resistance, either in the form of cables or of separate choking coils, on the A.C. side, the proportion of shunt and series winding can be so chosen that the current at light load is a lagging one (shunt made too weak for unity power factor), causing a large drop in the reactance and so lowering the A.C. terminal volts, whilst at full load the current could be made a leading one (series winding made too strong) which, in combination with the reactance, causes an actual rise in the alternating terminal volts above the supply volts. Thus, if in Fig. 1,

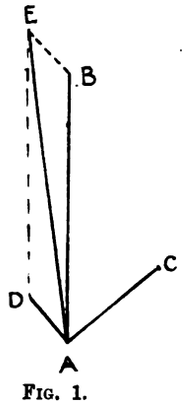

FIG. 1.

A B represents the alternating-current terminal volts at light load, and A C the lagging input current at light load, the drop in the reactance may be represented by the line A D at right angles to the current A C, and the line A E (which is the vectorial sum of the two voltages, A B and A D) represents the supply voltage.

At full load, if the supply current is a leading one, it will be represented by such a line as A C (Fig. 2), and the voltage across the reactance by the line A D (longer than A D in Fig. 1 in the ratio of full-load current : light-load current) at right angles to A C. The supply voltage required in order to obtain a terminal voltage, A B, will again be represented by the line A E, but this line will be

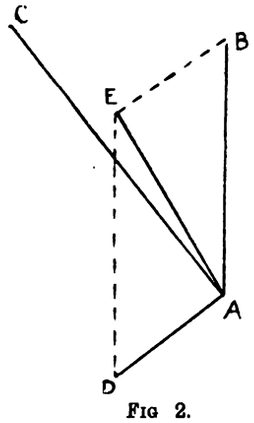

FIG 2.

seen to be shorter in Fig. 2 than in Fig. 1—*i.e.*, a smaller supply voltage is required at full load than at light load for the same terminal voltage, A B, or, in other words, with a constant supply voltage the terminal voltage will be higher at full load than at light load.

There is, however, an objection to this method of voltage regulation, in the fact that the power factor is unity only at one particular load (usually about half load), whilst at full load it may fall to ·9 or less with a leading current, and at light load to ·8 or less with a lagging current. This causes a greater line loss, greater heating in the rotary converter itself through $C^2 R$ loss, and unsteadiness in the running of other apparatus working off the same A.C. supply, through the wide changes of the power factor of the circuit.

Further, in order to get any considerable compounding effect the converter field strength has to be varied over a wide range between no load and full load by means of the compound winding, and this may in some cases give trouble through sparking and through instability of field.—Q.

Answer to No. 712 (*awarded* 5*s.*).—In the first place, it may be remarked that reactance is not an absolute necessity for the operation of rotary converters. In fact, in one London installation known to the writer the trouble experienced in running the rotaries was diminished when the reactance coils specially provided by the manufacturers were cut out. In some cases, however, these coils are used with advantage, and for the two following reasons:

1. The voltage on the D.C. side is made to rise with the load if the A.C. flows through a reactance, and *if it is leading* the applied E.M.F. This is shown in the accompanying vector (Fig. 1). O E is the voltage from the line, and O C represents the leading current. Then O E corresponds to the reactance voltage caused by this current, and this added vectorially to the back E.M.F. of A.C. side of rotary must equal O E (ohmic resistance being neglected). There-

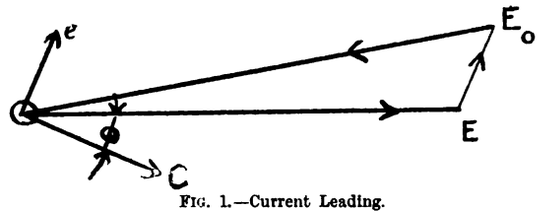

FIG. 1.—Current Leading.

fore, having regard to direction of arrows, we have O E_o as the voltage to be generated by rotary. This larger voltage is also generated on the D.C. side, for the ratio $\frac{\text{A.C. voltage}}{\text{D.C. voltage}}$ is a number depending only on the number of phases, and therefore constant for any one machine. So that when a leading current flows, the D.C. voltage is higher than at no load.

2. The second reason why reactance is put in series with the rotary is to minimise hunting by damping the surging currents, which flow only when the rotary hunts. The surging currents are of two kinds—viz: (*a*) those due to the swing of the machine about the position of absolute synchronism; and (*b*) those due to the different machines taking more or less current from the mains, because during the hunting they take more or less of the D.C. load.

For (*a*) the reactance coils are not of much use, as the period of the fluctuations of the current is large compared with the period of supply, it being of the order of seconds rather than of the order of hundredths of a second. For (*b*) the reactance coils are only of advantage when the current taken from the machine is lagging, for, taking the

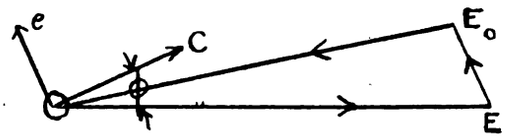

FIG. 2.—Current Lagging.

case of that rotary which at any instant is taking most current, the drop across the reactance will cause the required back voltage of rotary to be smaller (Fig. 2), and therefore the D.C. voltage will be smaller, and the machine will therefore take less load. If, on the other hand, the current supplied is leading, as we have already seen, the rotary taking most current will have the highest D.C. voltage, and will thus take more of the load, require more current from A.C. side, and so tend to increase the hunting.

The conclusion is, therefore, that if rotaries are inclined to hunt *among themselves*, the reactance coils are only of use if the current supplied is made *to lag*, and in this case they are not useful for self-regulation. If, on the other hand, the rotaries run well together, the coils may be used for regulating purposes by causing the current *to lead*.—Z. Y. X.

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SEPTEMBER 9, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

722. Describe the best methods of plating carbon brushes with copper or nickel, having regard to the fact that carbon is porous and absorbs the electrolyte.—W. G.

723. The poles of a shunt-wound direct-current machine (bipolar) are found to be reversed after dealing with a heavy short, the current probably amounting to 350 amperes, the normal full load of the machine being 180 amperes. Can any reason be given for this?—C. W. S.

724. A three-phase high-pressure alternator has too large a pressure drop from no load to full load. What means are there of remedying this?—V.

ANSWERS.

Question No. 713.—Describe what you consider the best method of truing up large commutators, say from 5ft. diameter upwards.

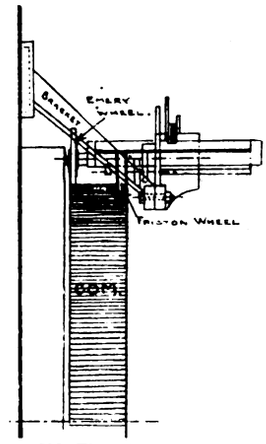
Best Answer to No. 713 (*awarded* 10*s.*).—Before attempting to "true up" a commutator by turning and grinding, it is as well to be sure that it really requires doing up. A well-built commutator, with the right kind of mica insulation, should not, if given proper attention, require truing up very often. Daily attention given to brushes and gear goes a long way towards keeping a commutator in good order without having to put a tool on it every few months.

There are several methods of truing up accumulators, two only of which need be considered here: (1) by ordinary tool held in a simple slide-rest; (2) by emery wheel mounted on a special slide-rest.

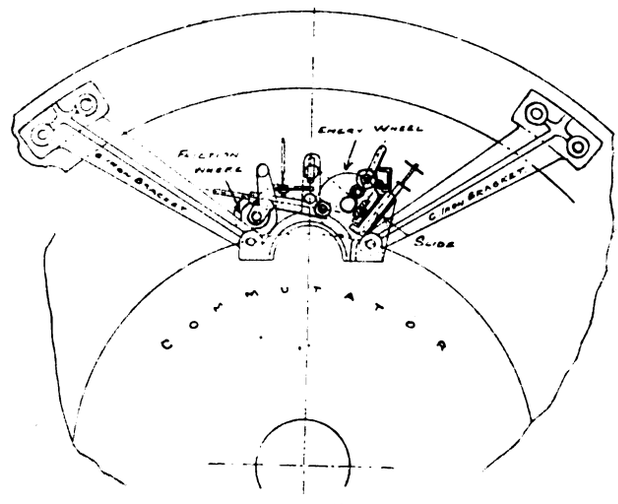
The first method possesses the advantage of being cheap in first cost, but against this it requires considerable skill in manipulating, as unless the operator has a good working knowledge of turning, he is pretty sure to make a mess of the job. Even after the finishing cut is taken it is necessary to run a file over the commutator, and here again a skilled operator is required, as the art of filing is not learned in five minutes. One often meets with men holding comfortable berths in large central stations who claim to have served their time in a good shop and know everything from the moulding shop right through to the test-house, yet when it becomes necessary—as it sometimes does—to tackle a small job at the vice, what a mess they make of it, and usually after a lot of tall talk to the fitter—"seems to be a bit skilled," "out of practice," etc.—the man in the blue slop eventually finishes the job. It is amusing to note the care the big-salaried one bestows on his highly coloured left thumb and the blister on his right palm for some days after his little attempt to air off his shop training. A small toolholder to take ½in. tool steel of V section is suitable for commutator work, as a breakage of the tool does not necessitate heating and drawing out, as is the case with an ordinary tool, grinding only being required. The correct cutting angle of tool for turning copper is 84deg., angle of relief = 7deg. Best speed for turning copper is from 90ft. to 120ft. per minute.

Method No. 2 is perhaps the best all round. Of late years the commutator grinding machine has found much favour with central-station engineers, many hundreds of these machines now being in use. There are two types of this machine, these being made in a variety of designs to suit different sizes of commutators: (1) driven direct from the commutator to be trued up; (2) driven from a separate source, usually a small motor.

Figs. 1 and 2 belong to type (1), and show two different methods of attachment on machines having commutators 4ft. to 8ft. diameter. This grinder—made by the Phillips Machine Syndicate, of Eastcheap, London, E.C.—can be fixed up in 15 minutes, and the commutator trued up in less than half the time ordinarily required, and in the most



Side Elevation.



Front Elevation.

FIG. 1

perfect manner. The grinding spindle is driven direct by means of a specially prepared rubber friction wheel running on the commutator, so that no motor is required to drive it. The spindle is carried in a strong slide and is absolutely rigid. The bearings are of great length, and the spindle and drum are evenly balanced, so as to run at the necessary high speed without causing vibration. The grinding spindle when working moves to and fro across the face of the commutator, and is automatically reversed at each end, and is so constructed that stops can be set as in a planing machine, grinding the surface right up to the connecting wires and back to the edge. The only thing required of the attendant is to watch the feed. The grinding wheel should, of course, run in the opposite direction to the commutator. In

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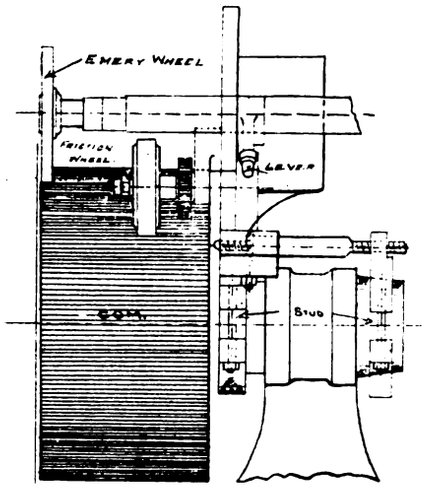
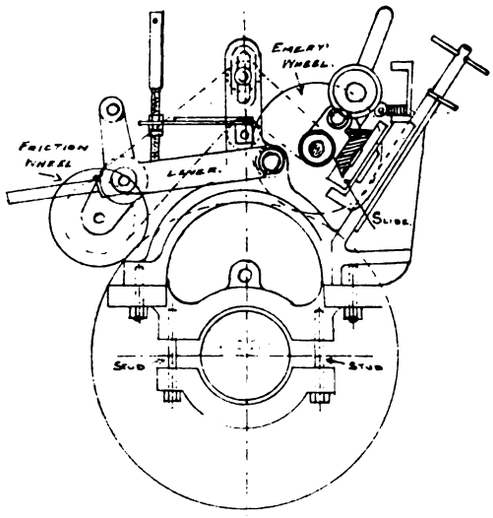
type (2) the machine is of somewhat simpler design, owing to the absence of the direct driving gear. The writer has used this machine on commutators up to 3ft. diameter with hand-controlled feed, but experienced a difficulty in getting a satisfactory belt drive. When truing up commutators, it is a good plan to fix a piece of stiff paper over the ends of



Side Elevation.



Front Elevation

FIG. 2.

the armature connections to prevent copper dust lodging between the windings.

A handy tool designed by the writer for cleaning commutators is shown in Fig. 3. It is made of well-seasoned deal, and built up in two pieces, the grain of the parts being at right angles to each other. It is best and cheapest in the long run to use emery or glass cloth, not paper.

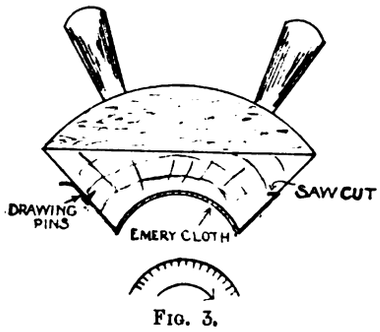
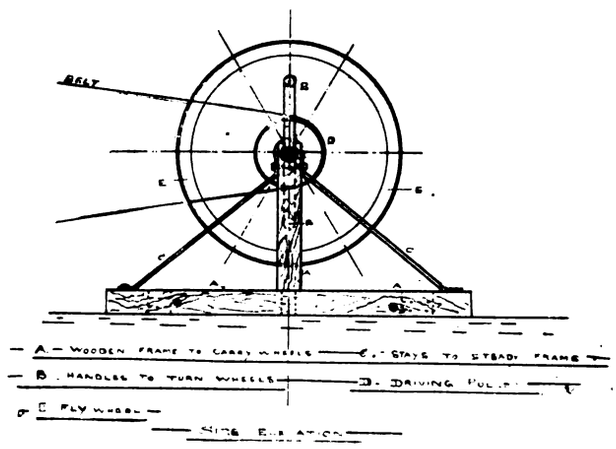
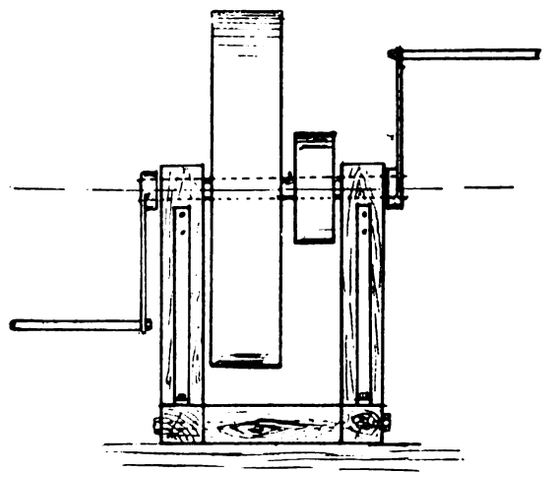


FIG. 3.

When using this tool, a little oil should be smeared along the front edge of the emery cloth, as this will prevent a lot of dust from rising and irritating the operator's eyes and nose. The correct way to use the tool is against the direction of rotation of the commutator, as indicated by the arrow. Where there are a number of commutators of different sizes it is, of course, necessary to have a separate block for each size. A commutator cleaner made by the Ediswan Company consists of a sheet of thin steel, which is curved to fit the commutator. By means of adjusting gear it can be adapted for use on different sizes of commutators. A sheet of emery or glass cloth is fixed to the under side of the cleaner, and suitable handles are provided for holding the tool to the face of the commutator.—S. L.

Answer to No. 713 (*awarded* 7*s.* 6*d*).—In truing up commutators two methods may be adopted—viz, grinding and turning—and as I consider turning makes the better job of it, I will speak chiefly upon that method. The first thing to be considered is the method of obtaining the necessary rotary motion of a proper speed, and it will be found that about 30ft. per minute is a good cutting speed, giving best results, but presuming that suitable driving gear is not to hand, then an improvised driving gear must be constructed. By referring to the accompanying sketches a method will be seen which has the advantage of being both inexpensive and efficient, and the writer has many times used the like for driving all kinds of machinery when





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other motive power was unavailable. The flywheel in this case was the wheel from a semi-portable engine, and the pulley a wooden one with wrought-iron plates screwed on to take the shaft and keys. The frame should be made of good hard wood, and well bolted together and stayed. Having now got the driving gear fixed up, disconnect the brush gear and rockers, field leads, etc.; get the compound slide rest of a lathe, and fix the same up upon suitable timber framing secured to the framework of dynamo at such a height that the point of the tool is just a trifle *above* the centre of commutator, and wedged firmly so as to prevent vibration or chatter whilst the tool is cutting. Take fine cuts, and do not use oil or emery. The tool should be a simple diamond point, with the "point" slightly rounded and free from lip or cutting edge, as copper is queer stuff to work, and if there is much lip on the tool it will "dig in," and the last state of the commutator will be worse than the first. For the finishing cut the point of the tool may be slightly more rounded, and with care no trouble need be found

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in making a first-class job. If it is desired to grind the commutator, an emery wheel may be fitted to the machine, with a friction pulley running on the periphery of the commutator, which gives the necessary rotary motion to the grinding wheel, or there are plenty of grinders on the market specially made for the job; but, as I said before, I consider the turning makes the better job, does not make such a mess, and there is not the danger of the copper dust getting into the armature nor the emery dust into the bearings.—BARON.

Answer to No. 713 (*awarded* 5*s.*).—There are generally two methods of truing up commutators: (1) by using a slide lathe rest, or (2) by using one of the emery grinders designed for such purposes. I have had to do with several grinders, but one that I am very familiar with is the Phillips Lightning grinder. It is designed to fit in the position taken up by the brush rocker on small machines, but for machines your size it is made to fit on the bolts that secure the pedestal on shaft bearing by means of a stand provided with grinder. When you have got your machine fixed you bring the rubber-faced wheel to bear on commutator, which drives the emery wheel by means of leather belt in the opposite way to which dynamo is running, and if used with a fair amount of judgment, and the instructions observed that are sent with the machine, you will find no difficulty making a first-class job of your *com.* The action of feeding your emery wheel along face of com. is entirely automatic or can be worked by hand. This grinding method is much more practicable than using the slide-rest and the ordinary V tools used for the purpose. After grinding use a sheet of emery cloth, preferably No. 0, and you have a com. in good condition without filing it, as is necessary after turning. Be sure to blow your machine out after job is finished.—S. H. LEE.

Answer to No. 713 (*awarded* 5*s.*).—The *best* method will depend considerably upon circumstances. If it is possible to rig up a slide-rest and run the machine at a slow speed, there is no more satisfactory method than turning up the commutator in position. The tool should be pointed, have little or no rake, and be placed slightly below the centre. By using a pointed tool there will be less chance of jarring; if the commutator is made true, it can easily be polished. Moreover, with such a shaped tool there will be less danger of small pieces of abraided metal short-circuiting the sections. Given a tool with little rake, and slightly below the centre, the liability to "run in" will be at a minimum. A smooth file will quickly give a good surface to the commutator. A small emery wheel, driven in opposite sense to that of the direction of rotation of the commutator, capable of being moved backwards and forwards across the face, makes a good job. If, however, there is much metal to be removed, it is a slow process. In any case before truing up, look round for any loose or badly worn sections; also any sections that may have risen above their normal positions. By slacking back rings, any such cases may be rectified, and if necessary, new sections inserted in place of any that are in a very bad condition. When there are only one or two "high" places, a few minutes with a rough file will save a considerable time in turning. With the dynamo as now made, commutators do not require to be turned up so often as was the common practice some fifteen or twenty years ago. Taking a case where neither slide-rest nor emery wheel is available, a good workman can still make a fair job of a bad commutator. First see that rings are tight and the sections in position. Rotate, and mark "high" places by means of piece of chalk held in the hand. These high places are now to be filed down with a rough file; mark again and so on. When got fairly true fill up whilst running. A pair of half-round polishing sticks and some emery cloth will soon make the commutator very presentable. The suggestion of emery cloth is quite contrary to the advice given in nearly all text-books; the general dictum of most writers on the subject is to use glass-paper. The writer, however, speaking after considerable experience, has never found glass-paper of much use for the purpose, and has invariably used emery cloth. There is rarely time to use glass-paper; emery cloth acts quicker and more satisfactorily.—M. M.

Question No. 714.—Give, with sketch, what you consider the best method for testing car axles; also the remedy for crystallisation, which has been found to take place just at the boss of wheel. All axles have been found broken at the same point, just inside the hub.

Best Answer to No. 714 (*awarded* 10*s.*).—To test the value of iron or steel for car axles, and the effect of strains similar to those imposed in service, Mr. Wohler, chief engineer of the Prussian State Railways, constructed machines for the purpose, by which the bars were exposed to vibrating actions and repeated strains within adjustable limits. For straining a cylindrical bar in the manner similar to that in which an axle is acted upon by the load it carries, the machine shown in Fig. 1 was employed. The bar was placed in bearing and caused to revolve at one end (corresponding to the journal of the axle), is loaded by a spring at a considerable distance, "overneck" giving a constant downward pull, by which action the bar is bent down to a fixed distance, and in its rotation the action of the spring caused it to bend in all directions round the circumference, by which means alternating strains of compression and tension are produced.

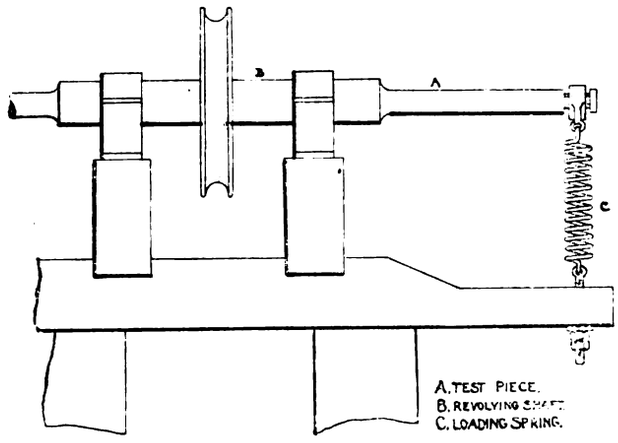

FIG. 1.

The following is extracted from a paper on "Steel Axles," read before the Western Railway Club, Chicago, in May last by Mr. J. L. Replogle, superintendent of the forge and axle department of the Cambria Steel Company: "We have seen broken axles around in various railroad shops, the examination of which leads us to the conclusion that failures were due to the fact that steel was too low in elasticity and tensile strength, steel of probably 30 or 35 per cent. carbon being used. The failures were due largely to what has been termed 'fatigue of metal,' and show a detail fracture, a gradual parting of the steel, extending toward the centre all round the piece, unquestionably caused by the imposed strains repeatedly approaching the low elastic strength of the soft steel. The substitution of a steel of higher carbon and elasticity would prevent failure of this kind." The observations of Dr. Chas. B. Dudley, the eminent chemist of the Pennsylvania Railroad Company, are interesting and pertinent to this subject, and we quote him: "It is obvious that the journal of a car axle gets alternating stresses—that is, the metal is subject to alternate tension and compression with each revolution, and that during the life of an axle these stresses are many thousand and perhaps million times repeated." The metal between the wheels is in like manner subjected at each revolution to the same alternating stresses. The effects of these repeated alternate bending stresses are almost too well known to need comment. A marked characteristic of the fractured surface of a piece of metal which has broken from this cause is that it never presents fibrous appearance in the fracture, but is more or less smooth, possibly due to the fractured parts rubbing against each other, and having the appearance of an old break. It commences where the maximum stress occurs on the surface of the section, and gradually works in from the surface until too small a part of the original area is left unbroken that a sudden shock or stress finishes the rupture. This breaking slowly, a little at a time, is called "detail fracture."

The experience of the Pennsylvania Railroad Company on car axles on this point may be interesting. Steel axles were first used on the railroad in 1875. The maximum

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calculated fibre stress between the wheels was about 15,000lb. per inch, and the maximum fibre stress in the journal was about 6,700lb. per square inch. The steel of these axles was an acid, open-hearth steel, containing from ·22 to ·28 per cent. carbon and not over ·04 per cent. phosphorus, and with a tensile strength of about 65,000lb. per square inch, and an elongation in 2in. of over 25 per cent. So tough was this steel that one passenger-car axle was tested under the drop test with 67 blows without rupture. (Note.—The drop-testing machine has always been favoured by railway companies for proving rails and car axles. The apparatus is simple, consisting merely of a large anvil on which are supports for the beam to be tested, a pair of upright guides, and a falling weight that can be raised to any height within them. The French railways use a "monkey" (falling weight) of 440lb., with a drop of 11ft. 6in., the supports being 3ft. 7¼in. apart, the anvil weighing 10 tons. Messrs. Cammell use a weight of one ton, a fall of 20ft. or 30ft., and a span of 3ft. Rigidity and inertia of anvil are of considerable importance, but the chief difficulty is to attain constant rigidity. The Pennsylvania Railroad place their anvil, weighing 17,500lb., upon 12 stiff helical springs, each having two coils of 8in. and 5in. diameter respectively; the outer one is $1\frac{3}{16}$in. steel and the inner of $\frac{13}{16}$in. steel, 9½in. long uncompressed and 5½in. compressed. These can support 80,000lb. and exert a constant resistance whatever the condition of the ground. The monkey weighs 1,640lb., its maximum fall being 43ft., and the span 3ft. (for axle testing). It is specified that the axles shall not deflect more than 5½in. with the first blow delivered from a height of 23½ft., and shall stand five blows before fracture.) Some 300 of the above axles were put in service, and in the course of two years the journals began to fail from detail fracture. The matter was serious, and a consultation was held how to meet the difficulty. There seemed two ways of procedure, either to increase the size or to change the nature of the metal. Since an increase in size meant a redesign of all the parts, the latter alternative was chosen, and a metal of 80,000lb. tensile strength was substituted for the softer steel, no other changes being made. This completely cured the difficulty, and no other case of detail fracture in car axles is known to have occurred since that time, unless the metal was of lower tensile strength than the figure given, or the axle was worn to limit, so that the maximum fibre stresses was too high. To obtain the best results, the carbon limits should be increased from ·35 and 50 per cent. to ·40 and ·55 per cent. This would ensure greater wear, permitting a higher polish with a consequent reduction of friction and, if properly treated, greater strength, but would necessitate a modification of the drop test. All axles should be thoroughly annealed, as by this method only the true strength of the steel is represented. The axle should be smooth forged between the wheel fits; rough turning between the wheel fits robs the axle of the tough surface skin, which is a valuable asset —H. E. H.

Answer to No. 714 (*awarded* 5*s.*). — The causes of broken car axles have, I believe, been discussed in these columns on one or two occasions. The probable causes have been said to be caused by electrolytic action due to dampness and the return current, weakness in construction, and crystallisation of the metal. In most cases, the axle appears to break at the keyway or the shoulders, and is undoubtedly caused by resilience due to the enormous strains and shocks which the axle is subjected to in passing over uneven rail joints, curves, and other irregularities in the track. The breakage may, therefore, be put down to weakness in construction. The testing of axles appears to the writer to be useless, as the strains brought upon them under the actual working conditions are practically unlimited, and may be many times in excess of the strain when testing. The question is, "Why should the axles break in the same place every time?" Because they are weak in the place where they are subjected to the greatest strain. The cause of breakage is obvious, therefore apply the remedy and put more material in the weak part. All shoulders and sharp corners should be avoided in axles, and from the above observations it would appear that an axle of even diameter over its full length would be much stronger; collars could be shrunk on to take the place of the shoulders at present turned out of the solid. I saw some experiments on new car axles some time ago, also the fractures that had taken place on some at the shoulders during actual working conditions. The experiments were made on similar new axles, and had fractures very nearly like the old ones. It was found that those axles which had been in stock for two years stood a better test than those a few days old, which seems to prove that crystallisation is not the cause of the fracture, but rather that the effect of age is to increase the strength of the axle. Crystallisation in axles seems to be fallacious. Probably the crystallisation spoken of at the boss of the wheel is actually corrosion caused by the accumulation of mud, which, as a rule, contains a quantity of mineral matter made up of acids, etc. The following has been found to check the trouble: dissolve 1oz. of camphor in 1lb. of melted lard; remove the scum that forms; mix as much blacklead with the lard and camphor as will give it an iron colour; clean the parts well, and smear with the mixture. This should be done frequently, cleaning the parts every time before applying the fresh mixture. Larger quantities can be made up in equal proportions.—J. W. W.

REVIEWS.

Die Prufung von Gleichstrommaschinen (The Testing of Direct-Current Machines). By C. KINZBRUNNER. Julius Springer, Berlin. Price 9 marks. 390 pp., 249 illustrations.

This book, though in German, is based on the author's course of instruction to students of the Manchester School of Technology, and is more especially intended for the use of students of the higher technical colleges, although the treatment has intentionally been made elementary enough to meet the requirements of test-room assistants and others engaged in the practical work of testing. A knowledge of the ordinary theory of direct-current machinery and a general acquaintance with methods of electrical measurement are, however, assumed. Chapter I. gives some useful general hints as to the systematic carrying out of tests, the arrangement of regulating, starting, and loading resistances, and the choice of instruments. Though stating that "the value of a test depends particularly on the right choice and treatment of the instruments," the author gives only a short and somewhat incomplete description of the various necessary instruments, and makes no attempt to explain how to check or calibrate them. Chapters II., III., IV., and V. deal respectively with the measurement of resistance, temperature, insulation, and speed, and in the remaining six chapters the various actual tests are considered in detail. These include the determination of open circuit and load characteristics, magnetic leakage coefficients, the shapes of field and potential curves, and the various losses and efficiencies.

In dealing with the latter, a somewhat undue prominence is given to the various mechanical and eddy-current brake methods, whilst the Hopkinson and allied methods are dismissed with a very cursory treatment. The author considers that the difference in the magnetic conditions of the two machines under test vitiates the assumption of equal efficiencies. Considering that these methods are employed, in England at least, far more often than any other for the determination of the efficiencies of medium sized and large machines, the opinion is hardly justified.

Towards the end of the book a reprint of the standard rating and testing rules of the Verband Deutscher Elektrotechniker is given, and these rules are referred to throughout the book. The index provided is meagre, but this is more or less compensated for by a detailed table of contents.

In spite of slight blemishes of this sort, the book should prove of great use to the test-room assistant (especially if it is followed by a similar book dealing with alternate-current work), as the methods of test and the practical difficulties to be met with are clearly and fully described, and the diagrams are simple and plentiful.

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Supplement to "The Electrical Engineer,"
SEPTEMBER 16, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

725. A double-cylinder, double-acting, high-speed steam-engine of 320 i.h.p. is found from consumption test to require 42·5lb. of steam per indicated horse-power hour. It exhausts against a pressure of 12lb. per square inch above atmosphere. Initial pressure of steam in the engine cylinders is 80lb. per square inch. The mechanical equivalent in foot-pounds of the heat liberated by the fall in pressure from 80lb. to 12lb. is not equal to more than half the 33,000 foot-pounds of work actually performed. As the heat units required must be from theoretical considerations more than the equivalent of 1 h.p., explain why the work performed is apparently in excess of the heat utilised.—E. G. B.

726. On Aug. 8 the North-Eastern Railway Company commenced an electric autocar service between Scarborough and Filey, and the other day I had the pleasure of a trip by it. The car generates its own current. A gas or petrol engine drives two dynamos, one for power the other for lighting. I didn't notice any accumulator. Can anyone furnish me with a full description of the above and discuss the advantages of converting the gas-engine power into electrical power.—FILEY.

727. State how to enter the navy as an electrician, the duties of same, and the prospects.—H. W. H.

ANSWERS.

Question No. 715.—Explain the principle underlying and give sketch showing the connections of starters for single and two phase alternate-current motors from 4 h.p. to 30 h.p. I do not refer to liquid starters, but to those made by the E.C.C., which have a two-way marked "start" and "load," and appear to be some sort of transformer device.

Answer to No. 715 (*awarded* 10*s.*).—It is well known that if you start an induction motor with a short-circuited rotor,

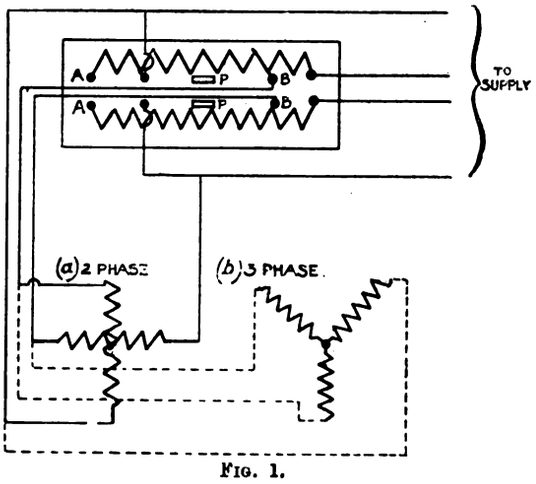

FIG. 1.

by switching it right on to the mains, a very large rush of current will take place in the stator, due to the heavy induced currents in the rotor. In order to check this rush, some sort of starting device is used, and placed between the stator and the mains, and is so arranged that it can be cut out of circuit when the rotor has run up to a good speed. The usual device used is the type of one mentioned by "Direct Current," though 30 h.p. is rather high for this type of starter, 20 h.p. being about the highest as a rule. The starter shown in Fig. 1 is an auto-transformer, which, when switched into circuit at starting up, chokes down the volts of supply, and, therefore, the rush of current through the stator winding. The amount of volts choked down is determined by the position of the tapping from the winding of the auto-transformer. The blades of the switch, which are pivoted at P, are thrown over to the left when starting, so put the coils from A to B in circuit and to the right when the motor has come up to a good speed, which cuts out the coils and connects right on to the mains; (*a*) shows connections for a two-phase stator; (*b*) shows connections for a three-phase star-connected stator.

There is another way, and one which is used for starting up rotors of larger horse-power, say anything from 20 h.p. upwards. This way is connecting resistance in the rotor circuit and connecting the stator right on to the mains. Leads from the rotor windings are brought through the shaft and fixed to slip-rings on the end; these in turn are connected by brushes to the resistances; these resistances are cut out step by step, thereby gradually short-circuiting the rotor. With this type of starter you get a much higher starting torque, on account of the increased slip due to the high resistance of the rotor circuit. Fig. 2 shows connections for such a starter for a three-phase motor with a three-phase wound rotor. The following is a simple way of finding the correct amount for such a starting resistance. Suppose the rotor to have a three-phase star winding, as in Fig. 2. Let r = the resistance per phase of

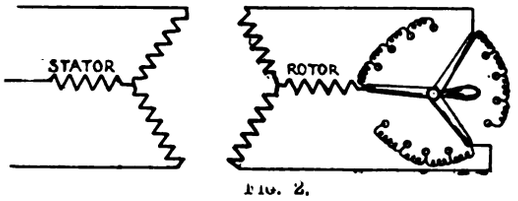

FIG. 2.

rotor winding; x = the resistance per phase of required starting resistance; c = full-load current per phase in rotor, which can be found from a Heyland diagram. Suppose the maximum starting current is not to exceed the full-load value—*i.e.*, stator current at starting = the stator current corresponding to c rotor current.

$\sim_1$ = periodicity of supply in periods per second.

$$\sim_2 = \frac{\text{R.P.M. at full load speed} \times \text{No. of poles}}{120}$$

$\sim_1 - \sim_2$ = slip in periods per second.

Then the volts induced in the rotor windings at starting must = $C(r+x)$ ohmic lost volts + $f \times c \times \sim_1$ inductive back volts (f being some constant). At normal full load speed the periodicity of the rotor currents = $\sim_1 - \sim_2$, and as the rotor is short-circuited, the ohmic loss and the inductive reaction will now be Cr and $f\,c(\sim_1 - \sim_2)$, and since the ratio of the reactive volts to the resistance volts remains practically constant we may say

$$\frac{f\,c \sim_1}{C\,(r+x)} = \frac{f\,c\,(\sim_2)}{Cr}, \text{ or } x = r\left(\frac{\sim_1}{\sim_1 - \sim_2} - 1\right).$$

With about 5 per cent. slip this gives $x = 20\,r$, and in practice $x = 30$ or $40\,r$, so as to reduce the starting current (and torque) below the full-load values. If the value of x given

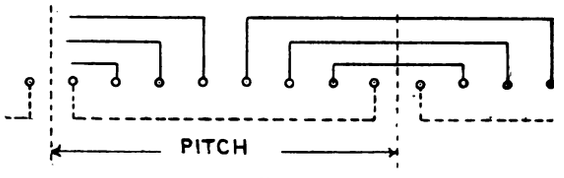

FIG. 3

by the formula is used, the starting torque will be equal to the full-load running, and this is unnecessarily large for most cases. In dealing with polyphase motors, it is only a matter of how best to control the starting of them, but with single-phase motors it resolves itself into how to make them start, for a motor with only a single winding on its stator has no tendency to start from rest, though if you give it a slight rotary motion it will then run up to speed.

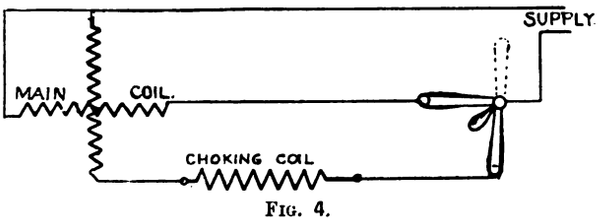

FIG. 4.

The difficulty is got over in practice by putting a special starting winding on the stator, which is cut out after the motor has come up to speed. With such an additional winding the motor can be started up as a two-phase motor, the main winding being connected direct to the supply mains, and the starting winding having a lagging or leading current supplied to it, it is sometimes wound in the same slots as the main winding and sometimes in intermediate ones, as shown in Fig. 3.

Fig. 4 shows the connections for a single-phase motor

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starter. When the motor has got up a good speed the two-way switch is put into position marked by dotted lines, thereby cutting out the starting winding. The rotor, which would be a short-circuited one, is not shown. Messrs. Brown, Boveri, and Co. use a condenser instead of a choking coil, and so create a leading current in the starting winding.—POWER FACTOR.

Answer to No. 715 (*awarded* 7*s.* 6*d.*).—The Electrical Construction Company make induction motors up to fairly high powers with simple squirrel-cage rotors, and for starting up these machines have adopted the method—much favoured by the Americans—of the "auto-transformer."

FIG. 1.

An auto-transformer is really a choking coil made with a closed iron circuit as with the ordinary transformer, but also with tappings off from various points in the winding, so that a lower voltage is available. The action of the auto-transformer under load is clearly seen by reference to the accompanying Fig. 1. There is a voltage drop all along the windings from A, and the voltage to any point C is proportional to the number of turns between A and C. If now A and C are connected together through a resistance, current will flow through this resistance; and this current will be made up partly of current flowing in from B to C and partly of current flowing from A to C produced by the transformer action of the coils B C on the coils A C.

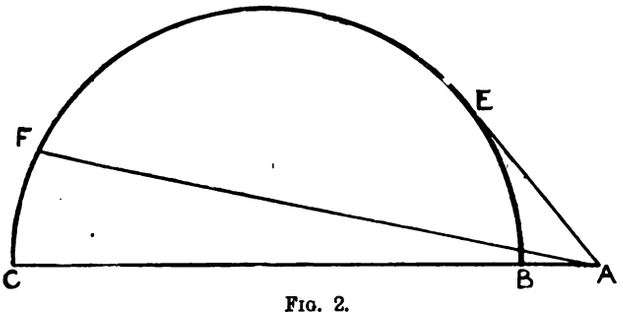

FIG. 2.

The actual values of these currents will be such that their arithmetical sum is the currents which flows through the resistance, and also the ampere-turns between A and C will be equal and opposite to the ampere-turns between C and B As an example, suppose volts across A B be 200, and volts across A C be 72. Then, if the current flowing through the resistance be 79, the currents in the sections A C and C B will be

$$79 \times \frac{72}{200} = 28{\cdot}5, \text{ and } 79 \times \frac{128}{200} = 50{\cdot}5.$$

We have discussed the action of the auto-transformer, and will now consider the behaviour of the motor under a

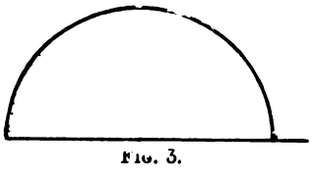

FIG. 3.

lowered voltage. Fig. 2 represents the circle diagram of an induction motor at full voltage. A B is the magnetising current necessary for this voltage, and as the iron parts of the motor are not all saturated, the magnetising current for other voltages will be proportional. For the same reason, the leakage at any lower voltage will be the same, and so the diagram of motor at half the voltage will be as shown in Fig. 3. In this, for similar points on the semi-circle, the currents are decreased by half, but it must be borne in mind that the torque, which is proportional to (load current × magnetising current), is proportional to square of voltage, and in this case is reduced to one quarter. The current which flows when the voltage is first applied to a squirrel-cage motor is known as the short-circuit current (A F), and the problem is to so reduce the voltage applied to motor at start that the line corresponding to A F in new diagram is a given number of times full load normal current (generally between 1·5 to 2 times). (The short-circuit current is best obtained by experiment at a lower voltage than motor is built for, and then increasing in proportion.)

We will take a concrete case of a 20-h p. two-phase motor, working on a 200-volt circuit at 50 ~, and taking 45 amperes per phase at full load. When tested for short-circuit on 55 volts the current was 60·5 amperes. It is stipulated that 1¾ full-load current is allowed at starting.

Short-circuit current at full voltage will be

$$\frac{60{\cdot}5 \times 200}{55} = 220 \text{ amperes.}$$

∴ Reduction of voltage for starting will be

$$\frac{1{\cdot}75 \times 45}{220} = \frac{1}{2{\cdot}8} \text{—}i.e.\text{, to 72 volts.}$$

The currents in the coils have already been worked out for this case, and they are: 50·5 amperes in the coil giving 72 volts, and 28·5 amperes in the coil giving 128 volts.

As the auto-transformer will only be used for starting, the flux and current densities must be made much greater than is usually the case. The accompanying sketch indicates a suitable design for this case, and it will be found that the flux density is somewhere about 60,000 lines per square inch, and the current densities are about 3,200 amperes per square inch. It will be noted that as the ampere-turns between A and C are equal and opposite to the ampere-turns between C and B, the two coils will both occupy about the same space, although, of course, they are wound with different sizes of wire. The arrangement of connections on the starting and running contacts is shown in Fig. 4.

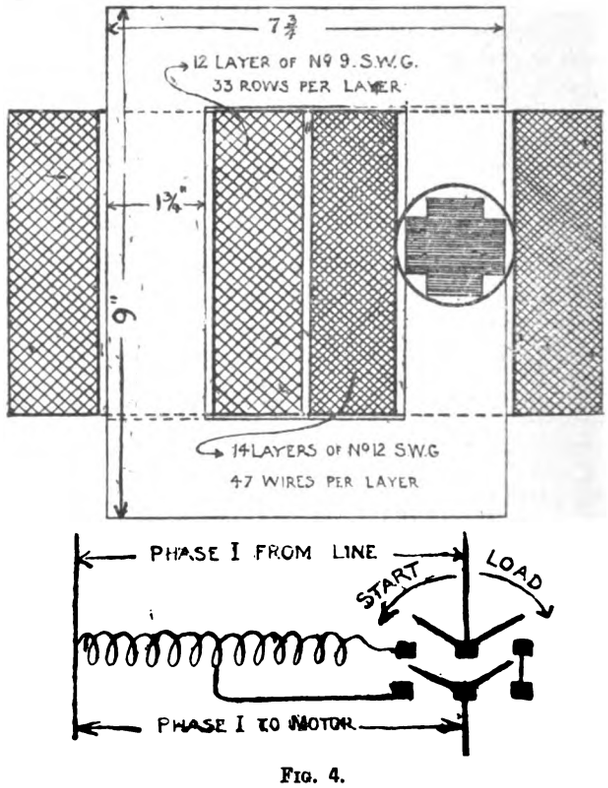

FIG. 4.

With regard to the starting of single-phase motors, other devices than those for cutting down the initial current are required, and, judging from the reference to liquid starters in the question, a description of these other devices is not required.—X. Y. Z.

Answer to No. 715 (*awarded* 7*s.* 6*d.*).—The principles underlying starters for single-phase and for two-phase motors are entirely different, and must be dealt with separately. In the case of a two-phase motor, nothing further in the way of a rotating switch is really required than a simple three-pole main switch (Fig. 1). Switching the motor direct on in this way, however, involves a considerable initial rush of current, owing to the rotor, when at rest, acting as the short-circuited secondary of a transformer, of which the stator winding is the primary. When

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only a low starting torque is required from the motor, this rush can be reduced by reducing the terminal volts whilst starting. This is usually accomplished by means of an auto-transformer and a special throw-over switch. An auto-transformer is simply an ordinary transformer with a single winding, the primary volts being connected across the whole of this winding, and one secondary connection being at one end of the same winding and the other secondary connection at some intermediate point along the winding, according to the ratio of transformation required. For small ratios of transformation this arrangement considerably reduces the size of the transformer, since a

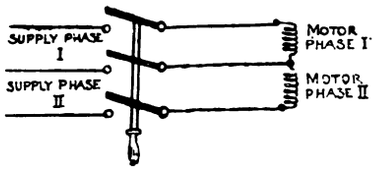

FIG. 1

part of the winding is common to both primary and secondary. When used for starting purposes, the ratio of transformation is usually made about 2 : 1—*i.e.*, the terminal volts at starting are reduced to half the normal supply voltage. The connections of such a two-phase starter are shown in Fig. 2. The switch would usually be of the throw-over chopper type, and is shown diagrammatically only. When the switch is moved upwards to the "starting" side, the arm, *a*, connects the free ends of the two auto-transformers to the middle wire, thus putting the transformers into circuit, and at the same time the three other arms connect half the transformer windings to

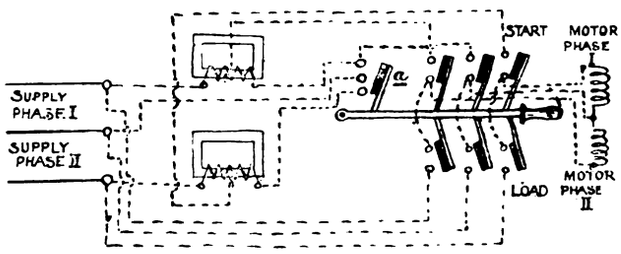

FIG. 2.

the two phases of the motor stator winding, thus starting the motor at half normal volts. As soon as the motor has obtained full speed the switch is moved over on to the "load" side, and this open circuits both the transformers at *a*, and so avoids all core losses, and at the same time the full supply voltage is switched on to the stator windings. The diagram is shown for a three-wire supply, but with very little modification is applicable to a four-wire supply, the switch remaining unaltered. The two separate single-phase transformers shown would usually be combined into a single three-limbed two-phase transformer. The switch given is equally adapted for starting three-phase motors.

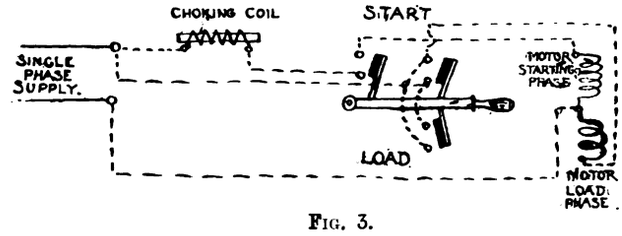

FIG. 3.

Turning next to the case of a single-phase motor, the principal object of the starter in this case is the production of the necessary phase displacement between the currents in the starting and load phases of the motor. Such a phase displacement is necessary in order to make a single-phase induction motor start at all, and it is very usually obtained by inserting a certain amount of inductance in the form of a choking coil into the starting phase winding. The arrangement for this is shown in Fig. 3. When on the "starting" side, the switch puts the load winding of the stator direct on to the supply mains, and the starting phase on to the mains through the choking coil. When the switch is moved over on to the "load" side, the starting phase winding is entirely cut out, but the load winding is still left connected across the mains.

Many other methods of obtaining the phase displacement have been employed, such as the use of a condenser in place of a choking coil, or simply inserting a non-inductive resistance in circuit with the load winding and connecting the starting winding direct across the mains, and so on, but the above arrangement with a choking coil is the one most commonly met with.—Q.

Answer to No. 715 (*awarded* 5*s.*).—"Direct Current" must have evidently made a mistake when he mentioned two-phase motors, as these do not require any special start-

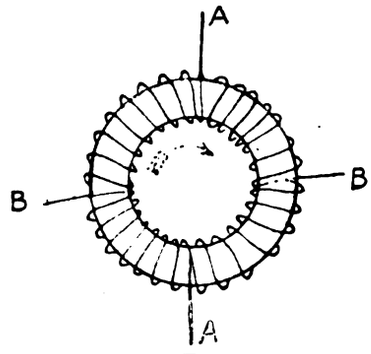

FIG. 1.

ing arrangement such as he mentions, so we will deal with the single-phase motor. If two equal alternating currents, differing in phase by a quarter of a period, are properly combined, they can be made to produce a rotary magnetic field, and in such a rotary field conductors can be set rotating. Consider Fig. 1. If a single alternating current were introduced at the points A A_1 it would set up an oscillatory magnetic field, a N pole growing at A and a S pole at A_1, then dying away and reversing in direction. Similarly, if another alternate current were introduced at B B_1 it would produce another oscillatory field in the B B_1 diameter. If both these currents were set to work, but timed so that the B B_1 current is one quarter period behind the A A_1 current, then they will combine to produce a rotary magnetic field, though the coil itself stands still. This is quite analogous to the well-known way in which a

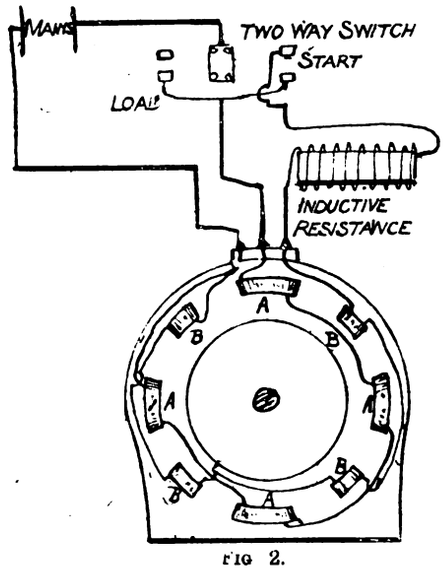

FIG 2.

rotary motion can be produced from two oscillatory motions by using two cranks at right angles to one another, the impulses being given a quarter period one after the other. In such rotating magnetic fields masses of metal at once begin to rotate. Any pivoted mass of good conducting metal, such as copper, will also be set in motion and will be self-starting. In such a centred mass or rotor eddy currents are set up which drag the metal mass and tend to turn it, but if only one phase was in action—say, the A A_1 part—the field would only oscillate and not rotate; and any currents generated in the rotor will be equal and opposite in direction, and, therefore, there will be no tendency to move. We can come back to our old

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analogy of the single-crank engine, which when on a dead centre will not start, but when set running at a speed high enough to carry it past the dead centre, will continue to run.

From the above it will be seen that it is necessary to get the single-phase motor running before applying load, and also a method is given of getting it running. The method is of splitting or diphasing the current in the stator, and thus getting a rotating field. In any book on alternating current it is shown that if an alternating current is passed through a circuit containing self-induction, the current will lag behind or differ in phase with the E.M.F., or if the circuit possesses capacity, the current will lead or differ in phase with the E.M.F. With the foregoing, Figs. 2 and 3 will now be understood. A is the running winding, B is the auxiliary starting winding, in the circuit of which is a self-induction and capacity respectively. Winding A possesses as little self-induction as is possible, so that the current will be practically in phase with the E.M.F., whereas winding B has either a self-induction or capacity which will cause a phase displacement, and therefore it will start up as a two-phase motor. Of course the phase displacement is not 90deg., but it is sufficient to produce a rotating field. Some makers modify the above by putting a capacity in the running winding circuit, besides a self-induction in the starting winding. All motors of this type

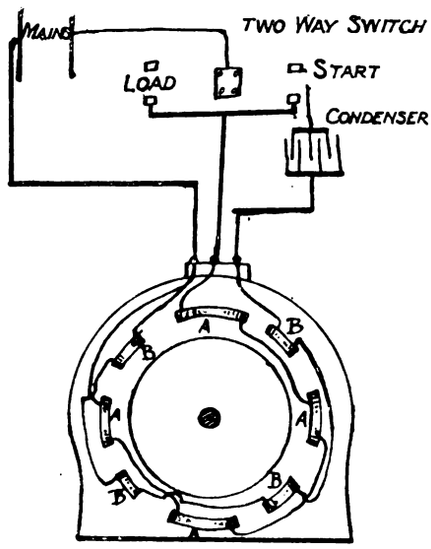

FIG. 3.

above 5 h.p. should have a starting resistance in the rotor circuit, but as this is off the point we will leave it, but if "Direct Current" wishes to go further I would recommend Hay's "Alternate-Current Working," published by Biggs and Co. at 5s.—A. W.

Answer to No. 715 (*awarded* 5*s.*).—In order to start a single-phase induction motor it is necessary to produce a rotary magnetic field, so that while starting the motor has to be fed with two separate currents lagging in phase. If a two-phase motor is running light, and one phase is suddenly switched off, the motor still continues to run at nearly the same speed, but the phase that is still being fed will now draw double the current. The reason of this is that, if a two-phase rotary field has been started, induced currents are set up in the rotor conductors which set up a magnetic flux in the air-gap. When one phase is switched out, the remaining phase still goes on producing a magnetic flux; and since the induced magnetising currents in the rotor are in quadrature with the flux produced by the supply current, and are carried forward nearly 90deg. by the practically synchronous rotation of the rotor before they reach their maximum values, it will be clear that the flux produced by the switched-out phase is now practically replaced, and so the motor continues to run with the single phase only. Single-phase motors that are started in this manner must obviously have two windings, one of which is used for starting only, while the other is permanently connected across the mains while running. Fig. 1 shows these two windings, A A and B B. Suppose A A to be the running coils, and B B the starting; then, to produce a rotary magnetic field, it will be necessary for the current in the B B coils to lag by 90deg. In order to cause this lag, or something as near to it as possible, a phase-splitter is introduced into the circuit, which usually consists of a choking coil or condenser in series with one branch, and a non-inductive resistance in series with the other. It will be seen that when the starting switch is on the contacts marked 1, we have a choking coil in series with the A A windings, and a non-inductive resistance in series with B B. When the motor comes up to speed, the switch is then thrown on to the contact 2, which cuts out both the choking coil and non-inductive resistance, and connects the A A winding straight across the mains, leaving the B B winding idle.

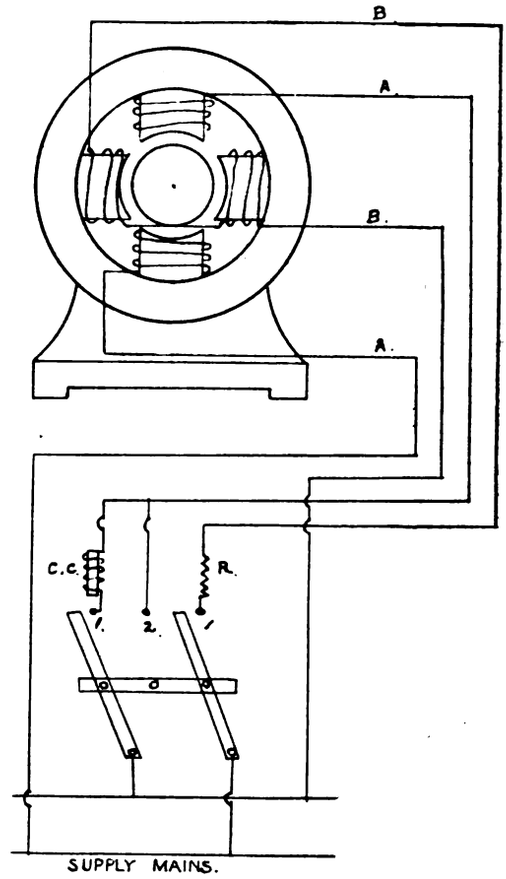

FIG. 1.

In dealing with starters for polyphase motors, matters become far less complicated, for since we already have a rotary field, phase-splitting devices can, of course, be dispensed with. There are two methods of starting these motors, one of which simply consists of reducing the pressure at the terminals, in the same way that a direct-current motor is started, but in this case the reduced pressure is brought about by a small transformer. On starting, the primary of the transformer is switched on to the mains, while the motor is already connected to the secondary. When the motor has gained speed, the switch is then thrown over on to a second set of contacts, which cuts the transformer out of circuit and joins the motor straight across the mains. This method is only used where a large starting torque is not necessary. In cases where a heavy starting torque is required a resistance is placed in series with the rotor windings and gradually cut out on starting. If we consider the induction motor as a transformer, it is a very simple matter to see how this arrangement prevents the motor drawing abnormal currents. Consider the stator windings as the primary, and the rotor the secondary. Now, in the ordinary way, the rotor windings are short-circuited; therefore, if the stator be switched on to the mains, we get the same result as if we switch in a transformer whose secondary is short-circuited—that is, it draws a very heavy current—but if the ends of the stator be first joined with a fairly high resistance and then gradually cut out, this heavy starting current will be obviously avoided. There is one rather bad point about this method which rather spoils the good properties of the induction motor—that is, it necessitates the use of slip-rings.—E. AUSTIN.

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SEPTEMBER 23, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

728. A house wiring specification calls for all casing under floors to be "half mitred and screwed." Give particulars, with sketches, of requirements, mentioning any other method ensuring a firm and workmanlike job.—J. E. H.

729. Much trouble has been experienced with various hand-wound armatures, on which wire of 18 S.W.G. and smaller has been employed, owing to breaking of end connections while running. The breaks always occur within ½in. of the end of the core and in the *straight* wires. Please explain the cause of the trouble and suggest remedies.—A. B. D.

ANSWERS.

Question No. 716.—In inspecting Lancashire boilers, what are the chief places to watch for defects?

Best Answer to No. 716 (*awarded* 10*s.*).—As a preliminary survey, prior to one of a more exacting nature, the boiler might be carefully gone over, while under usual working conditions, with a full head of steam. This survey will betray to the inspector any weeping joints or rivets, cracks in brickwork affecting draught, or crevices between the boiler plates and setting, permitting the collection of water emanating from roof leakage or other sources. The quality of the feed water may then be ascertained, also some knowledge of the usage to which the boiler is subjected, and whether the safety valve operates at the critical pressure may be observed. Frequently cracks in the brickwork setting will be noticed when everything is heated, which would otherwise remain unseen after the boiler has cooled down and all materials contracted to normal dimensions. On shutting down, and due time having been allowed, after running the water off, to permit the plates having cooled sufficiently, an internal inspection should be made before cleaning operations are commenced; this opportunity should be taken to note the quantity and quality of the deposit or incrustation and its position in the boiler. Demand a thorough scraping of all the internal parts, that all scale and sediment be removed, particularly about the rivet-heads and end plates, and all seams below water-level. On the outside, dust and soot should be removed from the flues, and the boiler plates directly in contact with flame or hot gases be carefully cleaned. Have portions of the brickwork pulled down where the boiler plates are in junction with the setting; the feed-water valve and blow-off cock might be dismantled from their positions. The following places may then be systematically gone over.

Internally.—Along the water-line—this line being the position about which the water-level varies under working conditions—the boiler plates should be lightly tapped with a small round-nosed hammer, each series of tappings being followed by the inspector's finger to learn, by the sense of touch, what impression is being made on the plates. If the impression is deep, the plates will be found to have thinned by repeated corrosive scaling or pitting. The sound produced by each hammer-blow will act as an additional guide to the condition of the plates, the average ear very readily detecting a dull from a sharp bell-like ring. The furnace tube crowns may next be gone over in a similar manner with light blows of the hammer. Any thinning of the metal, hogging of the flues, or signs of collapse will be instantly noted. Should there be fusible plugs in the furnace crown, their removal and a renewal of the fusible alloy is recommended before being replaced. Attention may in turn be paid to the thoroughfares of all gauges and cocks, a thick wire being used to clear out passages of the former. This part of the examination must be conscientiously performed, the serious results ensuing from choked gauge apertures being obvious. Probably there will be some internal mechanism known as a high and low water alarm. This, if worked by hand several times, will bring to notice any mechanical defects and remove any stiffness in its operation. The boiler seams below water-level are of vital importance, and time is not lost in examining these. To illustrate the nature of faults to be met with in the vicinity of boiler seams, the accompanying sketches may be useful. In

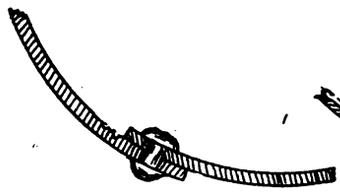

FIG. 1.

FIG. 2.

Fig. 1 the corrosive grooving has been started by the alteration of the boiler's shape during expansion, being localised at this seam. In Fig. 2 excessive scaling, due to corrosion, has caused the plates to thin dangerously and utterly destroyed the rivet head; and in Fig. 3 pitting and grooving in the vicinity of the working water-level. By sharp blows of the hammer on the longitudinal tiebars defects or fractures would instantly be noted, and by tapping the internal nuts their tightness would be assured. On the surface of the bottom plates, where most sediment would collect, the hammer should again be applied throughout the entire length of the boiler to detect any signs of deterioration.

External Examination.—There is little doubt but that many boiler failures can be attributed to exterior corrosive action, hence the need for carefully surveying the following places. Immediately in the vicinity of the manhole or mudhole doors and all flanges fitted to the boiler plates a careful scrutiny is necessary. A tiny leak at a joint, allowing a jet of stream to escape, given sufficient time,

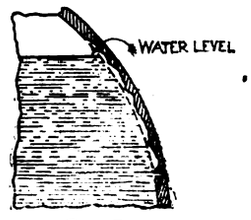

FIG. 3.

will cause serious pitting to result; the escaping steam, having been condensed on coming into contact with the atmosphere, falls as drops of water, which simmer on the heated plates. Particular attention should be paid to the joint between the boiler plate and flange of the feed-water valve, as, due to the expansion and contraction in the vicinity of the metals, leaks are likely to occur. At the commencement of this reply it should have been stated that any non-conducting composition on the boiler crown is presumably so applied as to permit ready accessibility to the plates for inspection. The removal of this covering should be rigidly insisted on, for it serves in many instances to hide a multitude of sins. On the boiler crown leaks from steam-pipe joints should be looked for, also the possibility of influx of rain-water through openings in the roof likely to fall about the boiler or brick setting. It would be well while the inspector is at this position to have the safety valve and stop-valve opened up, and, if necessary, the valves ground on their seats; this is applicable to all cocks

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or valves about the boiler fittings. The blow-off cock might come in for special notice, as boilers have been known to empty due to defective blow-off cocks. The pipe bend connecting this cock to the boiler bottom ought to be given ample space to expand, and not be built rigid in brickwork, as it often is, or held fast with damp ashes Entering the furnace tubes, the hammer might be brought into requisition and applied as at other parts, a sharp look-out being kept for blistering of the plate surfaces due to overheating. In the neighbourhood of the end plates, where the furnace tubes are attached, special attention may be directed, as it is here the flame and hot gases curve round on their way to the brick flue underneath. Following this latter flue, the same manner of investigation is continued, combined with an observation of the seating blocks, on which the boiler rests, to determine if the weight is evenly distributed thereon. Continuing along, in turn, each of the side flues, the general examination of the exposed boiler plates is made, and where the brickwork has been pulled down a rather more careful inspection is necessary to learn if corrosion of the plates has taken place, caused by their being in contact with damp brickwork or water leakage from other sources. If the flues are discovered to be damp, the inspection should enquire into the reason. The damper door should not be passed over. Its condition will be noted, and whether it is likely to be efficient in regulating draught Signs of the brick arches in the flues giving way are to be carefully looked for, as a complete shut-down of the boiler would result if either of the arches collapsed. With many firemen it is customary to pull out ashes from the furnace and slack them whilst lying against the front end plate; severe corrosion results from such practice; the inspector would do well to examine the lower part of this end plate, and if deterioration of the plate is noticed the cause is that just mentioned, therefore instructions to slack ashes at some distance from the boiler should be given. In the event of any doubt existing regarding the thickness of any plate, showing signs of severe pitting or scaling, a small test hole might be drilled through the plate, and on the dimension being taken a screwed taper plug is introduced to fill the hole. Having completed the survey, if considered advisable, a pressure test can be applied; the boiler being filled with water at a temperature of from 180deg. to 208deg. F., and the pressure raised to 50 per cent. above that of working, after the plates have absorbed sufficient heat from the water to permit of uniform expansion. While the pressure test is being applied, it is expedient that a standard hydraulic pressure gauge be used in conjunction with the gauge belonging to the boiler, thus ensuring a reliable indication of the pressure, and also acting as a test of the latter gauge for its accuracy.

Summarising briefly the places to be examined herein mentioned, they are:

Internal.—(1) All plates along the water-line or working level, including end plates; (2) the furnace tube crowns; (3) fusible plugs on furnace crowns; (4) apertures to all cocks, gauges, and valves to be thoroughly cleared; (5) high and low water alarm (if any); (6) longitudinal tiebars, including fastening nuts at the end plates; (7) all boiler seams below water-level; (8) surface of bottom plates, where sediment is most likely to collect.

External.—(1) The immediate vicinity of all manhole or mudhole doors and flanges fitted to the boiler plates; (2) possible leakage from boiler-house roof or steam-pipe joints; (3) all exposed plate surfaces in flues affected directly by flame or hot gases; (4) the furnace tubes; (5) seating blocks for even distribution of the boiler's weight thereon; (6) where brickwork setting is in contact with the boiler plates, and where such has been removed; (7) dampness in flues; (8) safety valve and stop valve, blow-off cock particularly, and other fittings; (9) damper door and brickwork arches in flues; (10) pressure gauge to be tested under conditions stated.—WALLSEND-ON-TYNE.

Answer to No. 716 (*awarded* 7*s.* 6*d.*).—The inspection of a Lancashire boiler, to be complete, must comprise—as one of the leading boiler insurance companies directs—an external, an internal, and a flue examination. The first deals with the external condition of the shell and furnace crown, and with the fittings, and should be made both when the boiler is under pressure and at rest. The second deals with the surfaces of plates, etc., usually in contact with steam and water, and also with the internal fittings. The last deals with the surfaces of plates, etc., usually exposed to the action of the flames or gases, and also with the brickwork flues.

The preparation of a boiler for inspection is a matter of considerable moment, and the following points should be noted: (1) the flues should be cleaned, and all soot, etc., brushed off the plates and rivets—if the boiler is set on mid-feather and wide seating walls, pockets should be cut so as to expose for inspection the rivets in the ring seams; (2) the inside of the boiler should be cleaned, and all scale, etc., removed; (3) the firebars and bridges should be removed, and all manholes, etc., opened for access to boiler and flues. The above are the general instructions for inspection and the preparation therefor; the inspector, while carefully examining the whole of the boiler, will give most attention to certain portions which are usually found to develop defects.

In an installation of 12 Lancashire boilers working under somewhat trying conditions it has been noticed that defects have developed in similar places in each boiler. The boilers have been working some 10 years, and are worked at a pressure of 130lb. They are fed with condensed water from the engines, and until some two years ago have shown more than traces of oil. They are fitted with mechanical stokers, and have been, at times, forced much beyond their normal capacity. As stated above, defects have been found to develop almost invariably in similar places in each boiler; these places are enumerated below, and may be thus classified as found in the inspections:

External and Flue Examination.—(1) In the shell: (*a*) ring seams, leakage and local wasting round the rivets especially in the flues; (*b*) front shell angle-iron, leakage in the lower part and consequent local wasting round the rivets. (2) In the furnace and flue tubes: (*a*) distortion and bulging of furnaces, especially in the second and third rings; (*b*) flanged seams of the furnaces, leakage especially in the first three seams; (*c*) welds of the water-pipes, leakage. (3) In the flues, seatings, etc.: (*a*) seating blocks and mid-feather wall; (*b*) down-take cover blocks.

Internal Examination.—(1) In the shell pitting through corrosion should be watched for, especially in the lower part of the shells; grease should be also sought for. (2) In the furnace and flue tubes, as in (1), pitting here usually in the crown and grease should be watched for. (3) Stays should be examined.

The above are the chief places to examine for defects; the most important are the furnaces and shell, as set forth in the flue examination (1), (*a*) and (*b*), and (2), (*a*) and (*b*). The bulges or distortion of the furnaces must be most carefully measured, and templates should be kept and tried from time to time to note the progress of such distortions. The boiler mountings call for careful examination. Pressure gauges should be periodically tested, safety valves, alarms, water and blow-off valves and gauges regularly overhauled.—S. E. T.

Answer to No. 716 (*awarded* 7*s.* 6*d*).—From the moment a boiler is finished it gradually becomes weaker, due to the destroying forces that are continually acting upon it. These forces are of both chemical and mechanical nature, and keep up their action with an ever-increasing rapidity. Corrosion, which takes place both internally and externally, is the most serious and subtle cause of weakening to which a boiler is subjected. Internal corrosion is generally in the form of wasting, of pitting, and of grooving. This *wasting away* of the plates is seldom so uniform in its effects as rusting, but it usually covers large patches of surface. It is produced by some chemical action of the water on the plates, and is more or less easy of detection. Sometimes it produces "bleeding"—that is, the scale and plates in the vicinity are streaked with red. When wasting is very extended, it is apt to pass unnoticed in a hasty examination, but it is always revealed by dulling the plate and calipering. This precaution of dulling should always be resorted to with old boilers. There are no rules to guide the inspector in searching for wasting, and it does not

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appear to take place in two boilers alike. However, the water-line appears to be especially liable to attack in boilers that stand quiet for a long while. For this reason boilers should not be allowed to stand idle when only partly filled with water. Sometimes this corrosion is hidden under a thin shell or crust of metal, when its presence can be detected by means of a testing hammer.

Pitting or honeycombing is in general well defined. It consists of small depressions of various shapes and forms. When the depressions are extended, the effect is more like wasting. It is not limited to any particular part of the boiler, and often appears in the steam space. The depressions are sometimes filled with a fine powder, being a mixture of iron, silica, and other earthy matters, and a small percentage of oil. These depressions are occasionally covered with a hard crust-like blister, but more frequently are open with sharp edges. Pitting is particularly likely to occur if a water very free from lime is used in a very clean boiler. When a boiler is one of a battery and is kept standing for a long interval, the top of the boiler is liable to pitting. Steam finds its way into the boiler, and, condensing upon the top surface, causes bad pitting there. Pure water, containing no air, does not harm, and steam alone will not cause pitting unless it contains a supply of air. Feed-water heaters often suffer badly from pitting, particularly near the cold-water inlet, and in boilers the parts most likely to be attacked are those where the circulation is bad, especially if such portions are also near the feed inlet.

Grooving occurs along the edges of laps, angle bars, stays, and cover plates. It is caused primarily by too great a stiffness, resisting expansion and contraction. This stiffness compels the play or breathing of the boiler to take place locally, similarly to bending backward and forward a thin plate with the hands. It is sometimes initiated through injury to the plates by a careless use of the caulking tool. In a crack once started grooving increases rapidly, due to the corrosive action entering deeply into the plate and exposing fresh surfaces. When cylindrical boiler shells are too firmly seated on their foundations, the expansion may promote grooving by causing the plate to buckle near the lap or butt straps, especially those of the transverse or ring seams. If the shell is not perfectly cylindrical, it tends to become so under pressure, and the longitudinal seams are similarly affected. To prevent grooving of the head or end plates at the flanges or angles where they join the shell, tubes, flues, and stays should not be located too near the shell; the flange should be turned with an easy radius about 2½ thicknesses, and the head should be made as thin as safety will permit.

Internal corrosion appears to be caused by acidity and air in the feed water, and perhaps, in special cases, to some form of galvanic action. Such galvanic action has been counteracted by the use of zinc plates. The electric couple separates the hydrogen, which passes to the steel and then escapes into the steam space, while the oxygen goes to the zinc. The proportions found requisite to ensure protection are about one square foot of zinc to 50 square feet of heating surface in the new boilers, and the same quantity of zinc to 75 or 100 square feet of surface in older boilers. The zinc plates should be about 10in. by 6in. by ½in., and the connection between the zinc and steel must be a good metallic contact to be effective. Usually the zinc is bolted to convenient stays or to studs formed for the purpose on the combustion chamber. The contact surfaces should be bright and clean, and the nuts should be well screwed down to prevent scale forming between them. The zinc slabs will last from two to three months. The zinc is sometimes carried in metal baskets to catch pieces that break off from time to time. The varied appearance and location of corrosion may be caused by the lack of either physical or chemical homogeneity in the metal. In order to prevent internal corrosion, the causes should be studied and neutralised as far as possible. The feed water should be kept slightly alkaline by the use of soda, and be free from air. A thin coating of scale will often act as a protective covering. When corrosion has attacked a surface that is not directly exposed to the fire or hot gases, it will often be found beneficial to clean the spot. Wash it with soda, and paint it with a thin layer of Portland cement. Wherever boilers are liable to excessive corrosion, they should be most carefully examined at regular intervals. This is true for external as well as internal corrosion.

External corrosion is just as active as internal corrosion, and in many ways more dangerous, since it is not so often suspected, and since boilers are frequently so set as to be difficult to inspect properly. The forms are similar to those of internal corrosion. It is generally produced by leaks or dampness and drippings from fittings. Ashes will rapidly corrode any metal against which they lie. In examining the fittings, the height of the bottom of the gauge glass (where the water disappears from view), and also the height of the feed pipe above the furnace crown, should be observed. The former should be about 3in. or 4in., so as to be sure that there is no danger from overheating so long as the fittings are in order and the water in sight. The position of the feed pipe is rather an important point. It should be so arranged that, in the event of a slight solid particle getting under the check feed valve, there is no risk of the water siphoning into another boiler connected to the same feed pipe and leaving the furnace crown bare. To reduce the risk of this occurrence, the opening of the feed pipe should not be more than 3in. or 4in. below the normal working level. If the boiler is fitted with a scum apparatus, the water-level at which the tap is intended to be opened is usually indicated by a pointer alongside the water-gauge. If this (the pointer) is too high, the troughs will not draw off the scum, and if too low, the tap will blow off steam and not water. To secure the best results, the water-level should be about ½in. above the top of the troughs. The level of the pointer, as well as the top of the scum trough, should be carefully measured, as the pointer frequently wants adjustment owing to carelessness in fixing when the boiler was put down. In this connection it should be noted that it is not sufficient to note that the troughs are the same height above the furnace tube throughout its length, as a boiler usually has a fall of about 1in. or 2in. in its length to enable it to drain empty when blown off, and hence, unless this point is watched when the troughs are fixed, they will not be truly water-level. In the case of bolt stays, it should be noted whether they are tightened up like a fiddle string, as they sometimes are, for if they are they are apt to distress the end plate by limiting the movement required by the furnace tubes for expansion, and cause leakage at the gusset and furnace, mouth rivets, and in extreme cases grooving, if the boiler is hard worked and subject to fluctuations of pressure. In old boilers the longitudinal stays are often secured with a pair of angle bars attached to the ends by means of an eye in the stay and a pin passing through the angle bars. In such cases the pin, as well as the angle bar, are liable to get fretted and seriously reduced in strength. Similar remarks apply also to the cotter or pin connections often found at the mid point of such stays.—H. E. H.

Answer to No. 716 (*awarded* 5*s.*).—Of the many defects which steam-boilers are liable to, grooving due to internal corrosion is certainly one of the most important. It usually occurs at the joints of the plates to each other, or to some fittings, or other parts of the boiler. Internally the effect is more generally due to the localisation of corrosion, owing to the fact that the plate at that part is subject to some bending action, tending to disintegrate the surface, and thus helping any corrosive action of the feed water. Externally the grooving is often due to leakage at, or adjacent to, the defective part, and unless there is brickwork or other materials in contact with the plates, the wasting is usually local. When lap seams are under compression, as in the longitudinal seams of furnace tubes of Lancashire boilers, grooving is frequently met with at the seams. This is probably due to the variations of steam pressure from time to time causing an alternate bending to and fro, rendering the plate adjacent to the lap more vulnerable, and with corrosive water frequently resulting in more or less severe grooving.

Cases of very peculiar grooving have been known to occur at the edge of the angle iron connecting the gusset stays to the shell plate. One of these is indicated in Fig. 1, a deep channel, G, being formed, extending the full length of the angle attaching the gusset plate to the shell. This

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is probably caused by mechanical action, due to the gusset plate drawing the shell a little from the true circular form.

Grooving of the end plates above the furnaces is another very common defect in Lancashire boilers; it is generally more severe at the front than at the back end, and is due to bending of the end plates, owing to the expansion of the flue and furnace tubes. Where the ends are properly stayed such grooving is seldom dangerous, although it may necessitate expensive repairs. Fig. 2 illustrates a case of this grooving, in which the tube was attached to the end plate by an angle ring, and the same movement which caused the grooving, G, of the end also resulted in a groove, A, being formed in the bend of the angle iron.

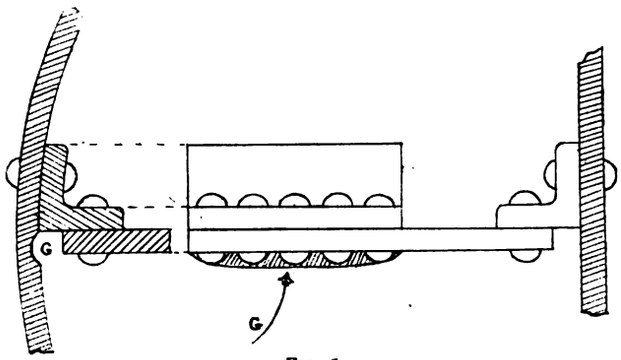


FIG. 1.

Fractures from overheating are also sometimes found in Lancashire boilers which have their boiler flues fitted with strengthening hoops or collapse rings, without water-spaces between the ring and the plate; a water-space of 1in. or more should always be allowed, to permit the water to come in contact with the plate at all parts. The water-spaces should be kept clear of deposit of all kinds, otherwise the benefit of the space would be lost. Side flues are occasionally met with too high at the top They should in no instance extend above the water-level in the boiler, as there is serious danger of overheating the plate. Amongst the defects which show after a boiler has been some time at work may be mentioned blisters or laminations in the plate. Blisters should be pared off down to the solid, and if of large proportions the plate should be patched or renewed.

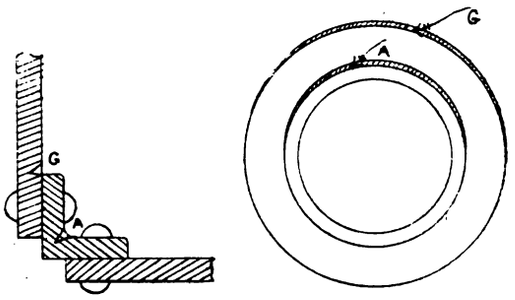


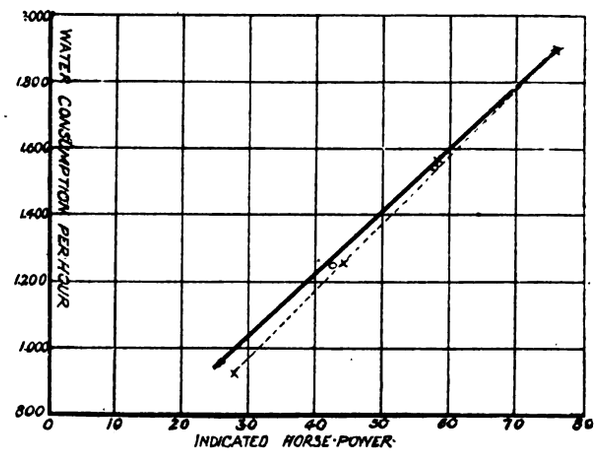
FIG. 2.

The most dangerous defect of all we meet with is external corrosion, principally at the seating walls, and it is good practice to keep all longitudinal seams entirely clear of the seating. Whenever any rust is seen about the seating, a thorough investigation should be made and the actual condition of the plates discovered. The stay-bolts that run through the boiler should be examined for flaws, and care should be taken that they are not too taut.

There are several smaller points of considerable importance about a boiler, one of which is that the bearers, which carry the firebars, must not be allowed to rest upon the sides of the furnace. They must rest upon supports riveted to the plates. This prevents the bearers cutting into the plates. The spindles of lever and deadweight valves are liable to get stuck fast where they pass through the cover of the valve, and all boiler fittings, such as gauge cocks, blow-off cocks, check valves, etc., should be thoroughly inspected before the boiler is passed ready for steam.—GEORGE EMENS, JUN.

Question No. 717.—A high-speed lighting set of 200 h.p. when working at full load requires 160lb. steam in steam-chest, but at three-quarter load only 120lb. is registered on the pressure gauge connected to it. The engine is controlled by throttle valve, and runs condensing. Which should be the most economical boiler pressure to use (as regards coal consumption) for continuous runs at three-quarter load—165lb. or 130lb., and why? Does superheating by 100deg. affect the case?

Best Answer to No. 717 (*awarded* 10*s.*).—If the engine be run on a steady three-quarter load, working the boiler at the higher or the lower pressure will make very little, if any, difference to the coal consumption. In the first case the steam will have to be raised to a pressure of 165lb. per square inch and be throttled down to 120lb. at the engine, while in the second case the steam is only raised to 130lb. and passed straight to the engine with practically no throttling. Experiments have been made to ascertain if there is any difference in economy between the two methods. The curves are the result of one made by Captain Sankey and published at the end of his paper on "Governing of Steam-Engines," read before the I.M.E., April, 1895. The circles and crosses plotted along the diagonal lines represent the experimental points, the full line represents the consumption when the boiler pressure itself was varied, and the dotted line the consumption when, the boiler pressure remaining constant, the steam was throttled, boiler pressure 120lb. The difference in consumption at the point where they are widest apart is only



about 1½ per cent., showing an economy in favour of the constant boiler pressure and throttling. If these curves are reduced to heat units per hour consumed instead of pounds of steam per hour, they will be found to practically coincide.

At first sight this coincidence appears rather strange, as the throttled steam is drier than the other owing to the heat generated by friction on its passing through the valve, which heat dries and perhaps superheats the steam. This dryness should reduce the cylinder condensation, and, therefore, the relative consumption, but the experiment shows otherwise. This can only be accounted for by the increased range of temperature in the cylinder and the slight loss owing to the transference of heat between the valve and the steam, the steam giving up heat on one side and the valve again giving heat at a lower temperature on the other.

A superheat of 100deg. F. would increase the economy of either method, but not influence their relative economy to any extent; perhaps the lower pressure would be more suitable in that case, owing to the slightly lower temperature (about 20deg. F.) to be dealt with in the steam-pipes. If the plant was run without the superheat, the higher pressure would be more more convenient, owing to the less liability of priming, and if the boiler delivered wet steam from any cause it would have less chance of damaging the engine.—E. J.

[Other replies to Question No. 717 will be given in our next issue.—ED. *E. E.*]

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SEPTEMBER 30, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

730. I have a 5-h.p., 500-volt, shunt-wound motor whose behaviour is somewhat weird, for on starting up in the ordinary way with the usual type of shunt motor starter, the machine on "no load" starts on the second live contact of the starter, runs about 20 or 30 revolutions, and then, apparently remembering it is running the wrong way, stops, and reverses itself. All this happens before the starter is put on the third contact, and except for this curious behaviour at starting, it behaves like any ordinary motor. There is no sparking at the brushes, or abnormal current during this phenomenon. What causes it?—H. G.

ANSWERS.

Question No. 717.—A high-speed lighting set of 200 h.p. when working at full load requires 160lb. steam in steam-chest, but at three-quarter load only 120lb. is registered on the pressure gauge connected to it. The engine is controlled by throttle valve, and runs condensing. Which should be the most economical boiler pressure to use (as regards coal consumption) for continuous runs at three-quarter load—165lb. or 130lb., and why? Does superheating by 100deg. affect the case?

Answer to No. 717 (*awarded 7s. 6d.*).—In replying to this question it would perhaps be well to primarily examine the comparative efficiencies of working at the two pressures without superheating the steam directly. Resolving the investigation of the economy in coal consumption into two factors, we have first to consider the efficiency of steam generation at the boiler, and latterly the conveying and utilisation of the steam in the engine cylinder. From the figures immediately given it will be seen that a saving undoubtedly results from generating steam at the higher pressure—165lb. per square inch—the increment of heat applied being proportionately less than the greater energy derived from the increased pressure. Evaporation at 165lb. pressure requires but six heat units more than are needed to evaporate at 130lb. pressure. The relative value of steam at different pressures, used without expansion, varies as the pressure multiplied by the volume; therefore, the higher the pressure, the greater power is available. Assuming an evaporation of 10lb. of water per pound of coal, then at 165lb. pressure with a volume of 2·75 cubic feet per pound of steam:

$$10 \times 2\,75 \times 165 = 4{,}537.$$

At 130lb. steam pressure and a volume of 3·4 cubic feet per pound of steam

$$10 \times 3{\cdot}4 \times 130 = 4{,}420;$$

$$4{,}537 - 4{,}420 = 117 = 2\,6 \text{ per cent.}$$

Deducting the six heat units originally added to give the higher pressure, which are equivalent by the following figures to 0·5 per cent.: Total heat units at 130lb. pressure = 1,188; ditto at 165lb. pressure = 1,194.

$$1{,}194 - 1{,}188 = 6 = 0{\cdot}5 \text{ per cent.}$$

Subtracting 0 5 per cent. from 2 6 per cent., we are left with 2·1 per cent. more energy for the same expenditure of heat by generating at the higher pressure.

Any additional radiation losses, by reason of the higher temperature of steam at 165lb. pressure over that at 130lb., are negligible if the boiler plates exposed and steam-pipes are lagged with good insulating material. We may reasonably rely upon 2 per cent. more energy available at the boiler, but this energy represents some mechanical gain, and can only be realised as such in the engine.

Considering next the performance of the steam through the throttle valve to the cylinder (the cut-off, and therefore steam expansion, in the latter being constant), the throttle valve, operating as a reducing valve at three-quarter load, brings the boiler pressure (165lb.) down to 120lb. at the steam-chest. This, providing the steam is dry, results in a slight superheat; and if the steam be wet, the heat units liberated evaporate part or all of the moisture Taking the former case and assuming the specific heat of steam as ·48, then the eight heat units liberated, when pressure is reduced to 120lb., will give these results:

$$\frac{8}{\cdot 48} = 12{\cdot}5\text{deg. of superheat.}$$

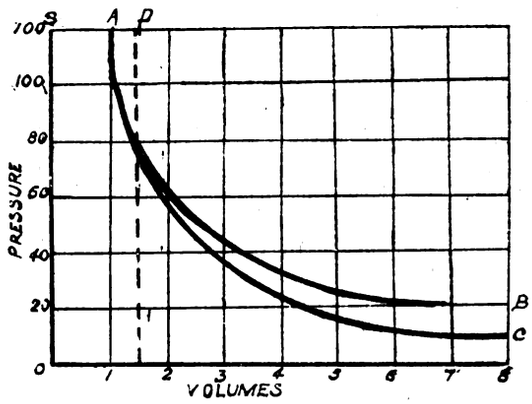
In the event of the steam possessing 2 per cent. moisture the aforementioned eight heat units will evaporate

$$\frac{8}{874} = {\cdot}009\text{lb. of water.}$$

(latent heat of steam at 120lb)

The wetness is, therefore, reduced ·02 − ·009 = ·011, or from 2 per cent. to 1·1 per cent.

There should be no need to herein emphasise the economy ensuing from the use of dry or superheated steam, but the expansion curves shown here may be of assistance to some. The main features of each curve are exaggerated, but they will serve to illustrate the argument. A C is the curve which would be drawn by the expansion of steam superheated or dried sufficiently to prevent initial condensation. The volume is therefore represented by S A. A B



is the expansion curve of saturated steam, its original volume being equal to S D, but due to initial condensation this volume is reduced to S A Some of the steam condensed is re-evaporated during expansion, hence $p \times v$ is greater at the point of exhaust than at the point of cut-off. The heat, however, used to re-evaporate is drawn from the cylinder walls, thus lowering the mean temperature of the cylinder and reducing the general efficiency. If steam had been generated at the lower pressure (130lb), this pressure being just sufficient to balance losses due to friction, etc., in the pipes, and to keep the engine running at its recognised speed, with three-quarter load, the throttle valve being full open, then this steam at the valve chest is considerably wet and will not act so efficiently in the cylinder, hence more steam is necessary. The heat units added at the boiler to increase the steam pressure make for economy, in so far that when either drying or superheating of the steam occurs by reason of throttling, these heat units are less than what would be necessary to generate steam at a lower pressure to compensate for the lower efficiency at the engine.

With the introduction of a superheater to give 100deg. superheat to the steam, the same principles as those already enunciated apply if the superheater and boiler be considered one plant. They should be reckoned as such if the one is built into the flues of the other. Economy will still accrue from generating at the higher pressure, but more because of side efficiencies, common to both conditions—with or without superheater—which will be dealt with later, rather than owing to drying of the steam at the

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throttle valve. The extra heat units, instead of being used to increase pressure, would be more efficiently employed adding a few degrees more superheat at the superheater. To generate steam at 130lb. pressure would be more economical, provided superheat is added, if the extra heat units are applied directly to the superheater rather than used to raise pressure to 165lb at the boiler, but should those heat units be dissipated, or should the superheater be separately fired, these conditions would be reversed.

However, most engineers will prefer to generate at the higher pressure (163lb.) for the following reasons, other than thermal, all of which make for more efficient running of the entire plant, and therefore indirectly result in economy: (*a*) If steam pressure is arranged at the boiler for different loads, the governors would be less sensitive, having to move the throttle more for regulation; in fact, if governing were performed at the boiler by raising and lowering pressure to suit the load, the governors may be dispensed with, only under such circumstances. heaven help the firemen. (*b*) Auxiliary plant, such as feed pumps, which are steam driven and may work expansively, would be run more economically with the higher pressure. (*c*) A greater margin is available to permit of fluctuations of pressure and still keep a constant pressure at the valve chest to maintain the correct speed. It is for this reason most refuse destructors, when employed for steaming purposes, have a reducing valve introduced between them and the main battery of boilers, as a constant pressure cannot be relied upon, from refuse-fired steamers, due to the varied classes of refuse consumed. (*d*) A greater store of energy is retained in the boilers.—WALLSEND-ON-TYNE.

Answer to No. 717 (*awarded* 5*s.*).—It is only natural that the pressure in the steam-chest should be considerably lower at three-quarter than at full load, for adjustment of initial pressure to suit the load requirement is the principle upon which throttle governing is carried out. The formula for the mean effective pressure—viz.:

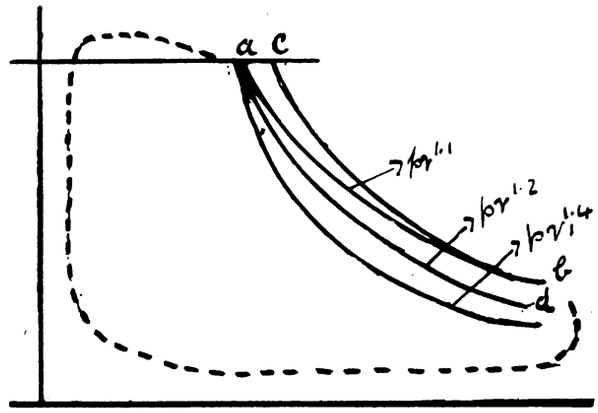
$$\text{M.E.P.} = p_i\left(\frac{1 + \log_e r}{r}\right) - p_b,$$

where p_i is the initial pressure and p_b the back pressure—distinctly shows this, for the other terms—r, the ratio of expanson, and p_b—are constants.

The initial pressure varies proportionately to the load, and at maximum the steam should not be throttled at all. Having the boiler pressure fixed, speaking generally, the weight of steam consumed per horse-power depends upon the number of expansions of steam that take place in the engine; in other words, upon the time of cut-off in the high-pressure cylinder, for the setting of the valves on the intermediate and low-pressure cylinders—the engine being assumed to be of the triple-expansion type—only determine the distribution of power between the three cylinders after the high-pressure valve has decided the power of all three combined. The most economical point of cut-off is by no means sharply defined; several in the same neighbourhood may give practically equally good efficiency. The extreme is reached when the work done by the steam as it expands just equals the loss due to piston friction, etc. In good practice the expansion is carried to within 4lb. or 5lb. per square inch of the condenser back pressure. But, in the engine considered, the valves are already set, so that the number of expansions is fixed also; the most suitable boiler pressure has to be decided upon. Now, the diameters of the cylinders, the cut off, and speed being fixed, a certain mean effective pressure must act on each of the pistons for a definite power to be developed. According to the particulars, 160lb. per square inch in the gauge steam pressure is required under the conditions to run at full load.

Clearly, then, if 200 h.p. is the maximum load, the boiler pressure must be 160lb. per square inch gauge + the drop in the steam mains—165lb. per square inch gauge will only just suffice. There will be no throttling at this load. Note.—This provides no margin for overload; in case of overload the speed will drop. It is evident the steam pressure must not be reduced. The steam, if dry on entering the throstle valve, is throttled when steaming on a load less than full. It is superheated slightly. At three-quarter load, from the pressures given, six British thermal units would be liberated, which would superheat the steam 12·5deg. F. Of course, this superheat would help to keep the steam dry during admission. With a considerable degree of superheat a reduction in steam pressure might be possible, not because of any thermodynamical reason, but on account of its beneficial effects in admitting the steam dry to the high-pressure cylinder, and possibly maintaining the dryness throughout expansion in that cylinder also. Any wetness reduces the heat units in the steam available for doing work, so that more steam has to be supplied. Condensation on the cooled cylinder walls adds to any original wetness, the degree being determined by the difference between temperatures of the steam upon admission and that of the walls. The point of cut-off, therefore, affects the wetness, for the later in the stroke it occurs, the higher will be the average pressure, and consequently the higher the mean temperature.

Since the heat exchange is directly proportional to the period of contact, the loss is smaller in high-speed engines. The steam becomes wetter as expansion proceeds, owing to molecular liquefaction due to the internal energy being expended in doing work. The wetness is a most serious source of loss, and leads to a great lessening of the useful heat extracted from all that taken from the furnace. The accompanying diagram gives an idea of the loss. In it are



shown four different curves, which represent the behaviour of the steam under different conditions; $a\,b$ is the saturated steam curve, assuming adiabatic expansion. It follows approximately the law $p\,v^{1\cdot1} = \text{constant}$; $a\,d$ is the hyperbola $p\,v^{1\cdot2} = \text{constant}$, and illustrates the action generally taking place under favourable circumstances, the steam being initially dry. Sometimes, however, the curve may fall away so far as to lie on the $p\,v^{1\cdot4} = \text{constant}$ curve. The last curve ($c\,b$) is the case in which the steam is originally superheated sufficiently to keep the steam dry up to release. It can be seen joining the saturation curve.

The object of superheating is to make the actual curve hug the saturation curve as nearly as possible. One per cent. of wetness in steam at 188lb. absolute would mean a decrease of 8·5 British thermal units in the total number available. Assume this percentage at cut-off. On the other hand, to have kept this steam dry would have required about 8deg. F. of superheat, or 3·8 British thermal units—that is, an extra expenditure of 3·8 units to avoid a loss of 8·5—obviously a wise course. Still greater gain would accrue from the use of a higher degree of superheat; 100deg. F. of superheat would be enough very probably to keep the steam dry in the high-pressure cylinder up to release. Superheating then would have the effect of improving the thermal efficiency, and therefore a less weight per unit power would be necessary. Even in this case, though, it would be advisable to use an earlier cut-off, and expand more fully if permissible. For three-quarter load, undoubtedly the most economical boiler pressure would be 130lb. per square inch, for, disregarding the question of whether any energy is lost at the throttle at the higher pressure, the increased radiation all over the pipe system at the higher temperature must cause extra loss. If three quarter load is regarded as top load, there would be no sense in using a so much higher boiler pressure than steam-chest pressure; but, as remarked before, if 200 h.p. is the full load, then, of course, one would have to have the reserve of pressure to meet demands.—T. H. H.

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Answer to No. 717 (*awarded* 5*s.*).—Taking first the difference in the amount of heat required to generate steam at the two different pressures, we find from steam tables: total heat of 1lb. of steam at 145lb. per square inch absolute—*i.e.*, 130lb. per square inch by gauge—from water at 32deg. F. = 1,190 heat units, and for the same amount of steam at 180lb. per square inch absolute (165lb. per square inch by gauge) = 1,195 heat units, and as the total heat losses would be practically the same in each case, the extra heat required to produce steam at the higher pressure may be put down as ·4 per cent. Now, the benefit derived from the higher pressure of steam at the throttle valve is the improvement in the dryness of the steam, due to the reduction in pressure, being equivalent to supplying the cylinder with a greater quantity of dry steam. Assuming the dryness fraction of the steam on the boiler side of the throttle valve to be ·9, then the dryness fraction after reduction of pressure is obtained from the equation

$$S_1 + x_1 L_1 = S_2 + x_2 L_2,$$

where S is the sensible heat, L the latent heat, and x the dryness fraction of the steam; or, taking the temperature of the feed water as T_1, and the temperature of the steam as T_2, it is expressed more fully as follows:

$$(T_2 - T_1)_1 + x_1 \{966{\cdot}6 - {\cdot}7\,(T_2 - 212)\}_1 = (T_2 - T_1)_2 + x_2 \{966{\cdot}6 - {\cdot}7\,(T_2 - 212)\}_2.$$

Case I.—Steam at 145lb. per square inch absolute reduced to 135lb. per square inch absolute.

$$(355 - 32) + {\cdot}9\ \{966\,6 - {\cdot}7\,(355 - 212)\} = (350 - 32) + x\ \{966{\cdot}6 - {\cdot}7\,(350 - 212)\}$$
$$1{,}103 = 318 + 870\,x. \quad . \quad . \quad . \quad . \quad (1)$$

$\therefore$ x equals ·9203, being an increase in the dryness fraction of ·23 per cent.

Case II.—Steam at 180lb. per square inch absolute reduced to 135lb. per square inch absolute.

$$(370 - 32) + {\cdot}9\ \{966{\cdot}6 - {\cdot}7\,(370 - 212)\} = (350 - 32) + x\ \{966{\cdot}6 - 7\,(350 - 212)\}$$
$$1{,}108 = 318 + 870\,x \quad . \quad . \quad . \quad . \quad (2)$$
$$x = {\cdot}9080,$$

giving the increase in dryness as ·80 per cent., thus showing the increase in dryness from the higher pressure of steam to more than compensate for the extra heat required in raising it, and although the economy is not much, it is better to work with the drier steam, as it lessens the cylinder condensation trouble. This practice of generating steam at a higher pressure than required by the engine, and reducing down, is being largely followed. With reference to the question of superheating by 100deg., the total heat of the superheated steam is obtained by adding to the total heat of the saturated steam the amount of superheat multiplied by the specific heat of superheated steam, which is ·48.

Case III.—Case I. with 100deg. F. superheat. From (1) we have the total heat of saturated steam at 145lb. per square inch absolute = 1,103 heat units; therefore, with the addition of 100deg. superheat, the total heat becomes

$$1{,}103 + (48 \times 100) = 1{,}151 \text{ heat units},$$

this being equal to the total heat after reduction to 135lb. per square inch absolute.

$$1{,}151 = (350 - 32) + x\ \{966\,6 - {\cdot}7\,(350 - 212)\}$$
$$x = {\cdot}957,$$

increasing the dryness by 5·7 per cent.

Case IV.—Case II. with 100deg. F. superheat. From (2) we have the total heat of saturated steam at 180lb. per square inch absolute = 1,108 heat units, which when superheated 100deg. F. becomes

$$1{,}108 + (48 \times 100) = 1{,}156 \text{ heat units},$$

which is equal to the total heat after reduction, as before, to 135lb. per square inch absolute.

$$1{,}156 = (350 - 32) + x\ \{966{\cdot}6 - {\cdot}7\,(350 - 212)\}$$
$$x = {\cdot}963,$$

increasing the dryness by 6·3 per cent. The increase in the dryness of the steam by superheating 100deg. F. is thus shown to be more substantial in both cases, but as to whether the superheating would be more economical depends on the cost of providing the superheat, as in the case of superheaters placed in the flue there is a loss of draught due to reduction of temperature in the gases, and with separately fired ones there is fuel and attendance as well as cost and maintenance in both cases.—E. L.

Question No. 719.—In an alternating-current plant with rotaries a bad phase was made when synchronising another alternator with one previously running, and which caused all the rotaries to lose their fields. The same thing has happened when a bad phase has been made in synchronising a rotary. Could anyone explain in full detail exactly what happens to the rotary as to how it loses its field?

Answer to No. 719 (*awarded* 7*s.* 6*d.*).—The cause of the trouble is the change in 'bus-bar voltage as a result of the bad parallelling. When the fresh alternator is switched on to the 'bus bars with its voltage out of phase with the 'bus-bar voltage, a large idle or synchronising current flows between the 'bus bar and the incoming alternator armature. This current may be either a lagging or a leading one with regard to the 'bus-bar voltage, according to the relative phases at the instant of switching in. Thus, in Fig. 1

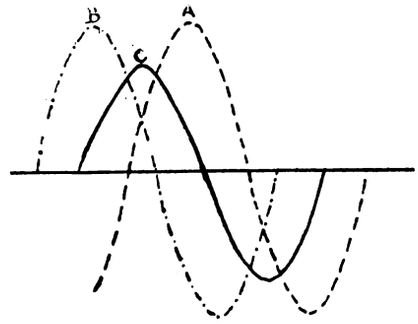

FIG. 1.

A and B represent the voltage curves of the incoming alternator and the 'bus bars respectively, and they are shown with A lagging considerably less than the correct half-period behind B. Curve C is the algebraical sum of A and B at each instant, and shows the net resultant voltage tending to pass the synchronising current between the 'bus bars and the incoming alternator. This net voltage, and consequently the synchronising current, lags with regard to the 'bus-bar voltage, B, but if B had been the incoming voltage and A the 'bus-bar voltage, the synchronising current would be a leading one relatively to the 'bus-bar voltage. Either case is liable to produce the effects mentioned. If it is a lagging current there will be a sudden fall in 'bus-bar voltage, whilst if a leading current the 'bus-bar voltage will rise, due to the demagnetising armature reaction of a lagging current and the magnetising reaction of a leading current respectively.

Now, when a synchronous alternating machine, such as a synchronous motor or a rotary converter, is subjected to changes of terminal voltage, the necessary balance between terminal voltage and internal back voltage is preserved, not by change of speed, as in a direct-current motor, but by changes in armature reaction. If the terminal volts drop, a leading current (lagging with regard to the internal back voltage) is immediately drawn from the mains and automatically weakens the field magnets of the rotary and reduces the back voltage to the required extent. The reverse occurs if the terminal volts rise. The amount of armature current taken to compensate for a given change in terminal voltage varies considerably with the design of the rotary, but a change of 10 per cent. in the terminal voltage might in some machines increase the input current of the rotary some 30 or 40 per cent. The current would *increase* whether the voltage charge were up or down, only in the former case the current would be a lagging one and in the latter a leading one. Supposing the rotaries to be already working at their full load, such an increase (or the still greater increase which would result from a greater voltage change than 10 per cent) would open the automatic cut-outs on all of them. This is apparently what happened in the cases mentioned both with the badly-paralleled alternator and, which is practically the same thing, with the badly-paralleled rotary converter. It is incorrect to speak of the occurrence as a case of loss of field,

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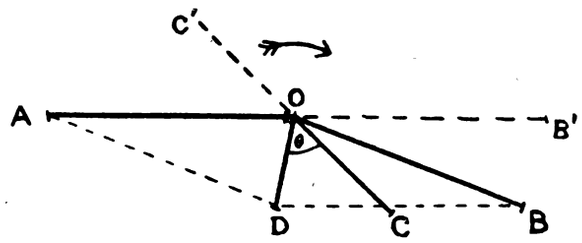
as a rotary cannot lose its field so long as it remains connected to the alternating mains, the direct-currrent voltage (which is also the shunt voltage) simply varying up or down in accordance with the alternating voltage.—Q.

Answer to No. 719 (*awarded* 7*s.* 6*d.*).—To answer this question we must find what effect a "bad phase" has on the circuit. Let O A represent the voltage of an alternator, A, already under load and with which another machine, B, is to be synchronised. Now, B's switch should be closed when the phase of B's voltage is at O B'—*i.e.*, opposed to O A—so that little or no synchronising current flows. Instead, however, a bad phase is made and B connected to A when B's phase is at O B. The resultant voltage acting through A and B is equal to O D The resulting current, O C (equal to O D ÷ joint impedance of armatures), lags by a large angle θ behind O D. Now, O C has nearly the same direction as O B, while it is nearly opposed to O A—*i.e.*, machine B is retarded while A is accelerated. Consequently the angle A O B increases to 180deg., when O D and O C become zero. But A is now running above normal speed and B below, so that the machines overshoot the mark, and a current, O C', now flows,



tending to again restore A O B to a straight line. This swinging or "hunting" continues (with a period dependent upon the inertia of moving parts, and impedance of armatures) for some minutes, it may be, but, in the absence of any regular disturbing force, gradually dies down to zero. The effect upon the distant rotaries, however, may be most marked, as may be seen. Every surge of the generators produces a fluctuation in magnitude and phase of the alternating voltage impressed on the line. This disturbs the rotaries, and they endeavour to follow these changes, and set up a see-sawing action amongst themselves, and between themselves and the generators. The effect is aggravated if the natural time of swing of the rotary armatures (determined by their inertia and impedance of the circuit) happens to be near to or a multiple of that of the generators. Under these circumstances, the effect may be so large as to swing a rotary clean out of phase, and cause it (if by that time the alternate-current cut-outs have not acted) to drop into phase again either with the same or a reversed polarity on its direct-current brushes. If the armature falls back a distance corresponding to an even number of poles, the polarity will be the same, and the field which had temporarily disappeared will rebuild in the same direction, but if an odd number of poles, the polarity will be reversed, and will reverse the field current. With several rotaries in parallel, probably all the direct-current breakers will open, and, if the fields are supplied from the 'bus bars cut them off, leaving the machines running with no fields. With the fields excited from the brushes, however, each rotary after such a disturbance will settle down with one or the other polarity, and the field build up again. In any case the field is temporarily or permanently lost. It is, of course, probable that flashing over will also take place at the commutator during the upset, especially with high-frequency machines.

Conditions vary so much with different plants that it is not always possible to say precisely in full detail the order of events, but the above describes what was the probable train of causes leading to what "F. B." observed.—R. C.

Question No. 720.—In a certain type of coking stoker the bars are subjected at the back end to a very intense heat and soon burn away, resulting very often in serious damage to the stoker, due to them falling. The bars supplied by the makers are of a low-grade cast iron. What should be the composition of the iron in order, as far as possible, to resist the intense heat?

Answer to No. 720 (*awarded* 7*s.* 6*d.*).—It is more than probable that the trouble is not due to the bars being made of any particular brand of cast iron, but is caused by other conditions, which we will consider in detail. The coal may be unsuitable; some coals require the furnace to be cleaned out very often, and when the boiler is fully employed the firebars are apt to become caked up with clinker and so get burned. There may also be inattention on the part of the attendant; many boiler troubles, at first unexplainable, are afterwards traced back to the personal equation. Some mechanical stokers have an intermittent instead of a constant supply to the furnace. When the coal is fed at intervals there is a tendency, particularly with certain brands of coal, to accumulate in heaps and prevent the passage of air between the bars. Another reason may be that there is not sufficient space between the bars for the particular coal used; in a somewhat similar case an increase of $\frac{1}{8}$in. effected a considerable improvement. Any increase made in the space between the bars must depend on circumstances, as too great a space may make matters worse. The bars should have end-play in the proportion of about $\frac{1}{2}$in. to the foot. Bars sometimes burn out through the upper surface of the grate being uneven—that is, should one bar be raised much above its fellows, that bar will stand a much greater chance of being fused. As a last resource wrought-iron bars might be tried; these stand a much higher temperature than cast-iron bars before melting, but would be considerably more expensive. Speaking from experience, the writer has never known firebars burn out except from the causes enumerated above. It is very doubtful whether an alteration in the brand of iron would mend matters; the remedy will almost certainly be found in another direction.—M. M.

Answer to No. 720 (*awarded* 7*s.* 6*d.*).—In this question it appears to the writer that the matter is not so much one of the firebars being of poor quality iron as the treatment to which they are subjected. The writer has experienced exactly similar troubles as those mentioned in the question, and found the causes to be as follows: Poor quality coal will require to be forced in order to keep up steam on heavy loads, and in forcing it it will melt and stick to the bars. This keeps the air from getting up between the bars to keep them cool, and the clinker fuses on to the bars and has to be kept free by the frequent use of the slicer. This separates the clinker, which takes the fused part of the bar along with it. The writer has seen new bars put into fireboxes, and the next time they have been examined (in about eight weeks) they have been burnt away so much as to be useless. By using a better quality coal, or by putting another boiler into service during heavy loads, so that the poor quality coal can be burnt without forcing, the trouble of burnt firebars has disappeared.

Another point with regards to the bars dropping down is in the way they are held. The bar ends generally work over a sill-plate, but ought not to rest on it, a bearer bar being fixed about 6in. further under the bars to support them. Sometimes through bad erecting this bearer bar will be too low, and consequently the bars will rest on the sill-plate, and when they get burnt short will drop on to the bearer bar and probably cause trouble. Boilers in which this defect has occurred, and which otherwise might have been kept in service much longer, have had to be shut down until new bars could be put in. If, however, the bearer bar is the right height, the firebars, although burnt short, will not drop and catch against the sill-plate, and the worst thing that will happen will be a small quantity of fire will continually be dropping out.

It is the writer's opinion that it is more economical to burn a better grade coal, with all its attendant advantages of better steam pressure, less forcing of fires, and less work for the stokers, and smaller repairs, than to burn a poor coal and firebars and have a heavy bill for renewals.—H. B.

[Other replies to Question No. 720 will be given in our next issue.—Ed. *E. E.*]

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OCTOBER 7, 1904.

QUESTIONS AND ANSWERS.

thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

731. How would you measure the self-induction of an alternator's armature?—E. V. C.

732. What is the best method of predetermining the voltage drop due to magnetic leakage in a transformer at, say, full load and any given power factor?—R. S. L.

ANSWERS.

Question No. 720.—In a certain type of coking stoker the bars are subjected at the back end to a very intense heat and soon burn away, resulting very often in serious damage to the stoker, due to them falling. The bars supplied by the makers are of a low-grade cast iron. What should be the composition of the iron in order, as far as possible, to resist the intense heat?

Answer to No. 720 (*awarded 7s. 6d.*).—A good cast iron for stoker bars should contain as great a percentage of iron (pure) as is practicable to procure a sound casting. It should contain as little sulphur as possible, not more than 2 5 per cent. of silicon, and not more than 1 per cent. of phosphorus. It is extremely difficult, and to some extent impracticable, to lay down any hard-and-fast chemical specification; the cost, if such a specification were adhered to, would be prohibitive. The old-time "trial by error" system has evolved, for each foundry or engineer, a bar which is suitable, and thus so many mixtures, each of them in the hands of a particular founder, can be cited as successful. A mixture which has been used for some 10 years in making bars for a well-known type of mechanical stoker is made up as follows: one part of hard iron, preferably old firebars; one part of pig iron, Scotch No. 1; three parts selected scrap iron. The above is a typical founder's mixture, and it is a matter of considerable discretion as to the selection of the scrap. No trouble has been, however, experienced, and a good sound uniform casting has almost invariably obtained. The personal element thus must enter into the question, but care and experience lessen the chance of failure.

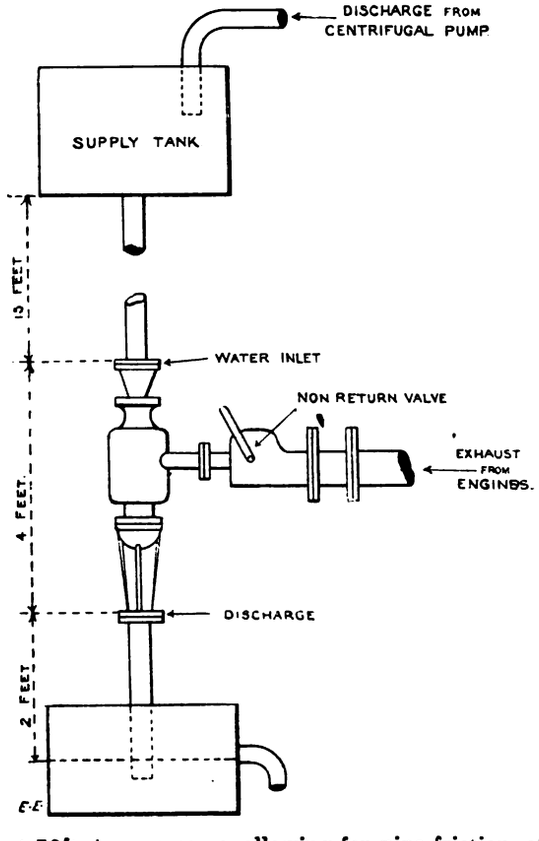
It must be said here that steam jets are used under the ends of the bars to keep them cool, and it may be that the propounder of this question has not availed himself of this method of prolonging the life of his bars. It is contended that jets are wasteful and a source of loss; they may be if not carefully used. All that is needed is a thin film of steam rising up under the ends of the bars, and the consumption need not, and should not, be more than of the order of ·1 per cent. of the steam raised. It is a simple matter to run a couple of ¼in. pipes along the side of the furnace under the bars connected by a cross pipe under the far end of the bars. The cross pipe need be only ¾in. diameter, and should have a number of small holes about $\frac{1}{32}$in. diameter drilled so that the steam may escape in a film and the draught carry it through the ends of the bars. Several firms advertise fireproof bars which they claim have a life many times that of the ordinary bars, but the composition of these is of a necessity a trade secret.—S E. T.

Answer to No. 720 (*awarded* 5*s.*).—The question as to the composition of the iron for the firebars of coking stokers, of the moving grate type, is not of such importance to the engineer as the proper working of the bars. If the writer of the question sees that his bars have a slight fall towards his back, say, of 3in., and a more efficient supply of steam jets to the back end of his firebars, he may get over the difficulty of his ends burning off. This has been the writer's experience for the last five years, having experienced the same difficulty when first starting the plant. He must also see that his bars have their full travel. Overhauling the stoking gear occasionally is conducive to economy.—J. C.

Question No. 721.—An ejector condenser coupled close to the exhaust range and about 2ft. below, supplied with water from a centrifugal pump at a pressure of over 20lb. per square inch, will not, either in a vertical or horizontal position, give more than 20in. of vacuum. Explain the reason for this.

Best Answer to No. 721 (*awarded* 10*s.*).—"E. L." does not give information enough to enable the peculiar defect, if any, in the ejector condenser, or its arrangement, to be determined. It is possible to maintain at least a 24in. vacuum with the type of condenser under consideration, and with enough cold water at the pressure mentioned that vacuum should be easily kept.

In the appended sketch, an arrangement of an ejector condenser plant which has been in daily use for some two years is shown. It deals with the steam from three 70-b.h.p. engines, and maintains a 24in. vacuum when all the engines are running at full load. About 4,000lb. of steam are used per hour by the engines, and the condenser is rated to pass 10,560 gallons of water (condensing) per hour. The centrifugal pump raises the water into a tank, the bottom of which is some 15ft. above the water inlet of the condenser; the condenser is 4ft. long, and the discharge pipe is 2ft. long. The difference of level between the supply and the discharge is thus some 21ft. The pump has a head



of about 30ft. to overcome, allowing for pipe friction, etc., and the power necessary is

$$\frac{105{,}600 \times 30}{33{,}000 \times 60} = 1{\cdot}6.$$

Allowing 40 per cent. pump efficiency, 4 b.h.p. would suffice for driving the centrifugal pump, and in the above case a 5-b.h.p. motor is more than ample for the work. The tank is interposed between the pump and the condenser, so that any air sucked in at the pump glands and pipe joints may be prevented from entering the condenser, as it is found to materially affect the vacuum.

The ejector should be fixed vertically—*i.e.*, the water inlet and discharge should be vertical, and the flow also; a minimum of 15ft. should be allowed as head at the condenser water inlet, and a clear discharge of 2ft. should be allowed below the discharge flange. Where practicable, a tank should be interposed between pump and condenser, and the discharge pipe should be water sealed. If these details be followed, and an allowance of 26lb. of water at 60deg. F. per pound of steam made, a 24in. vacuum should be readily obtainable. Of course, the pipes—*i.e.*,

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exhaust, water inlet and outlet pipes—must be of ample size.—S. E. T.

Answer to No. 721 (*awarded* 7*s.* 6*d.*).—It certainly seems strange that the condenser will not give more than 20in. of vacuum with an equivalent head of water of 46ft. In order to find what has become of the other 4in. or 5in., the following tests should be carried out. As a preliminary trial, the valve between the condenser and the exhaust range should be closed and the condenser started by opening the air-cock and turning on the water. The air-cock should then be closed and the vacuum in the condenser noted. It will probably rise to 29in. of mercury. If it does not rise above 28in., the fault must be looked for in the condenser itself. First of all, see that all joints are tight, and also that the water inlet is free from obstruction. Also notice whether there are air bubbles in the water, as these would, of course, partially destroy the vacuum. If the fault is not discovered in the condenser, attention should be turned to the pipework. This is the most likely place, and all joints should be carefully examined for leaks. If practicable, the pipes might be tested with steam up to 50lb. per square inch; this will show up any leaks at once. If bubbles are found in the discharge water when the engines are working they indicate a leak somewhere, providing no bubbles came through when testing the condenser by itself. Should these tests not discover the fault, it would seem as though the condenser had too much work to do. It may be taken as a rough approximation that 550 gallons per hour will be required for every 10 h.p., and other sizes proportionately. With the figures given a 25in. vacuum should be maintained, provided that the condensing water is below 60deg. F. Unfortunately, "E. L." does not say what size condenser or what weight of steam he is dealing with, as if he did it would be possible to speak more definitely as to the probable cause of his trouble.—H. C. H.

Answer to No. 721 (*awarded* 7*s.* 6*d.*).—One of the points often overlooked by engineers when installing condensers of the ejector or similar types, is the supply of water to the condenser free from air, and, from the particulars given by "E L.," I should say this is the cause of the trouble in his case. If the water supply comes from a river, or a running stream of any description, or even from the town mains, there will be a certain amount of air in the water before it enters the pump suction pipe; and with a very small leakage in the suction pipe a considerable amount of air will be drawn into the pipe. If "E. L." has not examined the suction-pipe joints already, I should advise him to do so, and he might find an increase in his vacuum right away. However, a perfect suction pipe will not get rid of all the air in the water, but there are several ways by which this air can be got rid of. A tank could be placed just below the pump, as near to it as possible, and the suction for the pump taken from this tank. This would allow the water in the tank to deliver up the air. The suction pipe would have to be as short and have as few joints as possible, or things might soon be as bad as before if one of the joints happened to leak. This method, however, is impracticable in a lot of cases and also expensive, as it involves the cost of a tank, and possibly of another pump to fill it.

Another way would be to place the tank high enough above the condenser to get the requisite pressure, and use the pump for filling the tank. This method also has the same objections as the last method. A way by which I have known the same difficulty to be overcome, and the cost of which is trifling, is as follows: An air-vessel, which should have an opening about equal to the diameter of the pipe to offer a fairly large surface to the water, is placed on the pipe between the pump and the condenser; a small pipe, say about 1in. gas-barrel, is screwed into the top of the air-vessel, and taken up high enough to stop the water running over the top, which is left open; it would have to be about 45ft. in "E. L.'s" case. It will be found that the air will escape by the pipe. An automatic valve could be placed on the air-vessel instead of the air-pipe, so arranged that when the water in the vessel got below a certain level, a cock at the top of the vessel would open to let out the air; only as the cost of this apparatus would be more than an air-pipe, and its action is not as certain, it cannot be considered such a good arrangement.—J. B. R.

Answer to No. 721 (*awarded* 5*s.*).—There are many reasons to account for the vacuum being as low as 20in. in the case mentioned. In the first place, is the condenser big enough for its work? Is the water supply sufficient in quantity and low enough in temperature? Water used over and over again from a cooling pond will be liable to get very warm as the day progresses, and this will easily keep the vacuum low. If this is the cause of the trouble, the vacuum will be higher when starting up for the day, and will gradually drop as the water in the pond becomes heated up. Better cooling facilities are, of course, the remedy for this fault. Are there any leaky glands on the engine, or leaky joints between the engine and exhaust range and condenser, these should be examined, and any leaky glands or joints repacked or remade. A very slight amount of air drawn in this way will make a very great fall in the vacuum. If possible, have the condenser outlet pipe discharging below the level of a small well. Any air brought in through leaky glands or joints, or entrained in the water, can at once be detected, as the air bubbles will, of course, rise to the surface of the well. The centrifugal pump may be drawing air either at the shaft glands or at a joint in the suction pipe. If the pump is not drowned, this will be found out by observing the amount of energy necessary to drive the pump. If this is at all excessive, the pump should be overhauled at once, as air introduced in this way tends to break the column of water supplied to the condenser, and as it is essential for the best working that the water be supplied in a steady, unbroken column, it is obvious that the vacuum will suffer badly. Any of the above defects will keep the vacuum down, and should be sought for and remedied at once, as 20in. is very poor for the type of condenser mentioned, the writer being able to keep 27in. on a constant all-day full load with a head of 12ft. to 15ft. and a constant supply of water from a river. The amount of head in this case is quite ample, and could be reduced with resulting economy, provided that the condenser or its connections are kept in a proper condition.—W. T. W.

Answer to No. 721 (*awarded* 5*s.*).—It is possible, though perhaps hardly probable, that the condenser put in is not of sufficient capacity to deal with the load of the engine. If the condenser *is* large enough, there are several things which would prevent its maintaining a proper vacuum. Unless the joints in the exhaust range and connections to condenser are well fitted, air leaks through and impairs the vacuum. Another reason may be that the piping for the delivery of condensing water is too small or has become partially choked by sediment, or possibly small stones which have been carried over with the water; this also applies to the condenser itself and exhaust piping. If the condensing water is used over and over again, being circulated through some cooling apparatus, it is possible that the water may become fairly hot, necessitating a bigger supply than the condenser can deal with. The question states that water is delivered at 20lb. per square inch. Is this pressure at the pump or at the condenser? If at the former, and the condenser is connected by a long length of piping having several bends in it, the pressure at the condenser is considerably lowered, and the quantity of water diminished, and not a sufficient supply kept up. The steam valves of the engine should also be examined to see if any leakage takes place, as this causes a considerable amount of extra steam to the condenser, which would prevent it maintaining the vacuum. As it is rather unusual for ejector condensers to get out of order when properly erected, on account of their simplicity of working, it would be as well to check the vacuum gauge. No advantage, in the writer's opinion, is gained by running the condensers horizontally.—ERG.

Question No. 722.—Describe the best methods of plating carbon brushes with copper or nickel, having regard to the fact that carbon is porous and absorbs the electrolyte.

Answer to No. 722 (*awarded* 7*s.* 6*d.*).—The only real difficulty attending the electroplating of carbon brushes is that arising from the absorption of the electrolyte by the carbon. During the drying of the brushes, after the plating is completed, the absorbed salts crystallise out,

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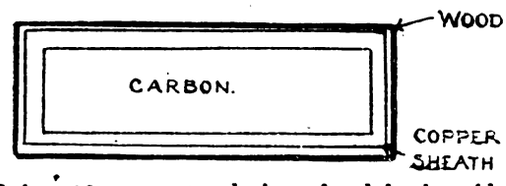
corroding the plating, and fouling the portion of the brush left bare. This will go on for a considerable time, and it is almost impossible to remove the absorbed salts by washing. The problem arises how to prevent the absorption. This might be accomplished by coating the carbon with a thin, acid-proof, non-absorbent material, such as paraffin wax dissolved in benzine; but this means that the metal plating would be more or less insulated from the carbon, and the beneficial object of plating impaired. The best method known to the writer is to soak the brushes in distilled water for a few days until they become saturated, after which they should be instantly placed in the electrolytic bath with the current connected, so that the deposition commences the moment the brushes touch the electrolyte. Even then a little of the electrolyte will be absorbed by diffusion, but not sufficient to cause any trouble. At the commencement, the brushes should be immersed $\frac{1}{8}$in deeper than their normal position, until a thin coating of metal has been deposited. By then raising them to normal position the carbon is brought out of contact with the electrolyte.

The following solutions will be found very suitable: For copper plating—to a quantity of distilled water, representing the bulk of the electrolyte to be used (which bulk will depend on the number of brushes to be coated at one time and the size of the tank), add crystals of cupric sulphate gradually, and with constant stirring until the solution attains a gravity of 10deg. Beaumé, or 1 075 specific gravity. Then add, with constant stirring, pure sulphuric acid until the specific gravity rises to 1 083. Filter the solution. Use clean pure copper anodes suspended on each side of the cathode brushes, the total working surface of anodes to be equal to total brush cathode surface. A current density of 10 amperes per square foot will be found suitable. On removing the brushes wash well in distilled water. Dry in hot sawdust or in water-oven. Polish gently with a steel burnisher.

For nickel plating it is best to first cover the brushes with a film of copper. Prepare the nickel electrolyte as follows: for every 10 litres of electrolyte required, according to the size of tank used, dissolve 135 grm. of pure nickel in weak sulphuric acid (one of acid to two of distilled water by weight), and heat until completely dissolved; add some distilled water and neutralise the liquor with ammonia. Filter the solution. In another vessel dissolve in distilled water 70 grm. of carbonate of ammonia, and add, with care and constant stirring, sulphuric acid until the solution becomes neutral. Filter the solution. Mix the sulphate of ammonia thus obtained in the second vessel with the sulphate of nickel made in the first vessel, and add cold distilled water to make 10 litres. Use pure nickel anodes having a total working surface equal to total brush cathode surface. A current density of 10 amperes per square foot of cathode surface will be right until a film of deposited nickel is obtained, then raise the brushes $\frac{1}{8}$in. (as in the case of coppering brushes) and reduce to five amperes per square foot. On removing wash the carbon brushes in cold water, and dry in hot sawdust. If required to polish the deposited nickel, it must first be cleaned by means of rapidly revolving brushes. An ordinary circular pig-hair brush sprinkled with soft chalk is first used, and a vigorous scrubbing given; then felt discs and finely pulverised chalk or hard red is used, and finally a disc of wool, which gives a shining brightness.—G. W.

Answer to No. 722 (*awarded* 7*s.* 6*d.*).—The first thing to do is to make the carbon brush waterproof. This is done by dipping the part intended to receive the coating of metal in hot paraffin wax. It is now necessary to remove the excess of wax, and to improve the conducting property of this part of the carbon. This is done by brushing it with a very stiff brush made of fine wire, and rubbing in the finest plumbago. Another method is to dip the carbon, after removing the excess of wax, in a solution of phosphorus dissolved in bisulphide of carbon; while still moist dip the carbon into a bath of sulphate of copper or nickel. It now becomes coated with an almost invisible film of metal, owing to the phosphorus acting upon the metal in the bath, and depositing it in a metallic form. The coating can now be deposited upon the carbon by either of the two following solutions: the two mentioned are the easiest and simplest, though there are many others as good. Get a sheet of copper and press it into the shape of the brush, making it so that the carbon can be easily suspended by means of a clip inside, leaving, say, $\frac{1}{2}$in. space all round; make the copper the anode by attaching the positive lead thereto, and the carbon the cathode. The carbon should be as central as possible, so that an equal deposit all round can be obtained. The carbon is suspended by a clip; one bought at a stationer's answers the purpose excellently. The electrolyte is dilute sulphuric acid, and the current quarter of an ampere per square inch.

The above remarks apply to nickel plating, though greater care is required. The anode (nickel) should be shaped as in the diagram. Some nickel should first be



dissolved in a 10 per cent. solution of sulphuric acid, and then neutralised with ammonia until there is no action either on red or blue litmus paper; the bath should frequently be tested so as to keep it right. As the nickel is deposited the bath becomes acid; then, if ammonia be added to make it neutral again, you may find a few minutes later the bath is decidedly alkaline. The current strength should be somewhat stronger at first than subsequently, but it must not be so intense that the metal becomes burnt (when too high a current density is used the deposit becomes grey in colour and pulverulent, and is said to be burnt).—C. A. B.

Answer to No. 722 (*awarded* 5*s.*).—The following method is one which I devised some time ago for plating carbon, and the results which I have obtained are entirely satisfactory. The objection caused by the soaking up of the electrolyte has been avoided to a great extent by securing a rapid deposit, and this has also its industrial advantage of lowering the time requisite to produce an adherent

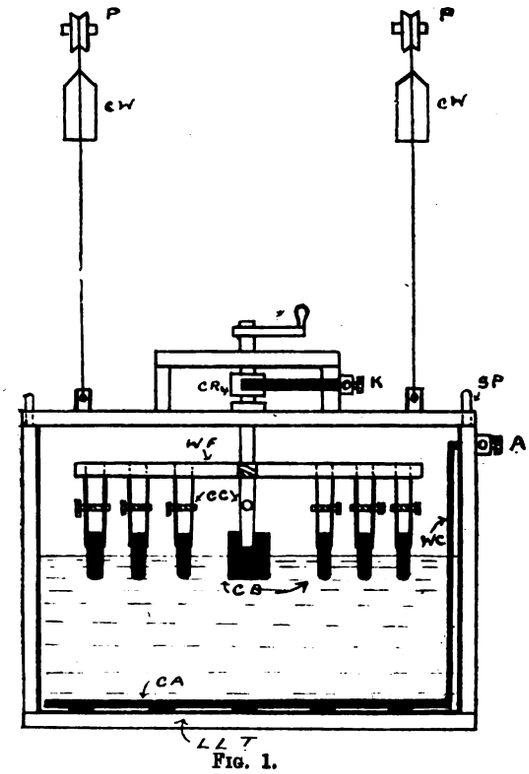


FIG. 1.

deposit. The effective operation in connection with this process is the rotation of the cathode (in this case the carbon brushes) which admits of a high current density being used, at the same time producing an adherent and uniform deposit of the metal. This rotation of the cathode causes the liberated gas to be thrown off from the surface, and, owing to the "skin" friction of the electrolyte, a very uniform deposit of copper is obtained.

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Fig. 1 illustrates an apparatus suitable for plating carbon brushes. L L.T. is a lead-lined wooden tank; C.A., copper anode, insulated from lead lining by means of glass strips, shown black; W.C, wire connection from copper anode to terminal A, insulated from electrolyte by enclosing in a glass tube; C.B., carbon brushes; C.C., clamps for carbon brushes; W.F., wooden frame, consisting of four radial arms, to which clamps are fixed; C.R., contact ring, which revolves in contact with a metal brush and forms a metallic connection between the cathode and the terminal K; P P., pulleys over which wire ropes pass and enable the frame to be raised in order to insert and remove carbon brushes; C.W., counterweight; S.P., steady pin for securing frame during rotation of cathode. Having placed the carbon brushes in position in the clamps, the frame is lowered, so that the area to be deposited upon is below the surface of the electrolyte; the frame is then rotated at a speed just insufficient to cause splashing, and the current switched on.

The following points should be noted: (*a*) the operation of lowering and rotating the frame and switching on the current should be performed as quickly as possible; (*b*) the cathode must be rotated continuously whilst the current is flowing, and only allowed to remain stationary after the current has been switched off. The actual time required to obtain the deposit is about two minutes at a current density of about 400 amperes per square foot of cathode surface. After removal from the plating frame, the plated portions of the brushes should be well rinsed in hot and cold water, and then the whole allowed to dry in a hot sawdust bath. When the drying is completed, the plated portions should be polished up by means of a calico mop treated with rouge; the metallic surface then presented should be brilliant and adherent. If the carbon brushes have been handled much before plating, they should be brushed over with an ordinary "blacklead" brush. Either of the following electrolytes will be found satisfactory:

(*a*) Copper sulphate, 20 parts; water, 100.

(*b*) Copper sulphate, 12 parts; sulphuric acid, 23; water, 64.

This method is equally well adapted to nickel-plating, the only difference being the substitution of a nickeling solution and nickel anode in place of the copper. A little practice enables this whole operation to be performed very rapidly, as no appreciable time is lost in waiting for the deposition to take place, as is occasioned when the cathode is stationary.—S.

Question No. 723.—The poles of a shunt-wound direct-current machine (bipolar) are found to be reversed after dealing with a heavy short, the current probably amounting to 350 amperes, the normal full load of the machine being 180 amperes. Can any reason be given for this?

Answer to No. 723 (*awarded* 7*s.* 6*d.*).—The polarity of the field magnets of any shunt-wound self-exciting dynamo is not a fixed property of the machine, as it is easily reversed under certain conditions. By referring to Figs. 1A and 1B it will be seen that the connections are

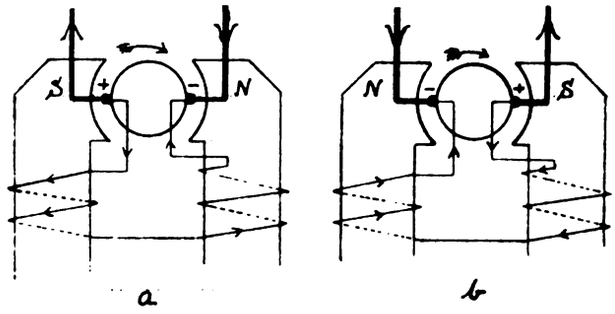

FIG. 1

unaltered by a change in the polarity of magnets, as a corresponding change takes place in the sign of the brushes. It is sometimes found necessary to separately excite from an external source the field magnets of a dynamo on test for the first time before it will excite itself; this is due to no residual magnetism existing in one of the magnets towards north polarity in excess of that in the other.

The output characteristic curve of a shunt-wound dynamo takes the form of that shown in Fig. 2. This curve shows that the voltage drops very gradually until a certain point is reached (usually about double or treble load), when it suddenly falls away to zero. This is due to the external resistance of the circuit becoming so small as to allow only a very low current to pass through the shunt coils, since the two circuits (external and shunt) are in parallel and the resistance of the latter remains constant while the former decreases. Consequently, at the point on the curve where the voltage drops away the field magnetism is very unstable, and it is under these conditions that the demagnetising field of the armature is at its maximum, as shown later.

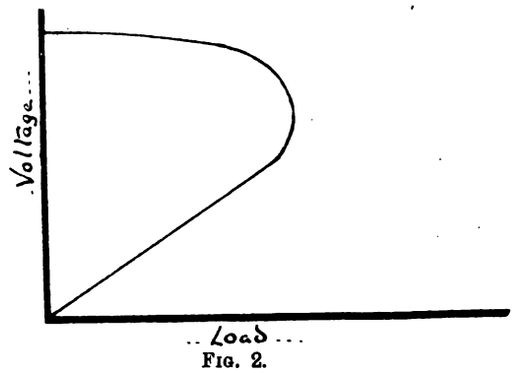

FIG. 2.

Fig. 3 diagrammatically shows a cross-section of a bipolar armature and field coils, the direction of the flow of the current in each case being by the symbols O and (×). The former indicates that the current is flowing towards the reader and in the opposite direction for the latter. The brushes are shown in the normal position with an angle of lead equal to ϕ, this lead being required to allow for the distorting effect of the armature demagnetising field. By careful study of the direction of the currents in the armature conductors, lying between the lines A and B, and also in the shunt coils, it will be seen that the field produced by these armature coils is in direct opposition to that of the shunt coils. As this demagnetising field (usually termed "armature reaction") increases with the load, it will be very strong when a dynamo becomes short-circuited, especially as the field produced by the shunt coils is in a very unstable condition under these circumstances, as stated previously when considering the curve in Fig. 2.

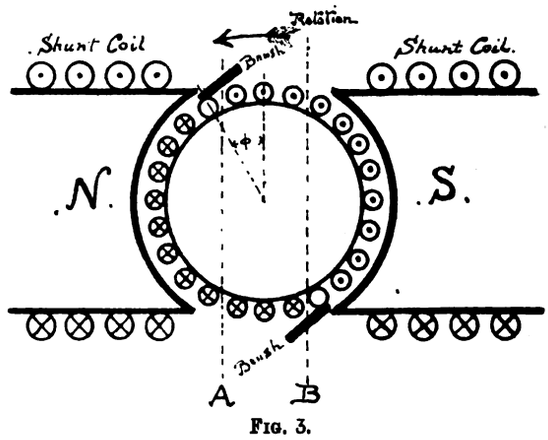

FIG. 3.

On a bad short-circuit and with inferior iron in the field magnets, the polarity of the machine is quite likely to be reversed by the field of the armature overpowering that of the shunt coils. Consequently, on removing the short-circuit and starting the machine up again, it will be found that the latter will re-excite itself in the reverse polarity due to the original residual magnetism being wiped out and replaced by residual magnetism of the opposite polarity.—P.

[Other replies to Question No. 723 will be given in our next issue.—ED. *E. E.*]

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OCTOBER 14, 1904.

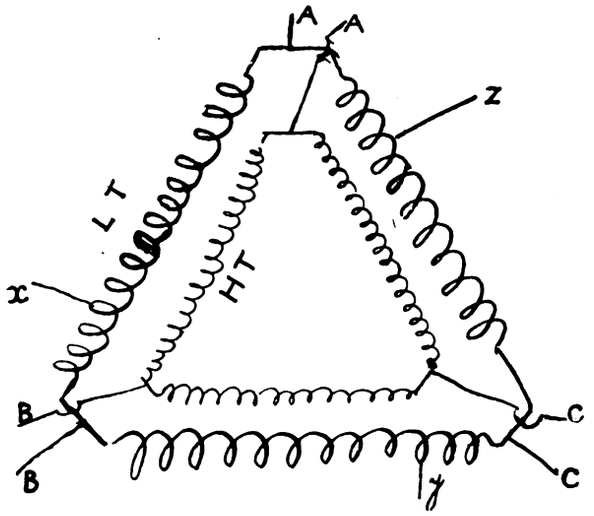
QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

733. In a three-phase sub-station for rotary converters, the three single-phase transformers are connected in mesh. From each of these transformers an extra lead is taken on the low-tension side



to provide a lower voltage for starting the starting motors of the rotaries. In what phase are these extra leads—x, y, and z?—POLYPHASE.

34. Describe the Harrison system of electric signalling for single-line working on tramways.—R. G. R.

ANSWERS.

Question No. 723.—The poles of a shunt-wound direct-current machine (bipolar) are found to be reversed after dealing with a heavy short, the current probably amounting to 350 amperes, the normal full load of the machine being 180 amperes. Can any reason be given for this?

Answer to No. 723 (*awarded 7s. 6d.*).—The explanation of the reversal of poles is a very simple one. It is easily understood that the greater the current delivered by a shunt machine, the smaller will be the voltage—magnetisation assumed constant. For by Ohm's law the loss of pressure in the armature is equal to the current flowing through it × the resistance of the armature. Now the resistance being constant (of course, it increases slightly on larger loads due to heating of the coils), and the magnetisation assumed so, it becomes clear that greater current means greater loss in armature, and therefore less external volts. In Fig. 1 is given the characteristic—the relation between voltage and current—of a shunt machine. The full line indicates the working part of the curve. Of course, there are other things which tend to reduce the pressure also. The existence of the armature cross magnetising turns necessitates the rocking of the brushes in order to obtain sparkless collection of current. This rocking of the brushes produces back magnetising turns, which, reacting on the field magnets, lower the value of the induction, and therefore lower the voltage.

Now, it is the combination of the demagnetising turns on the armature, combined with the lowering of terminal pressure, that produced the effects quoted by "C. W. S." Firstly, on the short happening a tremendous current poured out of the machine. The immediate effect was to lower the terminal voltage of the dynamo. This lowering of the voltage immediately reduced the current in the field magnets, which in turn reduced the excitation of the fields. The existence of the demagnetising turns now made its effect very sharply felt owing to the terrific current passing at the time. Again, down went the excitation and likewise the pressure, until, completely demagnetised by the armature turns, the magnetisation of the fields simply dropped out. By this time no doubt the machine was cut out. When run up again it is extremely probable that there was a small amount of residual magnetism in an opposite direction to the usual "flux," it being left by the *wiping out* action of the back magnetising armature turns. Consequently the machine generates inversely, and likewise the poles are found to be reversed.

The whole action is really due to the effect of the armature in the matter. The dotted line in Fig. 1 is the characteristic of the shunt machine beyond working loads. The machine is designed so that from A to B, the working limits, the pressure drop shall be a certain amount, but beyond this voltage falls off much quicker than formerly, until finally a point, C, is reached where the *magnetisation falls off at a greater rate than the pressure.* The result is that the

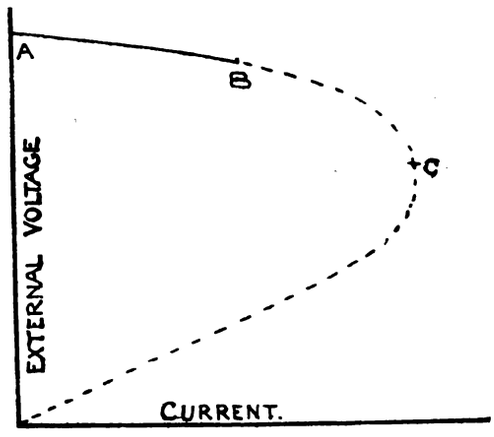


FIG. 1.

magnetisation drops out, and an explanation may be found in the fact that the back magnetising turns are much stronger in effect, the current being greater, and also in the fact that the actual magnetisation (direct) falls off much quicker at small currents (as would flow with decreased terminal pressure) than for normal currents. An examination of Fig. 2, which is an induction curve—that is, practically the relation between lines through armature and current in field coils—will make this clear. X is about the working part of the curve—that is, the position of X indicates the induction and current to be those at normal

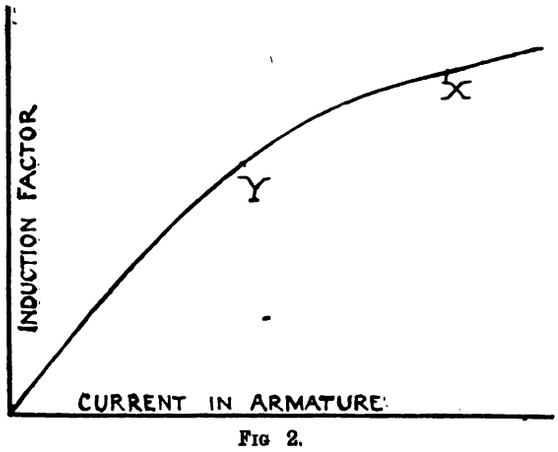


FIG 2.

load. Now, any decrease of current at X would not produce nearly as much effect as a corresponding decrease at Y. Now, any decreases that took place due to fall in terminal voltage, as indicated by the fall in A B (Fig. 1), would only act in the neighbourhood of X: whilst any fall in terminal voltage under short-circuit (the voltage, therefore, as explained before, being small) would be in the region of Y. Therefore, the whole tendency under short-circuit is to demagnetise the fields and remagnetise them in the opposite direction by the back ampere-turns on the armature. This explains the phenomena of reversal.—T. T.

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Answer to No. 723 (*awarded* 5*s.*).—It is not difficult to give a reason for this reversal of the magnetism when we consider the "characteristic curve" of the ordinary shunt-wound dynamo. In Fig. 1 two characteristic curves are shown for such a dynamo, the one marked A being the internal characteristic, and showing the relation between the total generated E.M.F. and the current in the armature; the other, B, showing the relation between the E.M.F. at the terminals of the machine and the current in the external circuit.

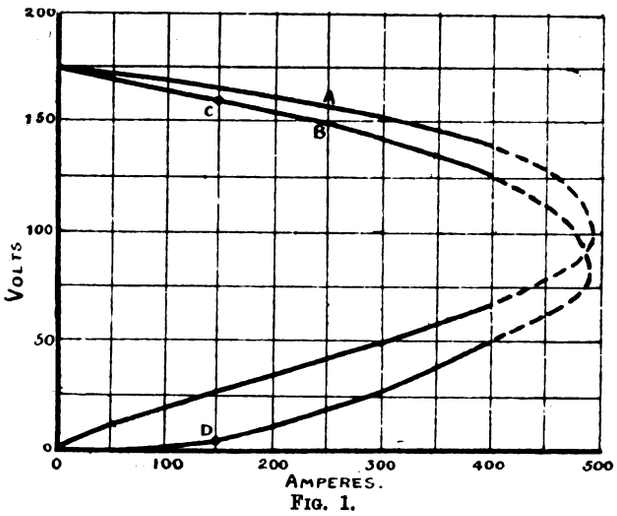

FIG. 1.

Now, suppose the machine is being worked at the point C on the Curve B—that is, it is giving 160 volts at its terminals, and a current of 150 amperes, and the short develops. The current rises and the volts fall along the Curve B, until the bend in the curve is rounded and the unstable portion is reached. The current then falls rapidly, and the voltage also falls, and we again pass through a condition at the point D where the current is 150 amperes. Now, the current in the armature of a dynamo tends to demagnetise the field magnets, because of the forward lead that must be given to the brushes, and this demagnetising action depends only on the current and the angle of lead, and therefore it will have the same value at D as it had at C; but now the volts at the terminals are only about five instead of 160 as before, and therefore the field magnets will be very weakly excited, and it is possible, as seems to have been the case in this example, that the demagnetising action becomes greater towards the end of the curve than the forward magnetising force, and hence the magnetism is reversed in direction in the field magnets.—W. S. P.

Answer to No. 723 (*awarded* 7*s.* 6*d.*).—There are two or three causes which will account for the reversal of shunt-wound dynamos, as described by "C. W. S." To understand the better what actually takes place, it will be necessary to go into a little detail concerning some of the characteristic features pertaining to them. Every such machine has what is termed its "limiting resistance" and its "critical speed." "Limiting resistance" means the lowest amount to which the external resistance can be reduced without causing the external current to fall. If this is exceeded, both volts and current fall back to zero. "Critical speed" refers to the lowest speed at which the voltage generated by a given flux through the armature is sufficient to send a current through the shunt coils large enough to produce that flux. Fig. 1 is an ordinary external characteristic curve of a shunt-wound dynamo, the ordinates representing volts, and the abscissæ current.

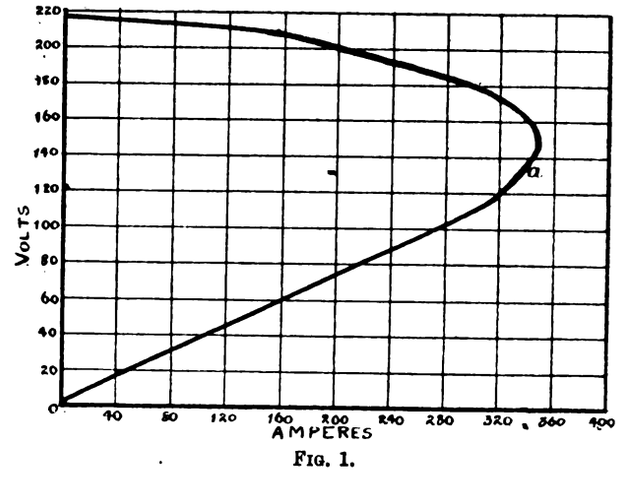

FIG. 1.

First, dealing with the "limiting resistance." When the external circuit is open its resistance is greatest, and the shunt field coils are at their maximum strength. As soon as parts of the external circuit are switched in, the external resistance becomes reduced, and the shunt field coils are proportionally weakened, because both are simply circuits in parallel, and the current flowing through them varies inversely as their resistance. The more the resistance of the outer circuit is reduced, either by the switching in of lamps, etc., or of "short-circuit," the weaker become the shunt coils, and the field-magnet flux is reduced, which results in a drop of voltage. The "limiting resistance" is reached when at a point *a* shown on the curve (Fig. 1) the resistance of the external circuit becomes so low that the voltage across the field coils is not sufficient to maintain the flux which is required to produce the voltage equal to the armature current × its resistance, and the volts and amperes fall back to zero. Secondly, a similar curve might be plotted in the same way, representing amperes and speed. If the speed for any given external resistance be reduced beyond a certain limit, then a point on the curve will be reached when the voltage will drop, and again the dynamo fall back to zero.

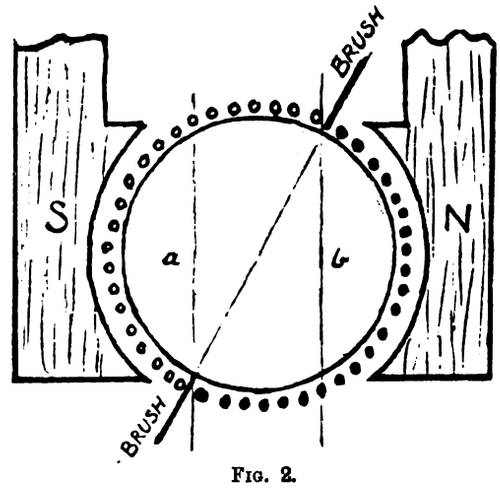

FIG. 2.

Now, let us see what happens when the "short-circuit" takes place. First, the external resistance is so much reduced that an abnormal current of 350 amperes is momentarily produced, which means that the point of "limiting resistance" has been over-reached, also the "critical speed" due to the extra load, and the machine falls back to zero. But not only is this feature (shown

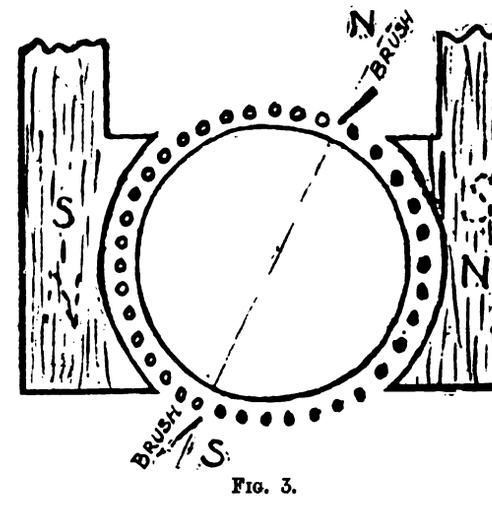

FIG. 3.

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by the characteristic curve) answerable for demagnetisation, but also for the reversal of polarity which sometimes takes place. Fig. 2 is an ordinary method of illustrating how the "back ampere-turns" of the armature react on the field. The neutral axis, or line of commutation, is advanced from the normal to make up for cross magnetisation and distortion of the field due to heavy load. This in a bipolar machine, unless the field-magnet strength is considerable in proportion to the armature, is appreciable. The result is that between the brushes there are a number of ampere-turns (shown between the two vertical and parallel lines, *a* and *b*) which are setting up a magnetic field in direct opposition to the flux of the field magnets. When the "short-circuit" takes place, an excessive current raises the value of these ampere-turns much above the weakened ampere-turns of the field, not only aiding the curve to drop as shown in Fig. 1, but completely overpowering them, and magnetising the fields in an opposite direction. This may also be further accentuated by "cross magnetisation." The current flowing through the armature, being produced by the shunt field, might lag somewhat when the shunt fails, owing to self-induction, not only producing final results similar to the foregoing, but also because of its magnetic axis being as shown in Fig. 3, different polarities are set up, as shown by the dotted letters. When the "short-circuit" has been removed, and the machine again started, it builds up with opposite polarities owing to this opposing magnetism being left as residual. These few suggestions will probably help "C. W. S." to form some idea as to what took place.—WILLIAM BEARD.

Question No. 724.—A three-phase high-pressure alternator has too large a pressure-drop from no load to full load. What means are there of remedy ing this?

Answer to No. 724 (*awarded* 7*s.* 6*d.*).—The regulation of the supply voltage of any alternating-current generator is dependent upon two things: (1) the mechanical governing of the prime mover; (2) the electrical design and nature of load.

1. Should it be found that there is a considerable drop in speed between no load and full load the fault is mainly due to the engine, and attention should be paid to the working of the governor and maintenance of full steam pressure at engine steam valve. Also the exciter, if separately driven, should not run slower due to decrease in steam pressure or any other cause. If the exciter is driven from the same engine by belt or direct coupled to the alternator, the governing of the engine is of the utmost importance, as when the load goes up, the speed decreases, causing a decrease in exciter voltage, so that we have a double reduction in our supply voltage. In any case some hand regulation is necessary to compensate for decrease in engine speed, and the drop in volts due to the increase of current in generator armature.

2. If the speed regulation is good, then we must look to the generator for the reason of the excessive pressure drop. Here, again, we have two things to consider: (*a*) the design of the machine, (*b*) the nature of the load.

(*a*) If the machine is over-rated or run at a higher speed than normal, we are bound to get a poor regulation. The pressure drop from no load to full load of an alternating-current generator is due to a combination of two things—viz., the armature resistance and its reactance. The resistance is a perfectly definite quantity, and cannot be altered without rewinding the machine, whilst the reactance is given by $(6{\cdot}28\ n\,L)$, where n is the frequency in cycles per second, and L is the inductance of the armature. The impedance, or term which governs our regulation, is equal to $\sqrt{(6{\cdot}28\ n\,L)^2 + R_a^2}$, and to improve our regulation it is necessary to reduce this quantity. There are, however, only two terms which permit of reduction—viz., the frequency or the inductance. The frequency varies directly with the speed, and to keep the volts constant the normal field current will have to be increased, and at the same time we stiffen the field by working the whole magnetic circuit at a higher flux density. The permissible reduction in speed will depend on several factors; the engine will have a smaller capacity for overloads if it is direct-coupled; any motors on the circuit will run at a correspondingly reduced speed, and the no-load currents will be higher. Also the no-load losses of any transformers will be increased, and if this generator is running in parallel with any others their speed will have to be reduced for synchronous running. The self-induction, L, of the armature may be reduced by increasing the reluctance of the magnetic circuit. This is done to a small extent by decreasing the speed and keeping the voltage constant, but we may make a further and material difference without interfering in any way with any apparatus on the circuit. This further reduction may be made by increasing the air-gap, and the extent to which this can be carried out depends on mechanical difficulties and the extent to which the field current may be increased without dangerous heating in the field coils themselves. The field may either be turned (if revolving field) or slots may be cut across the face of the pole, care being taken in either case to chamfer off all corners to prevent fringing and noise. The slots need not be cut deep, and should be not more than 2in. apart, the size and number of slots depending on the type and size of pole. At the same time it may be possible to reduce leakage and also variation in flux distribution by means of "damping coils" or wedges of copper. These may be placed in the slots already mentioned and an efficient electrical circuit completed outside, round the pole. The limits to which this increase of air-gap may be carried will depend upon the mechanical method by which the field coils are secured (if the machine is of the revolving-field type, otherwise this is not so important), the safe increase of field current and corresponding increase of field voltage, and also we must bear in mind the fact that we may be increasing the leakage flux by a considerable amount; some increase cannot be avoided, and it will vary the shape and size of poles and pole-tips.

(*b*) The second factor, which has a most important bearing on the regulation of an alternating-current generator, is the power factor. A good alternating-current machine may have a 4 to 6 per cent. drop from no load to full load with constant excitation and a power factor unity, but when this power factor falls to ·8 or ·7, as is the case in many power supply schemes, we may only have a 20 per cent. regulation. From this it will be seen that it is desirable to keep our power factor as high as possible. A low power factor may be due to a considerable portion of the load being due to small induction or synchronous motors or a large number of small transformers. In the case of synchronous motors, a considerable improvement may be effected by adjusting the field current to bring the current supply as low as possible, or if power factor indicators are installed, the field current may easily be so regulated as to give a slightly leading current. The same remark, of course, will refer to rotary converters. Small or partially loaded induction motors always decrease the power factor, especially if they are often started and stopped. Slip-ring induction motors are better than the squirrel-cage type in this latter respect, and large motors have a good power factor if they are loaded up to at least 75 per cent. of their normal capacity. A poor power factor may be due to there being a large number of small transformers on the circuit; if a number of these can be replaced by one larger one, not only will the power factor be improved, but the efficiency also will materially benefit by the change.

Should neither of these two methods be practicable or the improvements possible only small, then the only way out of the difficulty will be to add some compounding device. Two types which might possibly be tried with advantage work as follows: The Rice-Reist compensated exciter depends for its action on the fact that a lagging current tends to increase the field of a synchronous motor or rotary converter. The exciter has three slip-rings arranged on its shaft and suitably connected up to its armature winding as a rotary converter; current is led in through these three rings from series transformers, the primaries of which are in the main generator armature circuit. Even if the power factor be unity, we get a certain amount of boosting up of the exciter voltage, by reason of the series transformers supplying current, when the current through the primaries is sufficiently large, and the exciter acts as a rotary converter, whilst if the power factor is less than unity and lagging, the effect will be to still further increase the exciter voltage by increasing its field strength. The condition for this arrangement is that the product of

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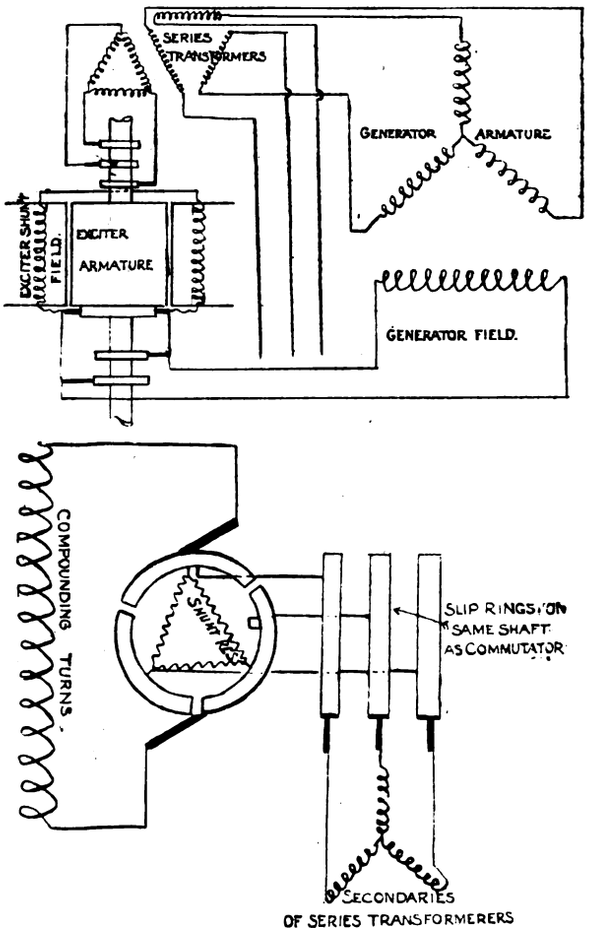
the poles and speed in revolutions per minute should be the same for both alternator and exciter, so that if the exciter is on the same shaft as the alternator, then the number of poles must be the same on both. Should the exciter be separately driven, then some positive method such as chain or gear must be employed, and the positive drive so arranged that the E M.F.'s on the exciter and alternator are in phase.

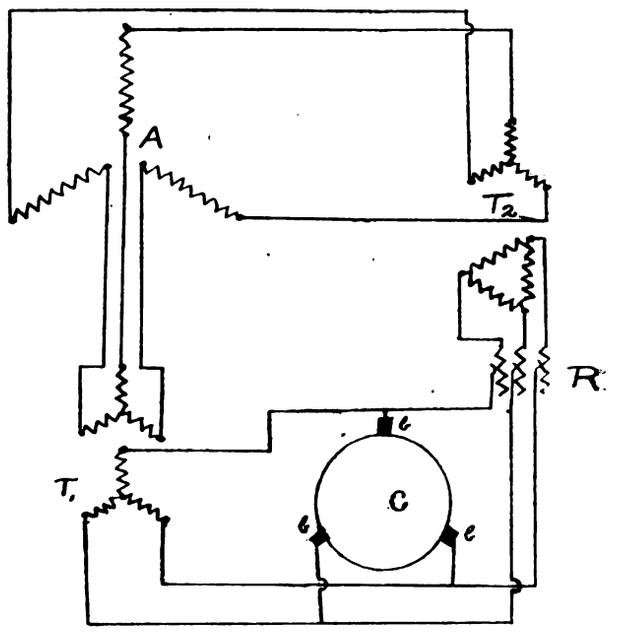
In the Rice-Reist machine the exciter field is so arranged that it can be rocked concentrically with its armature, and so regulate the amount of compounding. The diagram of connections will show the general arrangement. Another but not so satisfactory method is to fix a rectifying commutator on the alternator shaft and to rectify the secondary current from the series transformers, and pass the rectified current through additional coils placed on either the exciter field or the alternator field itself. With three-phase current it is possible to get practically direct current, not



merely unidirectional current, and sparking on the commutator can be avoided by inserting a resistance between each commutator segment. The arrangement is shown diagrammatically herewith, and the number of commutator segments required will be 1½ the number of poles on the alternator.—R. H.

Answer to No. 724 (*awarded* 5*s.*).—The excessive drop in pressure in the alternator in question between no load and full load may be due to faulty design, and therefore, in order to remedy the fault, would necessitate some constructional alteration. The principal causes of pressure-drop in alternators are armature reaction, increase of field-magnet and armature leakages between no-load and full load. Moreover, eddy-current losses and ohmic loss in armature winding affect it more or less. The armature flux due to the armature ampere-turns may be considered as having two components, one having the same path as the field flux and generally opposing it, owing to armature current lagging behind the pressure. The other component—the armature leakage flux—traverses a path not common to the field flux, and gives rise to the self-induced E.M.F. of the armature which is in quadrature with the armature current. The armature leakage flux, being confined to the neighbourhood of the armature winding, depends upon length of air-gap, form and dimensions of armature teeth, and the degree of saturation of teeth, air-gap, and pole-shoes. This flux, therefore, depends largely upon the construction of the machine. The armature reaction depends upon the relation, as regards phase, between the current and pressure in the armature. If the current lags behind the pressure, the effect of the armature reaction will be to oppose the field flux, and, if it be leading, to strengthen it. The armature reaction, therefore, can be increased or diminished by varying the power factor of the load. Its effect in causing pressure drop is less the higher the saturation of the field magnets. A well-saturated magnetic circuit conduces to good pressure regulation, as armature reaction will have less effect on the field. On the other hand, if the magnetic circuit be too highly saturated, the field leakage between no load and full load may be very great.

Synchronous alternators of the revolving field type excited and compounded on the Heyland principle have no pressure drop, and hand regulation of the field circuit in order to keep the pressure constant is not required. In the figure, C is a cross-connected commutator, with brushes, *b*, *b*, *b*, for the commutation of the alternating currents supplied to it from the transformers, T_1 T_2. The resulting unidirectional current is led around the field magnets by means of a number of inter-connected parallel circuits, which are connected to C instead of to the usual slip-rings.



T_1 is a current transformer in series with the armature windings, and supplies the "compounding" current. T_2 is a pressure transformer for supplying the exciting current. R is an adjustable resistance in the exciting current circuit.

A modification of the above method consists in compounding, where it exists, the direct-coupled exciter. The brushes in this case are connected to an auxiliary winding on the field magnets of the exciter, the original shunt winding of the exciter being retained. The compounding current, which may be obtained from a current transformer in series with armature winding (such as T_1 in the figure), is delivered to slip-rings, each of which are connected at suitable points to the commutator. The ordinary shunt winding of the exciter furnishes the exciting current necessary for the alternator at no load, and the current in the auxiliary winding furnishes the extra excitation necessary to keep the pressure constant (or, if necessary, to increase the pressure) at the terminals of the generator as the load increases.—H. J. W.

[Other replies to Question No. 724 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
OCTOBER 21, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

735. What is the most practical (not text-book) method of quickly locating faults in underground three-core lead-covered distributors (laid solid) or concentric feeders (in conduits) on a three-wire continuous-current system? Consider the following faults: (1) two cores short-circuited; (2) two cores short-circuited with "earth"; (3) earth on one core (unusual). It is required—first to quickly locate between disconnecting boxes, and then locate closely. The writer (for the latter) favours a simple system with comparatively large testing currents, such as taking drop of potential from each end of faulty main to earth, with heavy constant current passing along whole main, but fails to see how this method can be applied in the cases of (1) and (2). Accurate bridge tests, in the writer's opinion, are almost impossible for street work. Give particulars of most suitable instruments and apparatus that can be quickly arranged for tests.—R. V. M.

ANSWERS.

Question No. 724.—A three-phase high-pressure alternator has too large a pressure-drop from no load to full load. What means are there of remedy ing this?

Answer to No. 724 (*awarded 7s. 6d.*).—The fall of voltage in an alternate-current generator is due to two primary causes—viz., the self-induction of the armature and the demagnetising action of the current it carries. To reduce the former in the case of the armature with well open slots, the width of the air-gap should be increased (see Fig. 4), and in the case with closed slots the bridge at the top of the slots should be cut away. With regard to the first case, it is shown below that any advantage that is gained by increasing the gap is counterbalanced by other effects; and with regard to case 2, the remedy is, of course, impracticable if the machine is already built, and can only be adopted in constructing new machines of the same type.

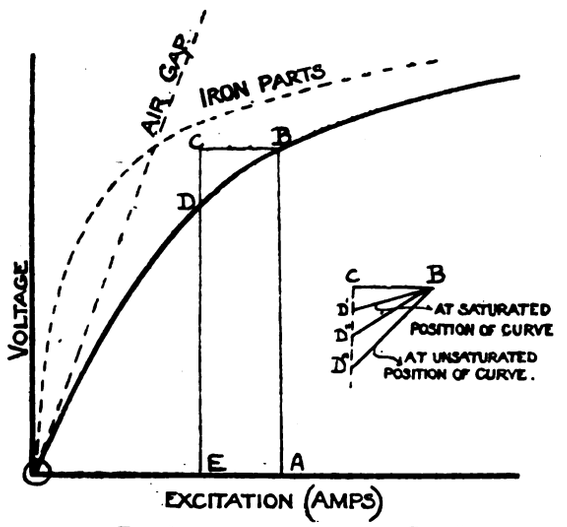

FIG. 1. FIG. 2.

It therefore remains to examine the demagnetising action of the armature currents, which will be done by reference to the no-load saturation curve shown in Fig. 2. Suppose that A B is the no-load voltage produced by the amount of excitation, O A. Then if B C is the equivalent value of the armature demagnetising effect on the magnet's current, only flux corresponding to the excitation, O E, flows through the magnet system, and the voltage, E D, only is generated. C D is, therefore, the voltage drop due to this cause. Now, if the points B and D are not too far apart, that portion of the curve between them may be taken as straight, and we can then consider B C D as a triangle in which the side C B is of a fixed length, the angle B C D is a right angle, and the angle C B D is a varying one depending upon the position of B on the saturation curve. In Fig. 2 a number of triangles have been drawn on top of one another fulfilling these conditions for different positions of B on the curve, and it is noticed that for the same amount of demagnetisation more or less voltage loss results, according to whether B is on the steep or the flat part of the curve. We therefore want to reduce the steepness of the curve at the point of no-load volts. Now, the saturation curve is made up of two curves—namely, the excitation for the air-gap and the excitation for the iron parts (see Fig. 1). We may, of course, make the slope of the curve less by increasing the excitation necessary for both parts, by making the gap longer and the iron parts more saturated, but if the magnets cannot be given more exciting current, either

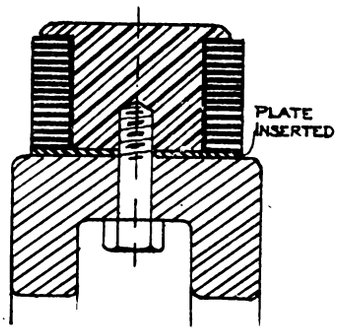

FIG. 3.

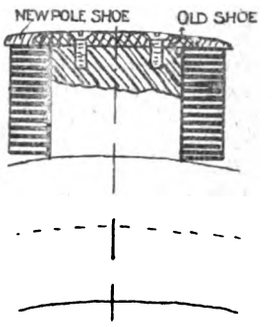

FIG. 5.

owing to the necessary higher voltage not being available, or the increased current heating the coils too much, this is not a possible solution. Therefore, to give the same excitation to attain the same voltage, but also to have the curve at this point less steep, the excitation for the gap must be diminished, and that for the iron increased by the same amount, because the slope of the air curve is constant, while that of the iron curve is continually diminishing. There are two methods of diminishing the excitation for the gap, and these are to make the width of the gap less by packing the pole-piece up with a plate of suitable thickness, as indicated in Fig. 3, or by fitting on a wider pole-shoe than the machine already has and leaving the width of gap the same (Fig. 5). There is an objection to the former procedure and an advantage in the latter. If open slots are used on the armature, most of the armature leakage goes

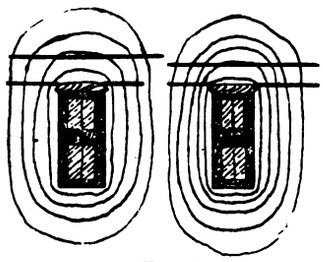

FIG. 4.

into the pole (Fig. 4), and the chief reluctance offered to these lines is therefore the gap, and if the gap is diminished the self-induction of the armature will therefore be increased. With regard to the second procedure, the self-induction is not appreciably increased, but as there will be more armature conductors under the pole at one time, the armature magnetomotive forces will set up more cross-magnetisation and less *de*-magnetisation. The iron parts may be made more saturated by turning some metal off the pole-cores. It will be noticed that if the iron parts are already saturated, and the curve has therefore already become flat, the remedy is not so effective as when they are only partially saturated. C. T. R.

Answer to No. 724 (*awarded* 5*s.*).—If there is any margin in the excitation—*i.e.*, if when giving its full-load output there is some resistance in series with the field winding and the winding does not overheat—the drop can be improved in various ways; but if the machine can only just do its full load at present, the reduction of the drop would be a

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difficult matter, necessitating partial or complete rewinding of the machine and involving its return to the makers. Assuming that there is a margin, the object to be aimed at in order to reduce the drop is the increase of the ratio of field ampere-turns to armature ampere-turns, for the drop varies almost in inverse proportion to this ratio. For a given increase in this ratio, a minimum increase in excitation would be required if the change is produced by reducing the turns in the armature coils, for this not only reduces the armature ampere-turns, but increases the field ampere-turns required to produce a given terminal voltage by about the same percentage, thus increasing the ratio and reducing the drop approximately as the square of the change in excitation. This method is, however, a troublesome one, as it involves the partial rewinding of the armature coils, and could only be satisfactorily carried out by the makers. A simpler method, though one involving about twice as great an increase in excitation as in the last method for a given improvement in drop, consists in increasing the air-gap resistance of the machine either by turning down the armature or the magnets or by reducing the pole-face area. Instead of increasing the air-gap resistance, the same increase in excitation can be obtained by increasing the iron saturation either through cutting down the cross-section of a part of each magnetic circuit or through artificially increasing the magnetic leakage—*e.g.*, by putting iron plates between neighbouring pole-pieces, as in Fig. 1. This last method is, however, less satisfactory than the others, as the iron plates not only increase the field leakage but tend to increase the armature leakage as well, and the latter, of course, adds to the drop instead of reducing it.

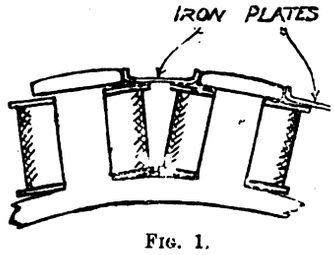


FIG. 1.

A quite different method of reducing the drop of an alternator consists in compounding it by one of the numerous processes which have been devised for the purpose. Thus, a part of the output current of the machine can be rectified (by fixing a small rectifying commutator on the alternator spindle) into a pulsating direct current, and this can be passed round an additional compounding winding on the field poles—the total excitation increasing with the load much as in a direct-current compound dynamo. As an alternative the existing exciter can be replaced by one of the patented compounding exciters—such as Hutin and Le Blanc's or the one made by the General Electric Company of America. Such an exciter could be arranged to keep the terminal voltage constant at all loads or even to increase the voltage as the load increases, irrespectively of whether it is an inductive or a non-inductive load. Any of these compounding arrangements, however, involve expensive alterations when applied to an existing alternator.—Q.

Question No. 725.—A double-cylinder, double-acting, high-speed steam-engine of 320 i.h.p. is found from consumption test to require 42·5lb. of steam per indicated horse-power hour. It exhausts against a pressure of 12lb. per square inch above atmosphere. Initial pressure of steam in the engine cylinders is 80lb. per square inch. The mechanical equivalent in foot-pounds of the heat liberated by the fall in pressure from 80lb. to 12lb. is not equal to more than half the 33,000 foot-pounds of work actually performed. As the heat units required must be from theoretical considerations more than the equivalent of 1 h.p., explain why the work performed is apparently in excess of the heat utilised.

Answer to No. 725 (*awarded* 7*s.* 6*d.*).—It appears to me that the reason for "E. G. B.'s" query is that he has not used the correct method in calculating the work done by the steam during expansion. I have worked out two cases of the problem, the first in which the steam is assumed initially dry and to expand down to exhaust pressure, and the second in which the steam contains initially 10 per cent. of moisture (dryness fraction = ·9) and only expands to 7lb. per square inch above the exhaust pressure (both these conditions entail a loss of heat), and found in both cases that the work equivalent to the expansion considerably in excess of the 30,000 foot-pounds made use of. Adiabatic expansion is assumed in both cases.

Case 1.—The temperatures corresponding to pressures of 95lb. per square inch absolute and 27lb. per square inch absolute are 323·94deg. F. and 244·33deg. F. respectively (Pullen). Now on a temperature entropy chart draw horizontal lines, A B at 95lb. per square inch absolute and C E at 27lb. per square inch absolute (or at corresponding temperatures). Then at B we have the steam as initially in the cylinder, the line B B represents adiabatic expansion, and the work done during expansion is given (in heat units) by the area C A B D. As the portion A C of the curve is practically a straight line, this area equals $B D \times \frac{A B + C D}{2}$.

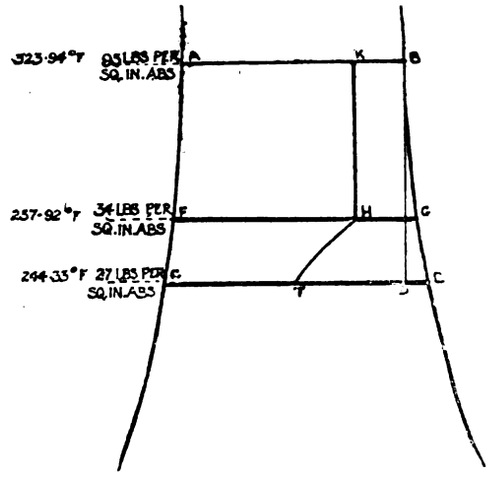
But B D equals the drop of temperature = 323·94 − 244·33 = 79·61deg. F.

A B equals the entropy of 1lb. of steam at 95lb. per square inch absolute = 1·15 ranks.

C D equals the entropy of 1lb. of steam at 27lb. per square inch absolute = 1·25 ranks.

Hence work done = 79·61 × 1·2 Fahr. heat units.

To convert this to foot-pounds we must make use of Joule's equivalent, which is one Fahr. heat unit equals 778 foot-pounds (Rowland). Hence foot-pounds of work



liberated by 1lb. of steam during expansion equals 79·61 × 1·2 × 778 = 74,322 foot-pounds.

But we are told that the engine uses 42·5 per indicated horse-power hour, and, therefore, $\frac{42·5}{60}$ = ·708lb. per indicated horse-power minute. Therefore the foot-pounds of work liberated per minute = ·708 × 74,322 = 52,620 foot-pounds, while the actuated work used is 33,000 foot-pounds.

Case 2.—In this case draw another line, F G, at 34lb. per square inch absolute (or corresponding temperature 257·92deg. F.), and divide A B at K so that A K ÷ A B = 9. Then, as before, the line K H represents adiabatic expansion to H. After the point H we have the steam at constant volume, but lowering in temperature; we must therefore proceed along a constant volume line till we cut C D in T. Then the work done during the fall of temperature is given by the area C A K H T, and this is most easily found by finding separately the two areas, F A K H and C F H T, and adding them together (H T is practically a straight line). This should be converted to foot-pounds and multiplied by ·708 as before. In this case I find the work liberated equals 46,160 foot-pounds. How "E. G. B." manages to get 16,000ft. I cannot imagine—H. E. H.

Answer to No. 725 (*awarded* 7*s.* 6*d*).—It would appear from the statement of this question that an attempt has been made to compare the test performance of a steam-engine with that which under the thermal limits imposed it might be expected to give from theoretical considerations alone. Further, it seems that the by no means uncommen error has been made of concluding that the heat available for the performance of work in a steam-engine cylinder is solely that represented by the difference in the total heat of the steam at the upper and lower limits of pressure given.

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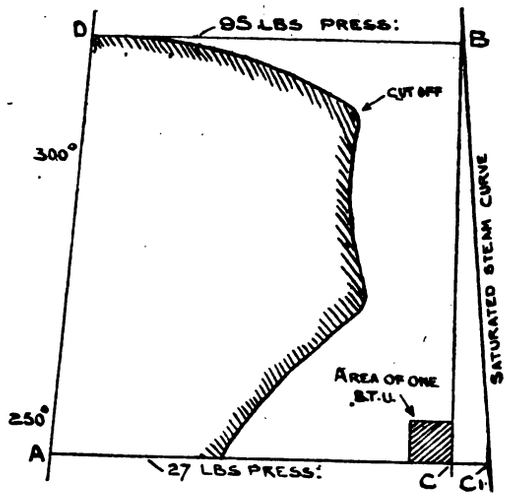
That this must have been so is evident from the following figures.

Total heat of steam at 95lb. pressure absolute = 1,180·3; at 27lb. = 1,155·8. Heat liberated by fall in pressure = 24·5; and $\frac{24·5 \times 778 \times 42·5}{60}$ = 13,500 foot-pounds, or about $\frac{13,500}{33,000}$ = 0·41, or less than the ½ h.p. mentioned.

When steam in expanding does work, it is done by virtue of its intrinsic energy, or largely at the expense of its latent heat and partly by loss of sensible heat or fall in temperature accompanying fall in pressure during expansion. It follows, therefore, that the condition of the steam or the quantity present in the engine cylinder as steam after the performance of useful or external work must be less than that admitted up to the point of cut-off, due to this heat conversion to mechanical work, and that as expansion proceeds, and the further it is continued, so the steam becomes wetter. This is true theoretically, but practically so many causes (among them the influence of initial condensation and subsequent re-evaporation due to abstraction of heat by cooler and restoration of heat from hotter surfaces) contribute to modify this conception, that usually the steam is actually drier after expansion than at the point of cut-off in the cylinder. This brief statement of facts is essential in order that it may be realised that the heat units required as the equivalent of the work done, or horse-power, are obtained from the internal or latent heat of the steam.



Returning to the case under consideration, the effect of expanding steam from 80lb. pressure to 12lb. may be graphically shown by merely drawing the adiabatic expansion line upon the temperature entropy diagram, and so ascertaining the condition as to dryness of the steam upon the assumption that it was dry or saturated steam at cut-off. The accompanying figure gives that part of the temperature entropy diagram which includes the required pressure range. Expansion commences at B, and follows the adiabatic line to C, at which point the steam occupies 14·2 cubic feet per pound. If the steam was all steam at this stage, or dry, it would occupy a volume of 15·2 cubic feet per pound, and the point C would be at C_1, or on the saturated steam curve. The proportion of steam present may be found from the ratio $\frac{A\ C}{A\ C_1}$, which in this case is $\frac{1}{1·08}$, or 92·5 per cent. The heat available per pound of steam expanding under these conditions, and represented by the area D B C A, is, by approximately correct direct measurement, 91 thermal units. (The equivalent value in thermal units of 1 h.p. is $\frac{33,000}{778}$ = 42·5.) By the test result figures, $\frac{42·5 \times 91}{60}$ = 64·5 thermal units were required per horse-power. The standard thermal efficiency of the engine is therefore

$$\frac{42·5 \times 100}{64·5} = 65·8 \text{ per cent.}$$

The point of cut-off in the engine cylinders is not stated in the question, and if an indicator diagram had been produced, more complete information might have been given. An engine of this type would, however, cut off at about half stroke, and if the admission and expansion lines from the indicator diagram were plotted on the temperature entropy diagram, an area of form indicated would be obtained. A comparison between D B C A and this area then enables the thermal efficiency to be graphically represented and an examination of the sources of heat loss to be made if desired.—Q. E. D.

Answer to No. 725 (*awarded* 7*s.* 6*d.*)—"E. G. B.," in calculating that the work performed by the steam, has apparently *neglected* the work done by the steam before the cut-off occurs, and so obtains the startling result that the engine indicates nearly twice the power supplied by the steam. The following shows that in reality the indicated power of the engine in question is only a little over half the mechanical equivalent of the heat liberated by the steam had it expanded completely and under ideal conditions. At 80lb. per square inch—*i.e.*, 95lb. per square inch absolute—the volume of 1lb. of saturated steam is 4·56 cubic feet, while at 12lb. per square inch—*i.e.*, 27lb. per square inch absolute—the volume is 14·9 cubic feet. Assuming ideal conditions, the work done between admission and cut-off is equal to the product of the effective steam pressure and the distance through which it acts

$$(95 - 27)\ 144 \times 4·56 = 44,700 \text{ foot-pounds}$$

done by 1lb. of steam before expansion commences. For these ideal conditions the law of expansion may be taken as

$$P\ V\ n = \text{constant},$$

where $n = 1·13$, the work done being the area of this curve, and is given by

$$\frac{P_1\ V_1 - P_2\ V_2}{n - 1}.$$

Substituting the actual values of pressure and the volume occupied by 1lb. of steam,

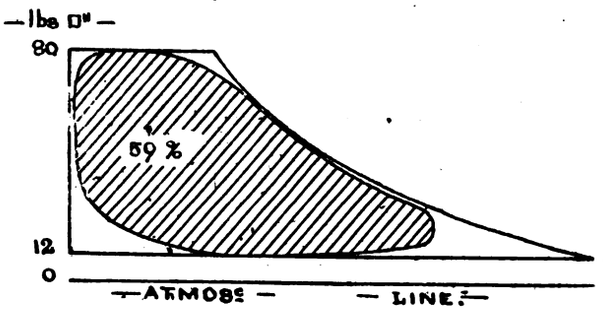
$$\frac{(95 \times 144 \times 4·56) - (27 \times 144 \times 14\ 9}{1\ 13 - 1\ 0}$$

= 34,600 foot-pounds of work done during complete expansion. The total work is, therefore, 44,700 + 34,600, or 79,300 foot-pounds per pound of steam. The actual engine uses 42·5lb. per hour, or 0 708lb. per minute, to indicate 33,000 foot-pounds, this weight of steam theoretically giving

$$0·708 \times 79,300 = 56,100 \text{ foot-pounds},$$

the efficiency of the cycle performed by the engine in question being equal to

$$\frac{33,000}{56,100} = 58·8 \text{ per cent.}$$



The accompanying diagram shows the ideal diagram, inside which the shaded area represents the probable actual indicator diagram obtained, this being 59 per cent. of the larger, and also shows the losses due to clearance, incomplete expansion, compression, etc.—J. K. C——S.

Answer to No. 725 (*awarded* 5*s.*).—The number of units of heat in 1lb. of steam at 95lb. absolute pressure above that in water at 32deg. F. is equal to 1,180 B.Th.U.; the number in 1lb. of steam at 27lb. absolute pressure above that in water at 32deg. F. is equal to 1,156 5 B.Th.U. The heat units liberated by the 42 5lb. of steam—the weight used per horse-power hour—in expanding from 95lb. to 27lb. pressure absolute are, apparently, 42·5 (1,180·7 − 1,156·5) = 1,028·5 B.Th.U. Taking Joule's equivalent at 772, these heat units converted into units of work are

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equal to $1,028{\cdot}5 \times 772 = 794,002$ foot-pounds. Now, the work actually performed by the steam in expanding between the above pressures is equal to one hour horse-power, or 1,980,000 foot-pounds—over twice the amount calculated above. It is a fundamental principle of all heat engines that the quantity of work done depends on the amount of heat which is converted into work; steam, or gas of any kind, is merely the agent by which the conversion takes place, and can do no work without yielding up heat. Now, it is a well-known fact that if saturated steam be expanded in a cylinder, and does work, that in addition to the fall in temperature of the steam due to the reduction of pressure, a certain quantity is condensed, giving up its latent heat. The quantity of steam condensed is such that the latent heat liberated is sufficient to meet the increase in the latent heat at the reduced pressure plus those units which with the units of heat liberated by the fall in temperature of the steam are, when converted into work, equal to the work actually performed by the steam upon the piston (I have neglected those units required to meet the losses due to radiation, etc.). If the cylinder be steam jacketed and the rates of expansion are high, the heat units liberated by the steam condensed in the jacket are, practically, a measure of the work done in the cylinder. In this particular case the work actually performed in one hour by the 42·5lb of steam in expanding from a pressure of 95lb. absolute to 27lb absolute is equal to 1,980,000 foot-pounds, which converted into heat units equal, say, 2,565 B.Th.U. The temperature corresponding to 95lb. absolute is 323·9deg. F., and that corresponding to 27lb. absolute is 244·3deg. F., therefore the sensible heat units liberated by the 42·5lb. of steam in expanding between these pressures are equal to $42{\cdot}5\ (323{\cdot}9 - 244{\cdot}3) = 3,383$ B.Th.U. If no condensation took place during expansion, the increase in the latent heat (assuming the specific heat to remain constant) would account for $42{\cdot}5\ (943{\cdot}1 - 886{\cdot}3) = 2,414$ B.Th.U., leaving 969 B.Th.U. to be converted into work This quantity is 1,596 B.Th.U. short of that required to produce the actual work done in the cylinder. This deficiency would be met by a certain portion of the steam being condensed, and thus parting with its latent heat. The latent heat of steam at 27lb. absolute pressure is equal to 943·1 B.Th.U., therefore the weight of steam condensed is equal to $\frac{1,596}{943{\cdot}1}$, nearly 1·7lb., or, 4 per cent. of the steam used per horse-power hour. As already stated, this quantity does not provide for the losses due to initial condensation, radiation, etc —E. G. S.

Answer to No. 725 (*awarded* 5*s*).—The direct answer to this question is that condensation takes place during the expansion of the steam, and thus the steam gives up some of its latent heat, which is converted into mechanical work. The weight of exhaust steam discharged in the form of vapour is less than the corresponding weight introduced into the cylinder, even when not taking into consideration the further condensation caused by the alternate heating and cooling of the cylinder walls. In what follows a knowledge of the elementary principles of thermodynamics and of Carnot's cycle for steam is assumed. A perfect heat engine, working on Carnot's cycle, receiving a quantity of heat Q at an absolute temperature T_1, and rejecting heat at an absolute temperature T_2, will convert the quantity of heat

$$Q\,\frac{T_1 - T_2}{T_1}$$

into mechanical work. Now imagine an engine which takes in different quantities of heat, Q_1, Q_2, etc, at absolute temperatures T_1, T_2, etc., and rejects heat at an absolute temperature T_0. As the engine is a perfect one, all the heat taken in will be used as efficiently as possible, so that the total work done will be

$$Q_1\,\frac{T_1 - T_0}{T_1} + Q_2\,\frac{T_2 - T_0}{T_2} + \text{etc.}$$

Now consider a perfect steam-engine, working on the following cycle: (1) gradual heating of the feed water from the condenser temperature, T_2 (absolute), to the boiler temperature, T_1; (2) evaporation of the quantity of steam, say 1lb., used per stroke at temperature T_1; (3) adiabatic expansion down to T_2 and condenser pressure; (4) condensation at T_2. No actual steam-engine working between the same limits of temperature can convert a larger portion of the heat received into work, hence this engine may be used as a standard of comparison for actual steam-engines. For purposes of calculation we may consider the feed water to take up its heat in a series of infinitesimal instalments at a series of temperatures from T_2 to T_1, from a series of imaginary sources, each of which has the same as the water when it is brought into contact with it. Let $d\,Q$ be any small quantity of heat taken up by the feed water at a temperature T lying between T_2 and T_1. This heat will produce the amount of work

$$\frac{d\,Q\,(T - T_2)}{T}$$

expressed in British thermal units. If h_2 is the total heat of the feed water leaving the condenser and h_2 its total heat at boiler temperature, the total work due to the heat taken in by the feed water before it is converted into steam will be

$$\int_{h_1}^{h_1} \frac{dh\,(T - T_2)}{T} \quad \ldots\ldots \quad (1)$$

The remainder of the heat taken in is the latent heat of the steam, or a fraction, q_1, of it, if q_1 is the dryness fraction of the steam as it leaves the boiler. This heat is all taken in at temperature T_1, and the work due to it is

$$\frac{q_1\,L_1\,(T_1 - T_2)}{T_1} \quad \ldots\ldots \quad (2)$$

L_1 being the latent heat of 1lb. of steam at T_1. Hence the total work done by the engine is

$$W = \int_{h_2}^{h_1} \frac{dh\,(T - T_2)}{T} + \frac{q_1\,L_1\,(T_1 - T_2)}{T_1}$$

$$= \int_{h_2}^{h_1} dh + T_2 \int_{h_2}^{h_1} \frac{dh}{T} + \frac{q_1\,L_1}{T_1}\,(T_1 - T_2)$$

$$= h_1 - h_2 + T_2 \log_e \frac{T_1}{T_2} + \frac{q_1\,L_1}{T_1}\,(T_1 - T_2)$$

since the specific heat of water may be taken as unity.

$$\therefore W = (T_1 - T_2)\left(1 + \frac{q_1\,L_1}{T_1}\right) - T_2 \log_e \frac{T_1}{T_2}. \quad (3)$$

The whole heat taken in is

$$T_1 - T_2 + q_1\,L_1,$$

and the heat rejected is $q_2\,L_2$, since the only rejection of heat is during the condensation at T_2, q_2 and L_2 being the dryness and latent heat respectively at temperature T_2. Hence, since heat taken in = work done + heat rejected,

$$T_1 - T_2 + q_1\,L_1 = (T_1 - T_2)\left(1 + \frac{q_1\,L_1}{T_1}\right) - T_2 \log_e \frac{T_1}{T_2} + q_2\,L_2$$

$$\therefore \frac{q_2\,L_2}{T_2} - \frac{q_1\,L_1}{T_1} = \log_e \frac{T_1}{T_2}. \quad \ldots \quad (4)$$

This equation gives us the dryness, q_2, at the end of expansion. In the actual case under consideration, $T_1 = 785$, $T_2 = 705{\cdot}5$, $L_1 = 885{\cdot}3$, and $L_2 = 942$. Assuming steam to be initially dry, $q_1 = 1$. Hence

$$q_2 = \frac{705{\cdot}5}{942}\left(\frac{885{\cdot}3}{785} + 2{\cdot}3 \log_{10} \frac{785}{705{\cdot}5}\right) = 92{\cdot}3 \text{ per cent.}$$

As the engine is non-condensing, the heat taken in is really

$$q_1\,L_1 + T_1 = 1,670 \text{ B.Th.U.},$$

and the heat rejected is

$$q_2\,L_2 + T_2 = 1,573.$$

Hence the greatest amount of heat that can be converted into work is $1,670 - 1,573 = 97$ B.Th.U. per pound of steam. As 42·5lb. are actually used per indicated horse-power hour, the actual work obtained from 1lb. is

$$\frac{33,000 \times 60}{42{\cdot}5 \times 778} = 60 \text{ B.Th.U.}$$

C. A. S. G. M.

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Supplement to "The Electrical Engineer,"
OCTOBER 28, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

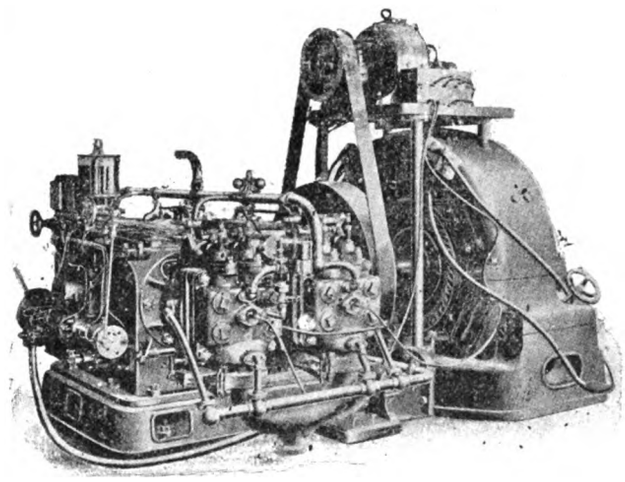
736. A shunt-wound generator is running at 440-500 volts. It is found, upon the shunt field circuit, which is separately excited, being made to the 'bus bars, a series of flashes occur midway between the commutator bars, where the conductors are joined, and the bearing surface of commutator—in other words, between the insulating varnish and air-space of the bars. This takes place immediately the shunt field or magnet coils are excited, and periodically while running on load; also, again, on breaking the shunt circuit. The armature in question was thoroughly cleaned and repainted, so it is no question of carbon or copper dust, neither is it due to oil, etc. Note that the sparking takes place between adjacent coils. Yet the generator is able to run without any undue heating, and a good insulation resistance to earth is obtained. Give what you consider the probable cause of this.—J. AINSCOUGH.

ANSWERS.

Question No. 726.—On Aug. 8 the North-Eastern Railway Company commenced an electric autocar service between Scarborough and Filey, and the other day I had the pleasure of a trip by it. The car generates its own current. A gas or petrol engine drives two dynamos, one for power the other for lighting. I didn't notice any accumulator. Can anyone furnish me with a full description of the above and discuss the advantages of converting the gas-engine power into electrical power.

Answer to No. 726 (*awarded 7s. 6d.*).—One railway after another is recognising the advantages attached to the employment of motor coaches actuated by light engines of moderate power for coping with the light traffic on their less important lines. The self-propelled petrol electric coach recently built by the North-Eastern Railway Company forms the subject of a very successful and interesting experiment. These coaches have gone successfully through an extensive series of trials, and are now running in regular service between Scarborough and Filey. The car is of the ordinary saloon type, it runs on two four-wheel bogie trucks, and measures 52ft. over the headstocks with an inside width of 7ft. 11in. It is divided into three compartments—the forward one being the engine-room, the centre part is devoted to the passengers, and the rear compartment contains the necessary controlling apparatus for driving the car backwards. Between the engine and the passenger compartments there is a gangway to permit of entrance to either compartments. Seating accommodation is provided for 52 passengers, and consists of two rows of reversible seats upholstered in the companies' usual style, situated on either side of a central gangway. The windows are provided with curtains, and the floor is laid with linoleum. The lighting arrangements consist of 24 16-c.p. incandescent lamps supplied with current from a battery of accumulators slung under the centre of the car and a small dynamo machine, which will be referred to later. The head and tail lights are also electrically fitted. The car is fitted with the usual buffers, coupling arrangements, chains, etc., and can therefore be easily used as ordinary rolling-stock.

The propelling mechanism consists of a four-cylinder petrol engine direct coupled to an electric generator, which supplies the current to two tramway motors which actually propel the coach. The engine, which was made by the Wolseley Tool and Motorcar Company, consists of four horizontal cylinders overhung on a stoutly built cast-iron crank chamber, with inspection covers above and an oil-trough beneath it. The valves of the engine are operated from two cam shafts, one on each side of the engine, driven by spiral gear and lay shafts from the crankshaft; the inlet valves are also mechanically operated. Forced lubrication is used throughout, and the engine is provided with a very efficient silencer slung under the coach, and a pipe is carried up through the roof, but as the exhaust is invisible, the coach appears to the casual observer just like an ordinary one. The crankshaft, which is "two-throw," and made of Vickers-Maxim cast steel, carries a truly balanced 3ft. flywheel. The engine cylinders and valve boxes are water-cooled—a Clarkson radiator and a Blackman fan are employed for the cooling water. The engine is governed on the throttle, but auxiliary hand throttling gear is provided, which enables the driver of the coach to accelerate the engine from either end. The ignition is on the high-tension system, with accumulators and a specially designed commutator. The fuel used is petrol of density about 0·725, and as the engine only uses one-tenth of a gallon per brake horse-power hour, and water is only used for cooling the cylinders, sufficient fuel and water can be carried for a full day's run. The total weight of the engine is 35cwt., and develops, at its normal speed of 400 revolutions per minute, 92 h.p., but when accelerated to 480 revolutions per minute (for starting quickly) it gives over 100 h.p. The dimensions of the cylinders are 8½in. diameter and 10in stroke. The engine, having four cylinders, is very well balanced, and runs extremely quietly, so that travelling in the coach is as pleasant as in an ordinary train.



This Illustration shows the Engine and Dynamo after being tested in the Wolseley Company's Works, which accounts for the irregularity of the piping and the cables.

The engine is direct-coupled to a six-pole Westinghouse generator, which is of the compound-wound direct-current type, and is of 55 kw. capacity. It is separately excited, and has been specially designed for working over a range of voltage from 300 to 550. The machine is supported on an extended bedplate, the armature being pressed on to the extended engine shaft, which is furnished with a flanged coupling between the engine and the generator. The field of the generator is split horizontally so that the upper part can be removed through an opening in the roof, provided with a movable cover so that the armature and field coils can be readily inspected. The exciter is a 3·75-kw. standard 72-volt, shunt-wound, belt-driven, multipolar generator. It is mounted on top of the main generator, and is driven by a belt from the flywheel of the latter. The function of this machine is to supply the exciting current to the main dynamo, and also the current to 30 72-volt 16-c.p. incandescent lamps. Arrangements are made whereby the voltage of this machine can be raised to 95 volts for charging the accumulators when not required for lighting.

Two Westinghouse No. 56 55-h.p. standard railway motors with single-reduction gear, ratio 13 to 64, are mounted on the front bogie by means of a nose suspension bar, with spring attached to the bogie frame. These motors are series wound, and are of the standard type usually employed for operating heavy high-speed tramcars. The controllers are the standard series-parallel tramway type arranged for electric breaking. Resistances are provided in connection with the controllers for gradually increasing the voltage of the motors at starting and for graduating the electric brake in stopping. These resistances are carried underneath the car. The engine compartment contains, besides the motor and generator, the petrol tank,

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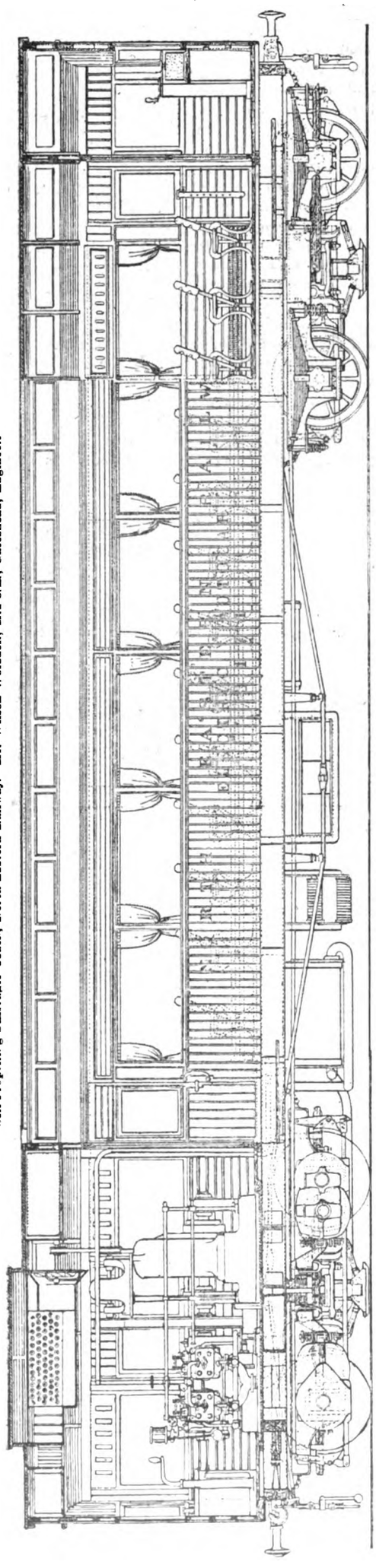
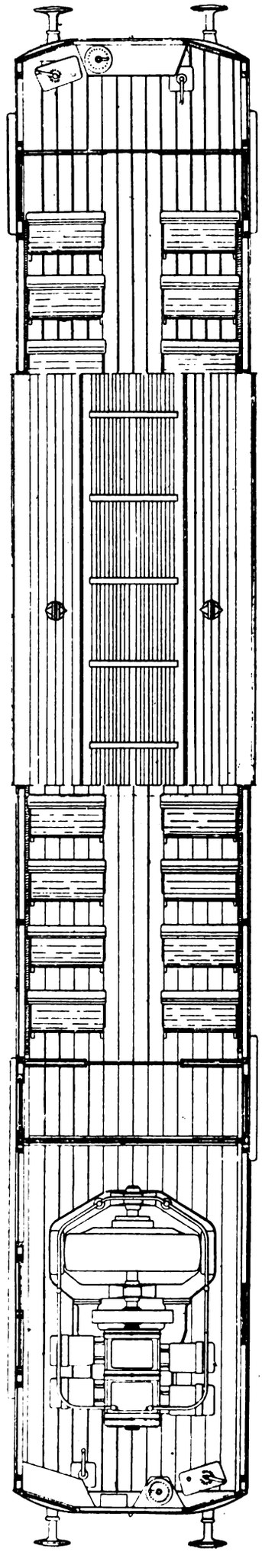


Self Propelling Passenger Coach, North-Eastern Railway. Mr. Wilson Worsdell, M.I.C.E., Gateshead, Engineer.



Sectional Elevation and Plan of Motorcar.

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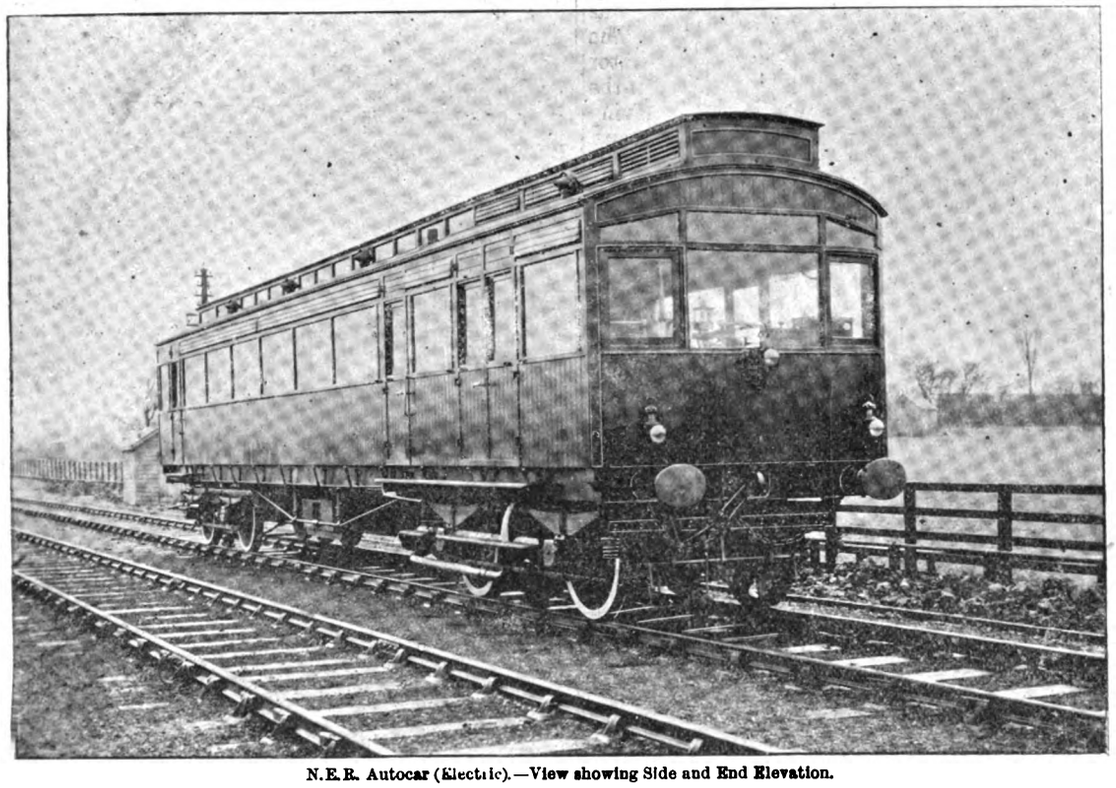
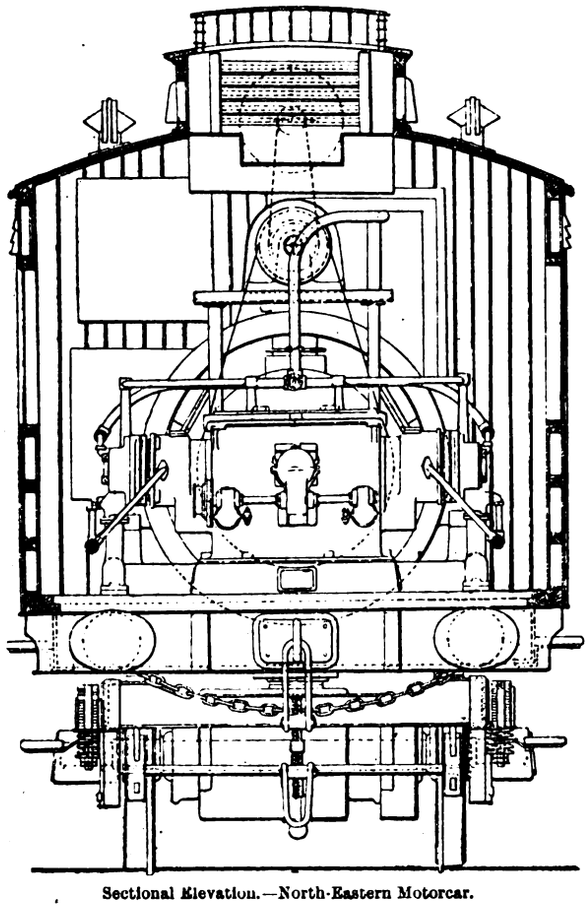
water-tank, radiator fixed in the roof, fan to induce a draught through the radiator driven by a belt from a pulley on the armature shaft of the exciter, the main switchboard, and one of the controllers already adverted to. The storage battery consists of 38 cells in ebonite jars assembled in a wooden box suspended beneath the car. Each battery has a capacity of 120 ampere-hours.

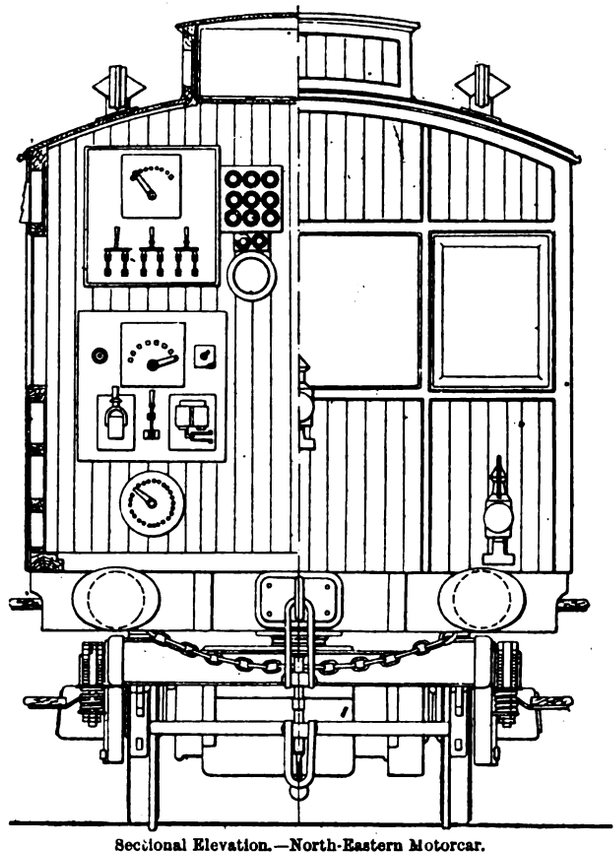


N.E.R. Autocar (Electric).—View showing Side and End Elevation.



Sectional Elevation.—North-Eastern Motorcar.

An air compressor is located on the rear bogie, and supplies air for the Westinghouse air brakes, and also for blowing an alarm whistle. It is driven by a 1-h.p. electric motor, which is automatically switched on and off by switches controlled by the pressure in the air reservoir, thus maintaining a constant pressure in the latter. Besides the air brakes, the coach is fitted with special electric brakes. These brakes consist of two electromagnets suspended beneath the wheels of each truck and immediately above the track rail. These magnets are so arranged that the magnetic circuit is completed through the rail, so that when the coils are energised the magnet is attracted to the rail, thus causing friction between the



Sectional Elevation.—North-Eastern Motorcar.

magnet and the rail, so retarding the car. The downward motion of the magnet also causes brake blocks to press on each of the wheels, thus further retarding the motion, and the two together can bring the car to rest in a very short

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distance. The brake coils are energised by the motors acting as generators, thus further increasing the braking power, and also making the brake perfectly reliable, as it does not depend upon the generator plant for the supply of power. The whole of the electrical equipment was furnished by the British Westinghouse Company. The method of working is somewhat as follows: The generator is used as a motor at a reduced speed supplied from the accumulators for starting the petrol engine. After having brought the engine up to speed, the pressure of the generator is adjusted to 400 volts by means of a rheostat in the field circuit, and the car started in the usual way by manipulating the handle of the series-parallel controller to series point for slow speed and to the multiple point for high speed. Afterwards the voltage of the generator is gradually raised to 550 volts by means of the field rheostat, and at this pressure the car will attain a constant speed of 36 to 40 miles per hour. To stop the car, the controller is turned to the "off" position and then over the braking points, thus applying the magnetic track brake. As soon as the car is stopped the generator voltage is again adjusted to 400 volts, when it is ready for starting. It will be seen that the speed is varied by varying the voltage of the generator at two points—namely, approximately half speed and full speed.

As regards the second part of the query, many people at first glance are not able to see why petrol motors should not drive the railway coaches in much the same way as they are employed to drive a motorcar, and why there has been any need to introduce the apparent complication of electrical transmission. The reason is this, that the effort required to propel a vehicle along rails is so very much less than that required to attain the same speed on the road (the average resistances as given by various authorities are: railway track, 8lb. to 10lb. per ton; turnpike road, 50lb. to 500lb. per ton). Hence railway coaches can be used which are proportionally heavier compared with the power of the engine than are motorcars. But while the power required to maintain the speed is less, the effort required to start the railway coach is proportionally greater with its increased weight, and consequently some form of variable transmission which is capable of producing extreme torque as well as extreme speed is essential. And this is provided in a highly practicable form by electric transmission using the series-parallel control system. This system gives very rapid acceleration at starting, and constitutes one of the chief advantages of the petrol-electric system over the self-propelled steam coaches.

The motor coaches when first equipped with the Wolseley motor were provided with a battery of accumulators to help the dynamo when starting the motors; but these were found too heavy, and the dynamo has now been rewound so as to be capable of giving the increased amount of current required for starting by itself, so that the main battery is no longer required and has been entirely discarded, and now only the small battery already averted to remains. These cars can be put in service in 10 minutes, can be driven from either end with equal facility, and can successfully negotiate any gradients on the company's system. The weight of the coach in full running trim is 35 tons.—H. E. H.

Answer to No. 726 (*awarded* 7*s.* 6*d.*).—This system of car propulsion, although new in its application to railway work, has been for some years in use on heavy road vehicles, such as omnibuses, and is known as the Fischer system. It consists essentially of a petrol engine driving an electric generator at constant speed, the car itself being propelled by electric motors deriving their current from the aforesaid generator. In the North-Eastern Railway equipment the petrol engine, which is supplied by the Wolseley Tool and Motorcar Company, of Birmingham, is of the four-cylinder horizontal type with two cylinders placed on each side of the crank chamber, a vertical engine having been found unsatisfactory for this purpose. The cylinders are 8½in. in diameter, with stroke 10in., and at normal working at a speed of 420 revolutions per minute the engine develops 80 b.h.p. The speed can, however, be increased to 480 revolutions per minute by hand regulation when it is required to get under way quickly. The flywheel used is 3ft. in diameter, and the rim is about 6in. wide and 4in. thick. The engine is coupled to 55-kw. six-pole direct-current generator design to work sparklessly between voltages of 300 and 550, and is separately excited by a small 3¾-kw. shunt-wound, four-pole machine, belt-driven from the flywheel at about 1,000 revolutions per minute. This exciter is wound for 72 volts, but this may be increased to 95 for the purpose of charging a battery of 38 secondary cells situated under the car body, and which do the lighting of the car when it is running. After what has already been described, the usual equipment of parallel-series controller and standard motors have been installed so that an ultimate speed of 36 miles per hour is attained on the level track. Advantage has, however, been taken of the fact that the generator is on the car, and a separate regulating rheostat has been inserted in the field circuit, so that its voltage is reduced to the lower limit when starting, thus wasting less energy in cutting down the current.

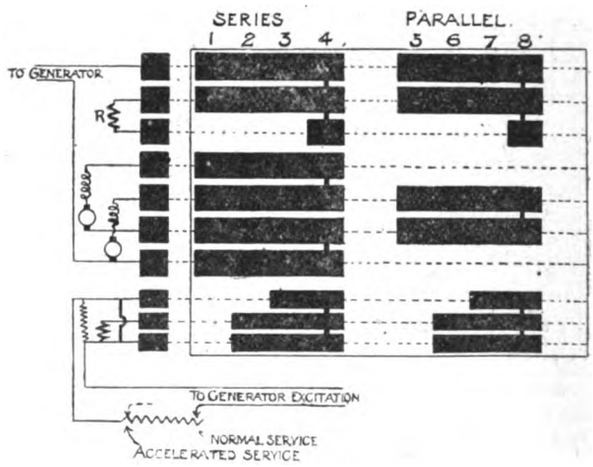

FIG. 1

The claims which may be put forward for this system are all the *advantages* of the oil-engine over the steam-engine and the elimination of the *disadvantages* of the direct-driving oil-engine by the use of the intermediate electric generator and motors. These are in the first case (1) the absence of a boiler and the attention it would require, the feeding of fuel into the oil-engine being automatic, and (2) the better thermal efficiency of the small gas-engine compared with the small steam equipment; and in the second case: (1) the oil-engine running always at a constant speed, thus giving out its power most economically at that time, at which otherwise it would be most inefficient—that is, at the time of starting; (2) the elimination of difficulties in the matter of clutches for connecting the motor to the axles at starting—the clutch being represented in this system by the electric controller; and (3) further economy at starting, as already pointed out, by reducing the voltage. An arrangement of a controller for dispensing with the use of the auxiliary rheostat at starting is shown in the figure. It will be noticed that the excitation is always on the generator, but when the car is not running the lowest voltage is being generated. On the second and third positions resistance is cut out of the generator field circuit, and on the fourth, the full series running position, the car is running at full voltage and with all resistance cut out of the main circuit between generator and motors. As already mentioned, accumulators are provided, but are used for lighting only. On omnibuses and other heavy vehicles on which the system has been used, and on which the voltage used is much lower (of the order of 80), sets of secondary cells are provided to run in parallel with the generator, and thus take the peak of the load at starting and allow a smaller equipment to be installed than would otherwise be necessary.—Z. Y. X.

[Other replies to Question No. 726 will be given in our next issue.—ED. *E. E.*]

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NOVEMBER 4, 1904.

QUESTIONS AND ANSWERS.

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Answer to No. 726 (*awarded* 7*s.* 6*d.*).—The petrol engine made by the Wolseley Tool and Motorcar Company, of Birmingham, which drives the North-Eastern Railway coach, is of 80 h.p., having four cylinders, 8½in. bore, 10in. stroke. The dynamo driven by this engine generates the current for the motors, the petrol engine being controlled by a governor working on the admission.

Now, as to the discussion regarding converting the gas-engine power into electrical power, I will presume the writer means the advantages there are in driving by the above method over other methods. I will take three ways of transmitting the power to the wheels: (1) by gearing, two or three speeds being required, and the engine thrown in at starting by either a magnetic or other friction clutch; (2) by the method used on the North-Eastern Railway coach; (3) by a direct drive from the engine to wheels of the coach (this is the Denn speed gear, illustrated in the *Autocar* of Sept. 17). The change of gear is brought about by the connecting rods having a variable throw. To weigh the advantages of these methods is not an easy matter.

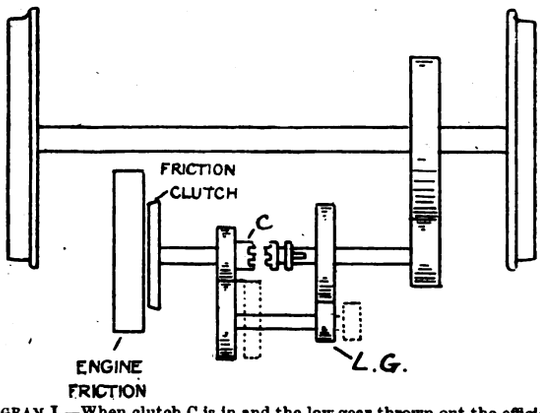

DIAGRAM I.—When clutch C is in and the low gear thrown out the efficiency is 85 per cent. With low gear in it is from 50 to 60 per cent.

Diagram 1 is a rough sketch of the most economical form of gear drive, and (2) gives an approximate idea of the Denn gear. Some details of it may not be quite correct, but the working of it is the same.

The following table gives the efficiencies.

	Efficiencies, per cent.		
	During acceleration and full load.		Normal load, say, 20 per cent. of full load.
No. 1. By gearing	50 to 60 (low gear)	...	85 (high gear)
No. 2. N.E.R. method..	75	...	85
No. 3. Denn gear.....	75	...	80

From this we see that the gearing is, taking all round, the least efficient (50 to 60 per cent. is from tests), and there is little difference between the others. The electrical method may be higher than I have put it in both columns, but the resistance when starting would bring the figure down; also the 85 per cent. in normal load column is also I think high, especially when running light, and the load on the level would be less than 20 per cent.

Now, as regards the Denn gear, if the connecting rod or coupling rod was like the locomotive, nearly all the power would reach the wheels, and on the high gear it is almost the same when C approaches D (see diagram 2). In this case the efficiency entirely depends on the clutch—a roller clutch is used in this gear—and not more than 20 per cent. ought to be lost in this. On the low gear there would be little difference. I have mentioned this gear because it must be better than the train of gearing now generally applied to traction work, and probably will be used for certain work in the future.

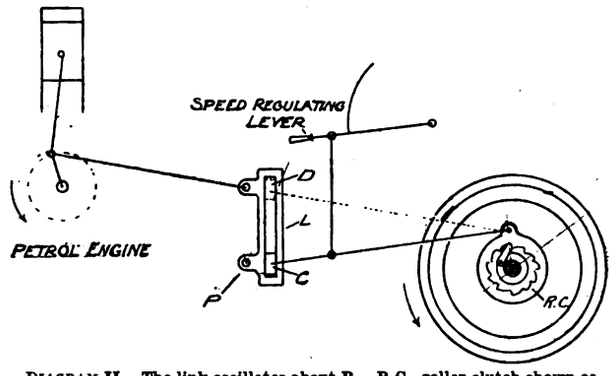

DIAGRAM II.—The link oscillates about P. R.C., roller clutch shown as paul and ratchet.

In further favour of the petrol engine for use on railways, the Wolseley Company have just secured an order for a six-cylinder engine of 140 h.p. from the General Electric Company, of Schenectady, N.Y., for the first of their petrol engine coaches. It is not impossible that the locomotive may be gradually superseded by the more economical gas-engine when a suitable gear or combination of cylinders is used. This same company are building a small shunting locomotive of 24 h.p., the engine being covered by a bonnet of the outline of a tank engine, and the vent of the silencer takes the form of the locomotive funnel (*Autocar*, Sept. 17). I have not touched on the possibilities of the pneumatic system (compressed air transmission), the efficiences of this system being uncertain.—J. ARNOLD.

Answer to No. 726 (*awarded* 5*s.*).—The self-contained autocars used on the North-Eastern Railway are 52ft. long over all, and are divided into three compartments. The front one contains the petrol motor-driven generator, switch, and other controlling and braking gear for driving the car from this end. The centre portion of the car is for passengers only, and the third (or end) portion contains the necessary controlling and braking gear for operating the car from that end. The generating plant consists of a 80-h.p. four-cylinder horizontal Wolseley petrol motor, running at 420-480 revolutions per minute. All the valves are mechanically operated by cams from a worm-driven cam shaft. The cylinders and valve boxes are water-cooled, and forced lubrication is employed where possible. This petrol motor is direct-coupled to a 55-kw. separately-excited compound-wound generator, designed to work over a wide range of voltage—*i.e.*, from 300 to 550 volts—with the normal speed of the engine 420 revolutions per minute. A small shunt-wound exciter is fixed above the main generator, and is driven by belt from the engine flywheel; its capacity is about 4 kw. at 72 volts, and is used, in addition to exciting the main generator, for car lighting, and by increasing its voltage for charging a battery of 38 cells suspended under the car. The storage battery supplies current for running the generator as a motor for starting up the petrol engine, also for car lighting when required.

We now come to the driving gear proper. This consists of two 55-h.p. Westinghouse series-wound traction motors, suspended in the usual way on the forward bogie, geared to the running wheels by single-reduction gearing. The controllers are of the ordinary series-parallel control type, with rheostatic braking notches. In working the generator (which is kept running when once started for the day), voltage is adjusted by a rheostat in the field circuit to 400 volts; the car motors are then started up in the usual way. The generator voltage is then gradually increased to 550 volts, at which pressure the car will rapidly speed up to 36 miles per hour. A small motor-driven air com-

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pressor supplies air for blowing a hooter or alarm whistle. Although this method of working seems a very inefficient and a roundabout way of obtaining power, the advantages gained more than compensate for the loss in efficiency that could be obtained by more direct means. As this double conversion of power is the only way of obtaining electric motive power, with the exception of external sources or a heavy and troublesome storage battery, it must be used.

The advantages are as follows: (1) the operation and control of the car is more convenient and effective by using electrical power; (2) more rapid and smooth acceleration is possible than with either steam or petrol motors direct, and for runs with many short-distance stops this is a most important point; (3) various economical rates of speed can be easily and quickly arranged; (4) the car can be driven from either end and in either direction. It will be seen from the above that the method of driving described has many advantages that would be almost impossible by using either steam or oil engines direct. For further particulars the reader is referred to the *Electrical Engineer* for April 17, 1903.—MAGNUS H. VOLK.

Question No. 727.—State how to enter the navy as an electrician, the duties of same, and the prospects.

Best Answer to No. 727 (*awarded* 10*s.*).—The post of electrician in the Royal Navy is open to all able-bodied young men, of good character, who have had experience as fitters in electrical shops. Candidates must be between the ages of 21 and 28, have a chest measurement of 32in., and stand 5ft. 3in. in height, although *specially* desirable candidates *may* be received under that standard. The height measurement is taken without shoes, and the chest measurement without clothes. Candidates should ascertain whether they come up to these requirements, and should, as a rule, apply by letter, before incurring travelling or other expenses in proceeding to a recruiting office.

Conditions of Entry.—The "King's Regulations and Admiralty Instructions" contain the terms and conditions under which men accept service in the Royal Navy. Candidates are entered as acting electricians, and are required to sign an engagement on entry to serve for 12 years' continuous service. After a course of training in a torpedo school, they are, if found duly qualified by conduct and abilities, confirmed in the rating of electrician, fourth class.

Medical Examination.—All candidates before being accepted are subjected to a strict medical examination by naval medical officers, and are required to be free from any physical defect or disability. The recruiting officer arranges for a provisional examination, when necessary, by a local medical officer at Government expense. Candidates who are accepted by the recruiting officer are sent free of cost to a naval depôt or training ship for an educational examination. Candidates are examined for entry on board the H.M.S. "Vernon" at Portsmouth and H M.S. "Defiance" at Devonport. Those for the Chatham Port Division are at present examined and trained on board the "Vernon."

Nature of the Educational Examination —The examination consists of three sections—viz., general education, theoretical technical, and practical technical. The first comprises a general education equivalent to the sixth standard in a Board school—that is, vulgar and decimal fractions, simple interest, dictation, and reading. The theoretical part of the technical examination consists of questions on the general construction of electrical apparatus, instruments, motors, etc., simple testing, etc. The practical part requires ability to perform the following jobs, etc.: relining and adjusting bearings; using a lathe, screw-cutting test for bolt and nut; repairs to any part of electrical apparatus, instruments, motors, etc. Candidates provisionally entered but rejected at the final examination are granted free passes to their homes.

Rates of Pay.—The rates of pay (besides provisions) are given below. Men are paid weekly at home and monthly abroad. Men re-engaging after completing the time for a pension receive 3s. 6d. a week extra: Electrician—On entry as fourth-class electrician, 38s. 6d. a week; advancing to third-class electrician, 40s. 3d. a week after three years' service; advancing to second-class electrician, 42s. a week after seven years' service; advancing to first-class electrician, 45s. 6d. a week after 12 years' service. Chief electrician—Second-class chief electrician, 49s. a week, advancing to chief electrician, first-class, after six years' service in the preceding rating, 52s. 6d. a week.

Messing.—A free ration is given, including 1lb. of meat, etc. For any portion not taken up "savings" are paid, with which relishes can be bought at the canteen. If not provisioned, men are given allowances of 1s. 1d. to 1s. 6d. a day in lieu. Chief electricians and electricians mess with the chief petty officers.

Allotments.—Great facilities are given for allotting or remitting money to families and friends free of expense; besides this, savings banks are established on board his Majesty's ships, and at the principal home dockyards, in which interest on deposits (3¾ per cent.) is paid by the Government.

Allowances towards Outfit —On entry and again on engaging to complete the time for pension (22 years), electricians receive £3. 10s. towards the cost of the outfit which they have to obtain, and £1 for bedding, subject to certain conditions specified in the "King's Regulations."

Medical Attendance.—Medicines and hospital treatment, both at home and abroad, are provided at the Government expense. In cases requiring it, treatment in a naval hospital is allowed, full pay being continued for three months, with a slight deduction after the first 30 days.

Leave.—Leave on full pay is allowed both while serving at home and on return from foreign service. This leave, after a full term of foreign service, amounts to six to eight weeks.

Gratuities.—Gratuities for good conduct, ranging from £5 to £15, are given to continuous-service men on being pensioned.

Pensions.—Life pensions of over £1. 1s. a week will be granted after 22 years' service with very good character; for each additional year of such service £2. 5s. 7d. a year extra pension will be given. Electricians are, if physically fit, allowed to remain in the service till they reach the age of 50 years. Men invalided for disability contracted in the service receive gratuities or pensions proportional to the length of service and conduct. Men incapacitated for duty by injuries or disabilities attributable to the service receive special consideration. If men are killed on duty, pensions will be given to their widows and allowances to their young children, who may also receive educational advantages.

Good Conduct Badges.—These badges, of which three may be obtained, are, in the case of electricians, as far as weekly pay is concerned, honorary, but reckon for an increase of pension.

Position.—Electricians are classed as chief petty officers, a position which carries with it many privileges.

Duties —These consist chiefly in the care and maintenance of the electrical apparatus on board, which differs little from an ordinary land installation.

Promotion.—Electricians on the completion of eight years' service, of which five must be at sea, are eligible for examination for advancement as vacancies occur in the rating of chief electrician.

Uniform.—The uniform worn by this rating is detailed below. Chief electricians wear three buttons on each sleeve of long jacket; all others wear an opening at the cuff with two small gilt buttons. In undress, the long jacket is made of blue serge or duck, single breasted; trousers of blue serge or duck. Long jacket—blue cloth, double breasted; monkey jacket—thick cloth, similar to above as an overcoat; white drill tunic, for hot climates; trousers—blue cloth or white duck; waistcoat—blue cloth, single breasted; cap—blue cloth with peak and device of crown and anchor in gold on purple ground; buttons—gilt, uniform.

For further information apply to the Royal Marine Recruiting Staff Officer, at 7, Whitehall-place, London, S.W., or to the Captain, Royal Naval Torpedo School, Portsmouth or Devonport.—H. E. H.

Answer to No. 727 (*awarded* 7*s.* 6*d.*).—The conditions laid down by the Admiralty for the entry of electricians into H.M. Navy are as follows. The candidates shall be able-bodied young men of good character. They must have had experience as fitters in electrical shops. The age limit of entering is from 21 to 28, and the candidates' stature should be 5ft. 3in. in height with 32in. girth of chest, but if the

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candidate is such as is specially desirable for the service, this standard may be lowered. Before he can be entered the candidate must pass a twofold examination—viz., education and practical work. The education comprises arithmetic, dictation, and reading; the arithmetic including vulgar and decimal fractions and simple interest. The practical consists of such work as relining and adjusting bearings, repairs to electrical apparatus and instruments, metal-turning and screw-cutting on a lathe.

The successful candidate enters the service as a chief petty officer, and the scale of pay is as under: on entry, 38s. 6d. per week; after three years, 40s. 3d. per week; after seven years, 42s. per week; after 12 years, 45s. 6d. per week, also free navy rations. After eight years' service he becomes eligible by examination for advancement to chief electrician, and is rated as vacancies occur. This scale of pay is: under six years as chief electrician, 49s. per week; after six years as chief electrician, 52s. 6d. per week, with free navy rations. As electricians are chief petty officers from date of entry, their service counts for increase to pension, and they can get as much as £1. 1s. per week after 22 years' service, and may increase such pension by £1. 10s. 5d. a year for each subsequent year served with good conduct up to the age of 50. The foregoing I have copied from a book which can be had at any of the naval recruiting stations.

Now, regarding their duties. To be brief, the electrician has to keep in working order and to do the ordinary repairs (the big items being relegated to the dockyards) to lighting circuits and fittings, motors and circuits, bells, telephones, etc., and holds himself directly responsible to the naval lieutenant told off for torpedo and electrical duties. The dynamos on a modern British battleship comprise four, each of about 50 kw. (the total output not being so great as in some of the foreign navies or the ocean liners). All the circuits, fittings, etc., are on the watertight two-wire principle; further detail does not come into the question. Applications from a distance can be directed to "The Captain, the Royal Naval Torpedo School," or to "The Commander, the Naval Recruiting Office," either at Portsmouth or Devonport. There is a notice in the recruiting office to the effect that there are no vacancies at present.—WILLIAM BEARD.

Answer to No. 727 (*awarded* 7*s.* 6*d.*).—The following particulars, which may prove useful to "H. W. H.," are extracted from the pamphlets which are issued by the Admiralty as a guide to prospective candidates on how to join for service in the Royal Navy.

Electricians.—Able-bodied young men of good character, with experience as fitters in electrical shops. Age, 21 to 28 years; girth of chest, 32in.; height, 5ft. 3in., but specially desirable candidates under that standard may be received.

Nature of Examination.—Educational: sixth standard—vulgar and decimal fractions, simple interest, dictation, and reading. Practical: relining and adjusting bearings; repairs to electrical apparatus and instruments; metal-turning and screw-cutting on a lathe.

Candidate's Entry Form.

.....
.....} Full address.

.....(Date).

I am desirous of being considered as a candidate for entry in the Royal Navy.

I wish to enter as .....(state rating).

My age is.....years.....months, and my height is.....ft.....in., and chest measurement.....in.

I can satisfy the educational and medical requirements, and give satisfactory references as to my character.

Please send me directions how to proceed.

.....(Signature.)

To the Admiralty Recruiting Officer,

.....

[Address of officer for electrician rating:
Captain, Royal Naval Torpedo School,
Portsmouth or Devonport.]

Pay and Position.—Electricians are entered as chief petty officers, a position which carries with it many privileges. The pay is as follows: As electrician—pay on entry, 38s. 6d. per week; after three years, 40s. 3d. per week; after seven years, 42s. per week; after 12 years, 45s. 6d., and free rations. As chief electrician—under six years as chief electrician, 49s. per week; after six years as chief electrician, 52s. 6d. per week, and free rations. After eight years' service they become eligible by examination for advancement to chief electrician, and are rated as vacancies occur. £4. 10s. is allowed on entry towards cost of outfit. Pensions to chief electricians and electricians: as electricians are chief petty officers from date of entry, they can get as much as £1. 1s. a week after 22 years' service, and may increase such pension by £2. 5s. 7d. a year for each subsequent year served with very good conduct up to the age of 50.

A short time ago an Admiralty recruiting officer stated to the writer that a candidate for the rating of electrician must be a fitter and turner, and possess a thorough working knowledge of the art of screw-cutting. If necessary, the candidate would be given an electrical training after joining the service.—S. L.

Question No. 728.—A house wiring specification calls for all casing under floors to be "half mitred and screwed." Give particulars, with sketches, of requirements, mentioning any other method ensuring a firm and workmanlike job.

Answer to No. 728 (*awarded* 7*s.* 6*d.*).—The specification in question calls for casing to be half mitred, which I take to mean a half-lap mitred joint. Fig. 1 shows two

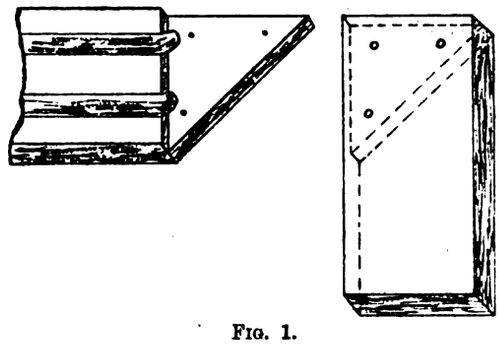

FIG. 1.

pieces of casing at right angles to each other, ready for jointing. By the above method you can make a strong job, because you can screw the half-lapped parts together. When two pieces of casing meet as shown in Fig. 1, one piece will be laid across the joists, and the other between two joists. The length between the joists will have no support, only at the ends that are screwed,

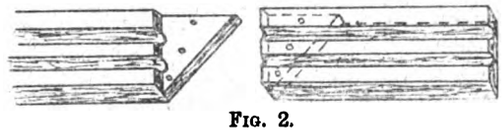

FIG. 2.

therefore a stemming piece should be fitted between the joists at intervals of about 6ft. or 8ft., to support the casing and keep the strain off the joints, which are half-lap mitred. Fig. 2 shows two pieces of casing ready for jointing, to form one length; you can also screw these half laps together. By this method you can save a lot of short pieces of casing, because if this method is not adopted you have to joint your casing in the middle of a joist, allowing

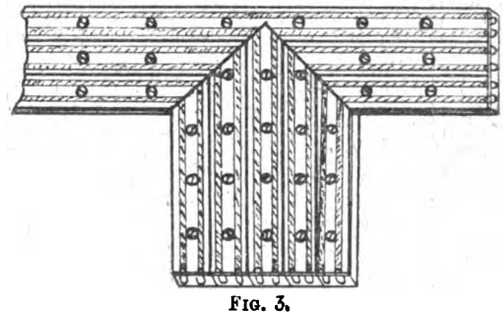

FIG. 3.

each length to come half-way on to the joist. This method no doubt takes up a lot of time. The capping in this method should be mitred in the ordinary way and screwed down. Where casings are run on the surface they can be made to look neat if they are half-lap mitred or mitred, and the capping mitred as shown in Fig. 3. Where casings have to cross each other on the surface, a bridge piece should be cut and

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screwed on, as shown in Fig. 4. This prevents the wires crossing each other. A very good way of jointing casing under floors is to mitre each length and joint them on a joist so as to get a screw or nail in each end, and the lengths which go between the joists should be left long enough to get a screw through the two casings, and so keep the strain off the wires In places where the wires go through fireproof walls or floors, or where they might be subjected to water, iron pipe should be passed through to carry the wires, and after the wires are drawn in and the casing fit close to the end of the pipe, the ends should be sealed up with magnesia cement. Some architects won't allow the joists to be cut up for casing, and in some cases holes are bored through each joist to allow the wires to pass through, then casing is fixed on the wires between each joist and allowed to hang on the wires. This is not a satisfactory job at all. In cases

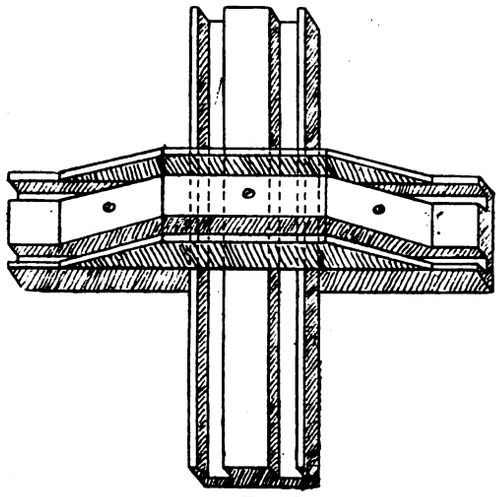


FIG. 4.

where the joists are not allowed to be cut for casing, tubing or conduits should be installed with plenty of inspection pieces, which makes a very strong and reliable installation, and does not require so much cutting of the joists. In an installation of this description, loop wiring, and split up into circuits, is the best method; thus you will have no joints whatever.—J. P. S.

Answer to No. 728 (*awarded* 7*s.* 6*d.*).—To half mitre casing is very unusual, the idea is to more completely "break" the joint. Half-mitred joints, though seldom employed by the wiremen, are well known to the carpenter, and require some little care in fitting to ensure a good job. A half-mitred right-angled joint in casing is

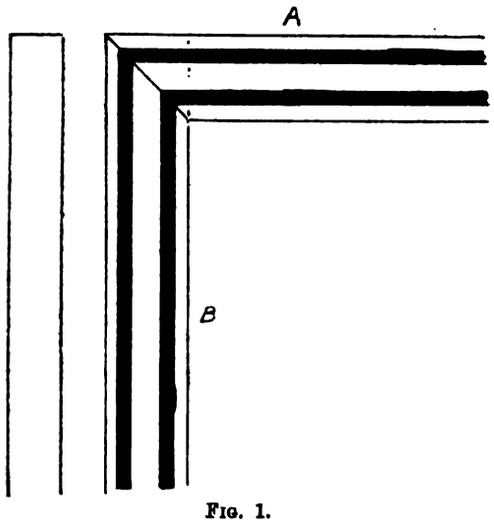


FIG. 1.

shown in Fig. 1. In order that the joint may be the more easily understood, Fig. 2 shows two views of *a*, and Fig. 3 two views of *b*. Fig. 4 is a half-mitred straight joint, *b* is cut the same as *b* in the right-angled joint, but *c* is cut rather differently, as shown in Fig. 5. It will be seen that although the joint is better covered, parts of the casing are so cut that they are very weak. Most engineers are satisfied with an ordinary mitred joint.

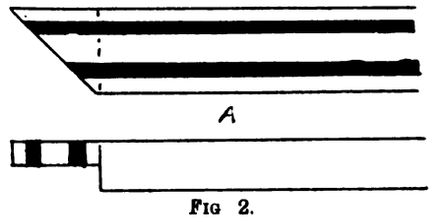


FIG 2.

It is good practice in any case never to make the joint in the capping over that in the casing. Casing should always be screwed in preference to being nailed. Where nails are

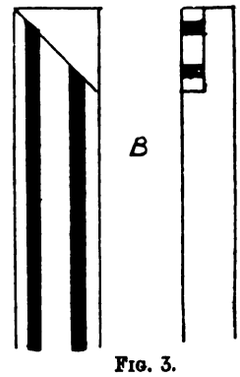


FIG. 3.

used the main consideration is cheapness. When casing is run under floors, it should be so let into the joists that it comes under the middle of a board. If casing is run under

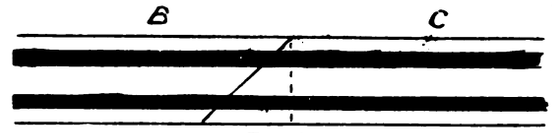


FIG. 4.

the joist between floorboards, there is great danger of water, etc., finding a road to the casing. In good work all boards over casing are screwed down. They may then easily be

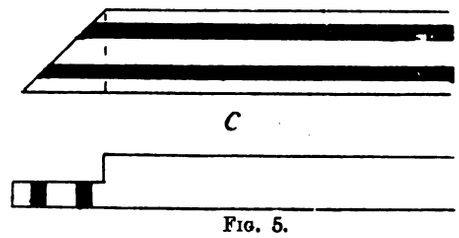
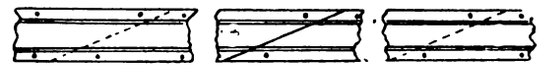


FIG. 5.

removed, if necessary, to inspect the wiring. All casing should be well painted or varnished. A thick layer of fireproof paint is also very desirable.—M. M.

Answer to No. 728 (*awarded* 5*s*).—A mitre is usually cut at an angle of 45deg. and a half mitre at an angle of 22½deg., although the latter term is seldom met with.



Presumably the idea is to use the half mitre at joints in the straight runs, so as to avoid plain butt joints. If the joints in the capping are kept well away from those in the casing, and are cut at the same angle, the capping will, if well screwed, keep the several lengths of casing well in line, and a good stiff job will be made. When the casing runs parallel with the joists, and is supported by means of strips placed from joist to joist, these strips should not be more than 5ft. apart. In the sketch three joints are shown—two in the casing (dotted lines) and one in the capping (continuous line).—A.

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Supplement to "The Electrical Engineer,"
NOVEMBER 11, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

737. Describe what you consider the best method of locating a middle-wire earth in any section of a network, giving sketches of same.—READER.

738. Describe a practical way (other than by indicator card) of taking valve settings of Willans three-crank compound engine fitted with automatic expansion.—VALVES.

ANSWERS.

Question No. 729.—Much trouble has been experienced with various hand-wound armatures, on which wire of 18 S.W.G. and smaller has been employed, owing to breaking of end connections while running. The breaks always occur within ½in. of the end of the core and in the *straight* wires. Please explain the cause of the trouble and suggest remedies.

Answer to No. 729 (*awarded 7s. 6d.*).—If by "end connections" the connections to the commutator are meant, the trouble is one from which most makes of small armatures have suffered. The cause is the perpetual vibration to which the short stretches of unsupported wire forming the connections to the commutator are subjected. This vibration may be due to (1) vibration of the whole armature, due to inaccurate balancing; (2) relative motion between the armature winding and the commutator, owing to the latter being insecurely attached to the spindle—*e.g.*, by means of a single small grub screw in place of a proper key; (3) electromagnetic interaction between the current in the connecting wires and the leakage magnetic field in which they are rotating. This last cause is, however, unlikely to be present to any great extent in a small armature.

The remedy usually resorted to, generally with complete success, is the employment of thicker wires to form the commutator connections. Thus, on all armatures wound with a wire smaller than about No. 16 S.W.G., half a turn of winding at the start and at the finish of each section is cut off and replaced by a piece of larger wire (about No. 16 S.W.G.) sweated on. These thicker wires are held firmly on the core amongst the other wires by means of the usual binding bands, and their increased cross-section enables them to withstand the unavoidable vibrations much better than the smaller wires which they replace. Sometimes each end of each section, to a distance about equal to half a turn, is doubled back and twisted on itself, thus practically doubling the cross-section of the connections. Part of the double wire thus made is clamped under the binding bands, and the remainder forms the connection to the commutator.—Q.

Answer to No. 729 (*awarded 7s. 6d.*).—The wires break at a spot between the core and the commutator because they are weakest just there. The vibration which is set up when the armature is running tends to crystallise the wires at the point where they eventually break. If the commutator does not fit tight on its pin or key on the spindle there will always be a very slight relative movement between the commutator and the core, which will be communicated to the wires behind the commutator. The straight wires, being less flexible than the curved ones, naturally tend to break first. Again, the heat imparted to the wires during the operation of sweating them to the commutator segments makes the wires brittle at a point where they enter the commutator. This can be obviated by dispensing with solder and using instead small steel grub screws for attaching the wires to the segments, a practice which has become quite common on the Continent.

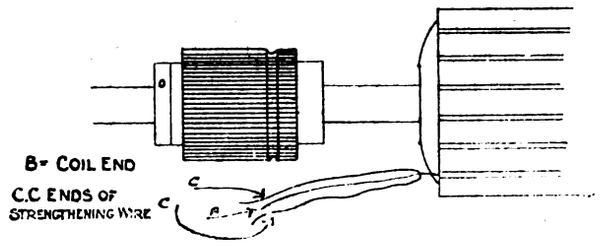

FIG. A.

The most effective remedy against these breakages is to strengthen the wires themselves. This may be effected in several ways: (1) by twisting together that pair of wires which is to be coupled to the same segment; (2) by doubling back the finishing end of each coil and twisting together the two wires of the loop thus formed; (3) by attaching "strengthening wires" to the coil ends (see Fig. A) as close as possible to the core, and twisting the three ends together and inserting them into the same segment (see Fig. B). Additional strength may be given to these twisted

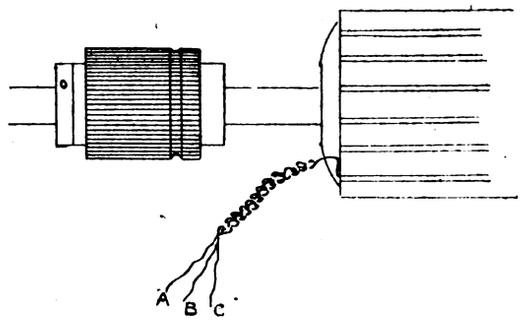

FIG. B.

wires by taping them before attaching to commutator. As the twisting by hand is a slow process, a wire twister (see Fig. C) should be used. This consists of a brass tube about 8in. long, fitted with a fibre plug of the same length driven tight inside it. Three holes about ⅛in. diameter are drilled through the fibre parallel with its axis. The armature winder inserts the three wires in these holes, and by turning the tube round, and at the same time drawing it towards himself, forms the three wires into a single twist.

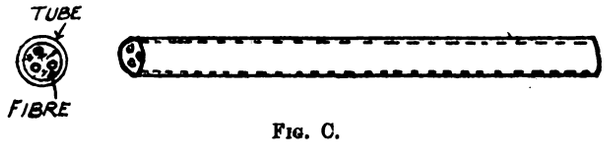

FIG. C.

If the design of the armature allows of it, a string band should be wound on over the wires between the core and the commutator. This should be done after the coil ends have been sweated to the segments, and the first turn of the string band which is nearest to the commutator should be laced over and under each successive wire. This lacing not only gives extra support to the wires, but also prevents the band from working down on to the commutator.—W. B.

Answer to No. 729 (*awarded 7s. 6d.*).—The cause of the breaking of end connections of small armatures is largely due to mechanical defects. A considerable amount of trouble was caused by the breaking of the wires of the armature of a 3-h.p. two-pole motor running at 1,300 revolutions per minute driving a scissors-grinding shop.

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The general arrangement of the armature was as shown in Fig. 1. It consisted of a smooth-core ring armature. The stampings were mounted on a brass hub having an end plate fixed by means of three $\frac{5}{16}$ Whitworth screws, marked A, the hub being fixed on the shaft by a feather key. The commutator was driven by the steel pin, B, let into the brass hub and into the cast-iron bush. After the machine had been running a few weeks the armature wires began to break off. On examining the armature, it was found that (1) the screws, A, had worked loose; (2) the pin B was also loose. The above had worked loose due largely

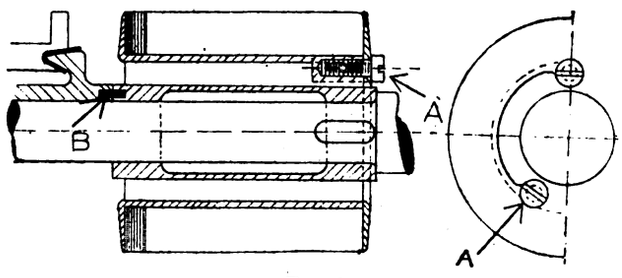

FIG 1.

to a bad joint in the belt and the grinding stones being out of balance. After the screws, A, had been replaced by steel studs screwed well home, also the commutator hub had a keyway cut in it, and a jib-headed key fitted, and also a good joint was made in the belt, the troubles entirely ceased, and the machine has now been running $3\frac{1}{2}$ years without having any further breaking of end wires, showing that it is due to mechanical and not electrical faults.—C. G.

Answer to No. 729 (*awarded* 5*s.*).—The cause of the trouble which "A. B. D." is experiencing is probably due to vibration in the connections between the armature and the commutator, owing to the conductors not being held

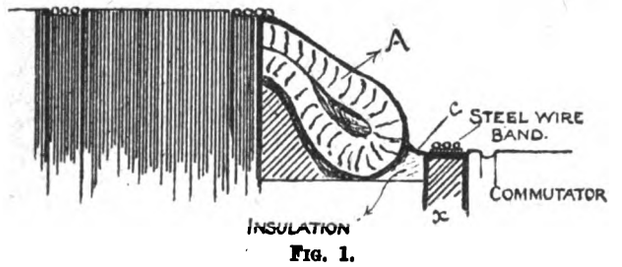

FIG. 1.

down securely by steel-wire bands. On small armatures it is important to have the commutator connections as short as possible, and also to have a firm support for them to rest on. In Fig. 1 the armature winding and commutator

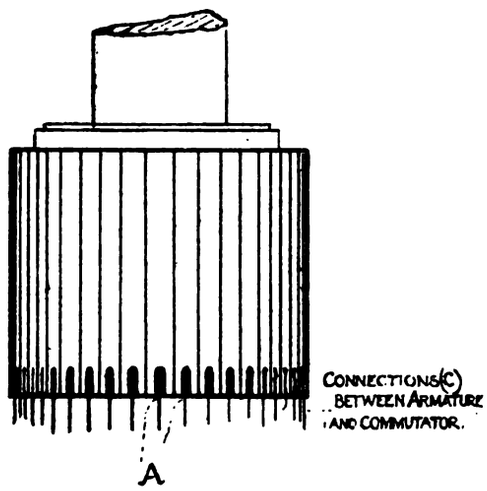

FIG. 2.

connections are shown of a small bipolar slot-wound armature, A being the armature coils and C the connections between the armature and the commutator. Several turns of steel binding wire are placed over the connections, C, thereby holding them firmly down on the insulated support, *x*. This arrangement is being used on armatures up to about 10 h.p. capacity; in many cases, where high voltages are used, the size of the wire in the connections, C, is less than No. 18 S.W.G., but no trouble is found with the wires breaking off. It may be mentioned that the wire used in the coils, A, is also used for the connections, C, in order to avoid any soldered joints, except, of course, where the connections are soldered to the commutator plates.

The standard practice on small commutators is to saw-cut small slots in the plates, as shown in Fig. 2. The connecting wires, C, are then placed in these slots and soldered up. In most cases these wires are tapped into the slots by means of a small hammer, and special care should be taken to prevent the wires being cracked at the point A (see Fig. 2). If accidentally a partial break does occur at this point, it is quite possible that the armature would work satisfactorily for a short time, but sooner or later it would break down due to excessive heating and natural weakness.

Without complete particulars of the design of the armatures to which "A. B. D." refers it is impossible to state definitely the alterations required to overcome the present difficulty, but the writer considers that by careful attention to the above-mentioned points satisfactory results will be obtained.—P.

Answer to No. 729 (*awarded* 5*s.*).—The breakage of end connections on an armature wound with a small size of wire is generally due to one or more of the following causes:

1. Neglect to firmly secure the top layer of the winding in place in the core slots. The slots should be closed by a hardwood strip, slightly larger than the actual slot, wedged firmly down to prevent outward movement of the wires due to centrifugal force as the armature rotates. These wedges will, of course, be surrounded with either presspahn or some other insulating lining. Two or more bands of binding wire should be tightly wound on mica strip over the wedges, and the ends properly soldered. A layer of strong twine should be placed over the *end connections* extending in width from the commutator lug inwards, at least a third of the distance from lug to core plates. Another similar binding should secure the straight wires where they leave the ends of the wedges. Space for ventilation is thus allowed between the two bindings and the connections prevented from bulging and breaking.

2. The soldering of such small wires is often done with too much heat. The copper becomes brittle, and will break very readily.

3. Any looseness of the commutator sleeve on the shaft, or movement endways, will, of course, strain the connections. The copper segments, if not properly tightened up, will move outwards, carrying the lugs with them and subjecting the connections to movement and possible breakage, for if badly put together, the copper segments will vary their position as soon as the machine gets warm, so straining the connections every time the load is put on. Some makers fit "expansion lugs" in the form of a semicircular bend in the commutator lug to permit a certain amount of expansion or vibration, but their use has been wholly abandoned in one shop well known to me without any apparent detriment to the machines.

4. An armature core is sometimes fixed to the shaft with too narrow a key. The result is that the plates cut themselves loose on the two outer edges, so allowing the whole core to work loose, and again break the end connections. A loose clamping nut may also be responsible for movement of the core.

5. If the machine be well finished, but fixed on a bad foundation, the connections will soon suffer. I remember a case where several direct-geared motors were bolted down to some flags on an earth floor, the proprietors refusing to supply other foundations. The result was a constant succession of breakages of the end connections, which ceased entirely when the flags were replaced by proper foundations.—A. M. L.

Question No. 730.—I have a 5-h.p., 500-volt, shunt-wound motor whose behaviour is somewhat weird, for on starting up in the ordinary way with the usual type of shunt motor starter, the machine on "no load" starts on the second live contact of the starter, runs about 20 or 30 revolutions, and then, apparently remembering it is running the wrong way, stops, and reverses itself. All this happens before

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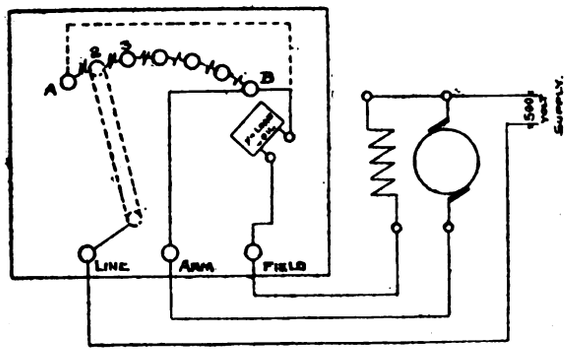
the starter is put on the third contact, and except for this curious behaviour at starting, it behaves like any ordinary motor. There is no sparking at the brushes or abnormal current during this phenomenon. What causes it?

Answer to No. 730 (*awarded* 7*s.* 6*d.*).—Since the reversal of a shunt motor depends on the independent reversal of either the shunt or armature current, and as the armature current cannot be reversed in the case under consideration, it is clear that the curious behaviour of the motor at starting is due to a temporary reversal of the field current. This is very probably due to heavy armature reaction, which takes place before the field coils are properly energised. The actual value of the shunt current in the coils of the motor when the switch arm is moved on to contact A (in diagram) will depend on (1) the value of the



resistance interposed between the main or line terminal, L, and the no-load coil, which will be connected to the field coils as shown. If the no-load coil be connected to the end of the starter resistance marked B, it is clear that this resistance is inserted between the supply and the shunt coils at starting. Hence the exciting current will be reduced and the field intensity proportionately. (2) The shunt coils of a 500-volt motor possess considerable self-induction, which prevents the field current immediately reaching its full value when the circuit is closed.

Both these conditions are very probably fulfilled in the present case, resulting in a weak field excitation with the first movement of the switch arm. At the same moment current flows through the armature, the value depending on the resistance of the armature and the starting resistance. The latter will be calculated to *prevent* the passage of a dangerously heavy current on the first two or three contact positions of the switch arm, so that no sudden rush takes place during the starting period. The passage of this current causes a drop in volts across the field coils, and a further decrease of the exciting current. The resultant torque between the armature and shunt fields is insufficient to move the armature. When the switch is moved on to contact 2 the value of the armature current rises; the shunt current also increases, but in much less proportion. The armature field now reverses the weak magnetisation of the poles, and sufficient torque exists between the two fields to produce the rotation described. As soon, however, as the armature begins to run, a back E.M.F. is developed, resulting in (1) immediate decrease in value of the armature current, (2) consequent increase in the volts across the field coils. The shunt current becomes stronger, and reverses the polarity induced by the armature current. The armature stops, but the exciting current (which cannot change in value quickly, due to self-induction) suffices to maintain the polarity of the field—particularly as *drop* in the exciting current will mean a very brief extra current in the right direction to maintain the field—and the instant the armature starts in the right direction the field strengthens with the rising E.M.F. and the machine runs up to speed. If such a shunt connection exists it should be altered, as shown, to stud A, when the full voltage available will be applied to the field coils at starting. Should a considerable increase in speed be the result of so weakening the field at full load, connection may be tried at some point of the resistance intermediate between A and B.—A. M. L.

Answer to No. 730 (*awarded* 7*s.* 6*d.*).—It is quite evident from the particulars given that the motor runs in the wrong direction at starting, due to some defect in the rheostat and not in the machine itself, as the fact that on about the third stop it runs all right proves that there can be no defect in the motor. The reason for the machine running in the wrong direction is that the shunt field for some reason does not attain appreciable strength sufficiently quickly, thereby allowing the armature to induce a field of ito own, due to the current passing through it. This induced field would cause the motor to run backwards if the brushes had a backward lead, which, of course, is usual on motors that are not required to be reversible. Supposing the brushes happened by chance to have a forward lead, the direction of rotation would be the same throughout, though the motor would spark when the load came on at full speed.

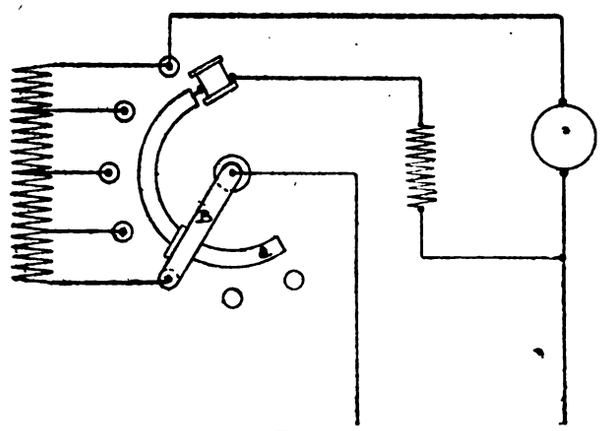


Fig. 1.

It would be easier to say what is amiss with the starter if more particulars as to the type in use had been given. It is, however, probable that it is of one of the two types shown in Figs. 1 and 2. Supposing that it were of the type shown in Fig. 1, then it is likely that the semi-circular contact *a* is not long enough (and, therefore, does not meet the spring contact on arm B soon enough), or else it may be worn down at that end, due to soft metal. The spring contact on arm B would seem to be all right, as it apparently meets *a* when the third contact stud is reached, as the motor then runs all right. On the whole, it seems probable that the starter is of the type shown in Fig. 2, which shows a form supplied by an American firm, and which is connected up incorrectly. Fig. 3 shows the correct connections. A large number of rheostats were made and sold wrongly connected. The defect has, however, been rectified in their later ones.

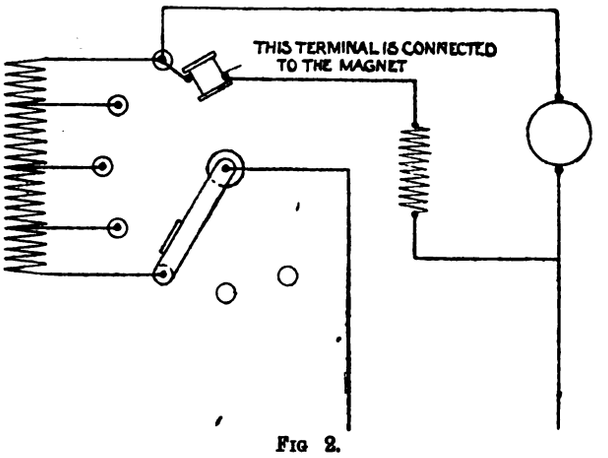


Fig 2.

Referring to Fig. 2, it will be seen that the shunt lead is taken off the last stop, which means that when the arm is on the first contact the whole of the resistance is in series with the shunt field as well as the armature. The large current flowing through wire brings the voltage down to, say, about 40 volts, which across a 500-volt spool winding will give a very small amount of field. This effect will, however, decrease by the time the third or fourth contact has been reached, due to drop in armature current, which thereby increases the volts across the field considerably. On the other hand, referring to Fig. 3, it will be seen that the full field is put in immediately the first live contact is

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reached, and when the arm is on the last stop cutting out all the resistance from the armature circuit, it would be all in series with the field only for the fact that it is automatically cut out by the no-load release coil, the magnet of which is made to form part of the circuit. Even supposing it were not cut out, then it would form a negligible percentage of the whole field resistance; as there is such a small current flowing through it the voltage drop is very slight. It will be seen that this is the case when the arm is on the last contact but one.

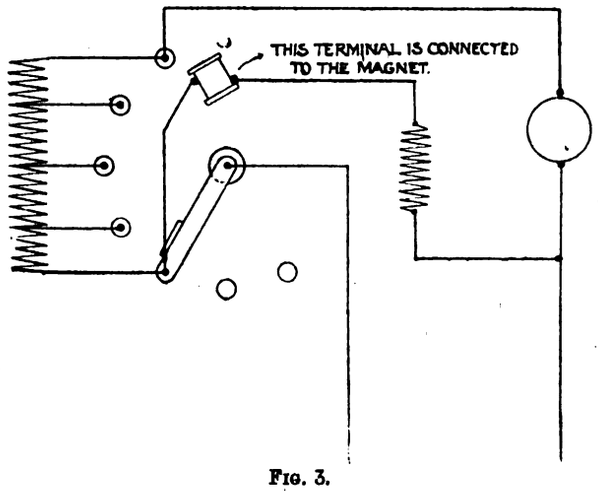

FIG. 3.

The reason that the machine does not spark is no doubt due to the large resistance in series with the armature when on the first two stops. I have seen a motor started with the brushes about on the neutral point, or perhaps slightly forward of it and with no field on. It commenced to rotate in the right direction at about the third or fourth contact, and there was no appreciable sparking till the fifth or sixth was reached, when it was shut down, the mistake being discovered.—R.

Answer to No. 730 (*awarded* 7*s.* 6*d.*).—As a motor ought not to behave in this erratic if intelligent manner, it is necessary to assume that there is some mistake in the connections. The simplest assumption that will explain the observed phenomena is that the shunt is connected across the brushes as shown in Fig. 1. The dotted line shows how it ought to be connected. With the shunt so connected, the exciting voltage before the motor starts is only that due to the ohmic drop in the brushes and armature. We must make one other assumption (a very likely one)—namely, that the brushes are set with a backward lead—that is to say, in the best position for running on load.

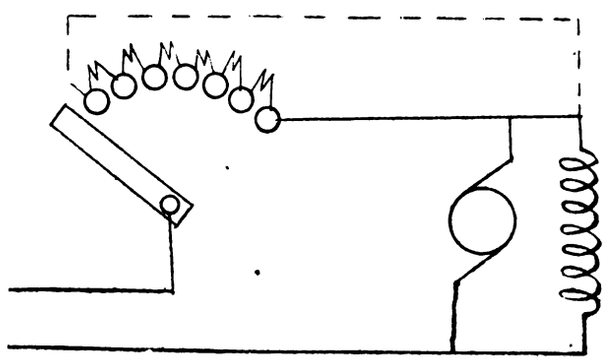

FIG. 1.

With this backward lead the armature ampere-turns tend to demagnetise the field, or, in the absence of any other field excitation, to cause a negative field. We thus see that there are two magnetising forces: first, the shunt, giving a positive magnetisation; and, second, the armature, giving a negative one. Now, the main circuit consists of a large practically non-inductive starting resistance and a small slightly inductive armature resistance, and may be considered as forming a non-inductive whole. On switching on, the full current allowed by the starting resistance at once passes. The shunt circuit, however, consists of a very large number of turns enclosing a large number of lines of force, and is consequently very inductive indeed. The shunt current, therefore, takes an appreciable time to rise to its maximum value.

What actually happens then is this: When the current is switched on, while the shunt current is still almost zero, the armature runs backwards because of the backward lead to the brushes. Meanwhile the shunt current is steadily growing, and its growth is slightly accelerated by the increase of voltage across the brushes due to the back E.M.F. of the armature. In a few seconds the shunt current overbalances the armature field, and the motor stops and then reverses. It is quite a chance that "H. G.'s" motor performs in this way, for if the brush lead or the self-induction of the shunt were a little less, or the friction a little greater, the motor would not run backwards, while these might be so proportioned that the motor would not start at all or would only run backwards. But we can easily show that the above is a possible explanation by considering an actual motor. A certain 5-h.p., 500-volt, four-pole shunt motor has the following values: full-load current, 9 amperes; resistance armature and brushes, 2·5 ohms; total armature turns, 1,200; total armature flux, 1·56 million lines; total flux, 1·8 million lines; total turns on shunt, 36,000; resistance of field, 1,600 ohms cold. If the starter passes full-load current on the second contact, volts across brushes = 22·5 volts, then total ampere-turns in shunt = $\frac{22{\cdot}5}{1{,}600} \times 36{,}000 = 505$.

To give the desired effect, the back ampere-turns of the armature must be less than this—say 320. This requires a backward lead of about 5deg.

Again, with ·26 ampere in the shunt each turn cuts ·9 million lines.

$$\text{S.I.} = \frac{\text{megalines per one ampere} \times \text{turns}}{100}$$

$$= \frac{\cdot 9}{100} \times \frac{1}{\cdot 26} \times 36{,}000 = 1{,}250 \text{ henrys.}$$

$$\text{Time constant} = \frac{L}{R} = \frac{1{,}250}{1{,}600} = \cdot 78 \text{ second.}$$

The shunt current, therefore, rises along an exponential curve whose time constant is ·78 second. Fig. 2 shows

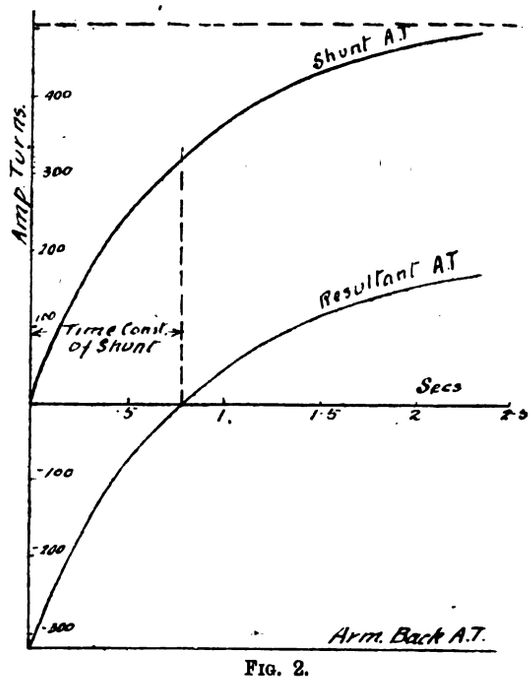

FIG. 2.

the result graphically. The field is negative for ·78 second, by which time it has fallen to zero, and after that it is positive.—W.

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Supplement to "The Electrical Engineer,"
NOVEMBER 18, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

739. A 50-h.p. gas-engine and a 40-h.p. motor, shunt-wound, are connected by belts and clutches to the main shaft of a factory, so that in the event of the gas-engine breaking down the motor may take the load running on town current at 460 volts. It is desired to instal two electric cranes requiring 12 h.p. each, and to feed them by driving the motor as a dynamo when gas-engine is running, and direct from town mains if gas-engine is stopped and motor has to drive the factory. What voltage would we likely get, and what is the best arrangement of switchgear, etc., for changing over?—D. R.

740. I have been much interested in the statistics given by Mr. J. Hall (*E. E.*, Nov. 4) concerning the "Raworth system of regenerative control for electric traction." Could anyone give me diagram of the application, with detail of controllers, etc. If it gives all that it is claimed to do, why is it not generally adopted in preference to the S.P. control? Are not the reduced expenses counterbalanced by failings (due to shunt motor) of greater consideration? A comparison of the two systems is invited.—W. B.

ANSWERS.

Question No. 730.—I have a 5-h.p., 500-volt, shunt-wound motor whose behaviour is somewhat weird, for on starting up in the ordinary way with the usual type of shunt motor starter, the machine on "no load" starts on the second live contact of the starter, runs about 20 or 30 revolutions, and then, apparently remembering it is running the wrong way, stops, and reverses itself. All this happens before the starter is put on the third contact, and except for this curious behaviour at starting, it behaves like any ordinary motor. There is no sparking at the brushes or abnormal current during this phenomenon. What causes it?

Answer to No. 730 (*awarded* 5*s.*).—The cause of this phenomenon is that the shunt current has not time to build up before the second live contact is reached, and the motor field, owing to the position of the brushes, becomes excited by the current in the armature. It is well known that when the brush axis is placed (as in Fig. 1) at right angles to the magnetic axis the field is distorted, but as a

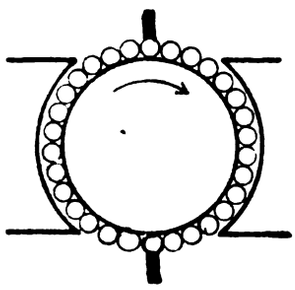

FIG. 1.

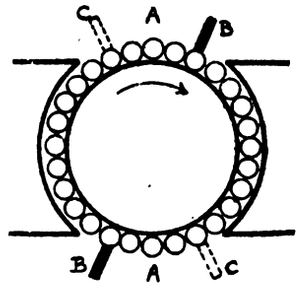

FIG. 2.

whole is not appreciably altered in value. When, however, the brush axis is moved away from the neutral position (as in Fig. 2), a real magnetising or demagnetising results, because the conductors between A and B, instead of opposing those between A and C as before, help them, and even with no current in the magnet coils the machine will now magnetise itself. This principle has been used to a considerable extent in toy motors. The idea of shifting the position of the brushes is to facilitate sparkless commutation, and the direction of the rotation of the brush axis for this purpose is in the case of generators the same as that of the armature, and in the case of motors in the opposite direction, so that taking the armature in Fig. 2 as revolving as indicated by the arrow, when acting as a generator the brush will be at B, and when being used as a motor at C. Now, when a machine acts as a motor the torque is in an opposite direction to that when it is used as a generator, and taking it that the field is magnetised in the same direction in both cases, it follows that the current (the other factor in producing the torque) must flow in opposite directions through the armature in these two cases. Suppose when acting as a motor the current flows *in* at C, then when acting as a generator it will flow *out* at A, and it is clearly seen that in the conductors between C and A the current flows always in the same direction, whether machine is acting as motor or generator. When the brush is shifted forward in a generator the field is demagnetised, therefore the field is also demagnetised when the brushes are shifted backwards in a motor, and if the current is switched on to the armature before the field current is on the motor will be partly magnetised in the wrong direction, and will start turning in the wrong direction. When the field is switched on and grows to its full value, it will have completely overcome the back action of the armature, and the motor will be revolving in its proper direction. As the current is in any case kept down entirely by resistance at starting, excessive current will not flow in this case, and as to sparking, it must be a very poor motor, indeed, which sparks at all at starting, because the frequency of commutation is then so low. The remedy is, of course, to look at the starter and see if the field is really made on what appears to be the first live contact, and if it is, to keep the starter arm on that contact for a sufficiently long time to allow the field current to grow to its normal strength. The writer always considers it advisable to have a main switch installed in the starting equipment, and not to rely upon the starter to fulfil that function. The shunt connections are then made across the motor side of the switch, and the shunt current has then time to grow during the period which elapses between the shutting of the switch with the right hand and the consequent manipulation of the rheostat arm with that *same* hand.—P.

Question No. 731.—How would you measure the self-induction of an alternator's armature?

Best Answer to No. 731 (*awarded* 10*s.*).—The practical methods of determining the self-induction of the armature or stator of an alternator may be classified under two heads—viz.: (1) by applying current at a known frequency and taking simultaneous readings of voltage and current and voltage at terminals of machine, and (2) by taking saturation tests on the machine, from the results of which the inductance can be calculated. Before discussing these methods in detail, it will be advisable to investigate the matter of inductance of alternator windings. In calculations respecting direct-current machinery, it is the inductance of the turns undergoing commutation at the brushes which is of the chief interest. This can be estimated with fair exactness from experimental data available, firstly, because the range of sizes and shapes of slots and coils is not extremely great, and secondly, because the required value of inductance corresponds to the position of the coil in the open space between the pole-tips Numerous tests have shown that the inductance of the coils under these conditions is about the same when the armature is in position in the field frame, and when it is free in the air. Now, in alternators an entirely different state of affairs exist, as it is required to be able to estimate the inductance for *all* positions of the armature relatively to the rest of the magnetic circuit, and not for a small compact group of coils, but often for more or less distributed windings. The effect of the field-magnet system has a great influence on the values of the inductance measured when the field is in position and when it is removed. Thus the proximity of magnetic material so situated as to decrease the reluctance of magnetic circuit will have a tendency to increase the values of the inductance. With windings embedded in partly closed or tunnel slots (as is the practice with Continental builders) this difference is not so marked as with open slots. The arrangement of the magnetic circuit, whether solid or laminated, has also a great influence on the values obtained for the inductance. The approach of solid masses of magnetic material affords paths for induced secondary currents, and the inductance will not be increased to such an extent as for correspondingly situated laminated masses of magnetic material. As it is

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generally the *average* value of inductance that is required, it will be seen from the above that, for the method coming under the first classification, readings should be taken with the armature in different positions relative to the field, the latter, of course, being in place. The extent to which the inductance varies for different relative positions of armature and field system is indicated in Fig. 1, in which the curve represents the values of inductance for different positions. The average inductance is, of course, obtained from the mean of the ordinates. A description of the above methods for the practical determination of inductance will now be given and values deduced from observed results in each case.

Method 1.—If the machine is a single-phaser, alternating current from a similar machine—*i.e.*, a machine giving the same frequency as the one under test—is applied to the terminals, and amperes input and volts drop across the terminals observed on suitable instruments. If E is the impressed E.M.F. required to pass a current, C, through the armature of the alternator, the ohmic resistance of which is R, then it is known that

$$C = \frac{E}{\sqrt{R^2 + (2\pi L n)^2}}.$$

In dealing with alternators, the ohmic resistance may generally be neglected in comparison with the reactance ($2\pi n$ L), and hence for any value of current up to about full load the C R drop is very small in comparison to the

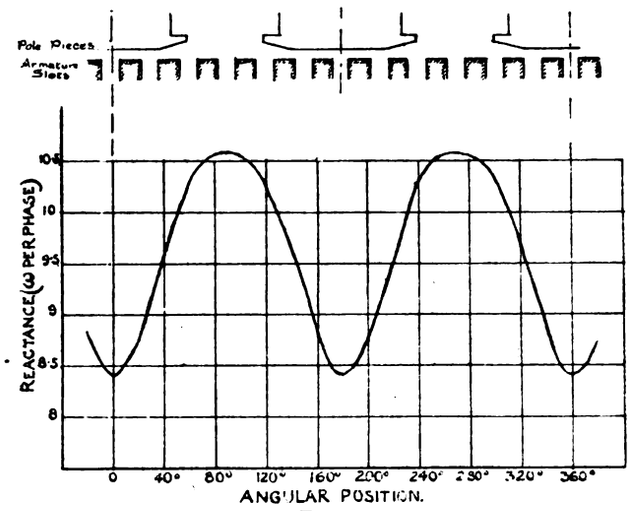

FIG. 1.

reactance voltage, and the reactance can, therefore, be obtained from $\frac{E}{C}$. With a three-phase machine the procedure is very much the same, but a knowledge of the connection of the windings is required in interpreting the results. In this case three-phase current is supplied, an ammeter being inserted in each line. If the windings are Y-connected (which is the general connection for high voltages) and the voltage measured across each pair of terminals, as in Fig. 2A, the expression for the volts per phase becomes $\frac{\text{volts across terminals}}{\sqrt{3}}$, the value of the ampere per phase being taken equal to the mean of the three ammeter readings. The reactance *per phase*, which is of chief interest, is then at once obtained as in the previous case. If, however, the volts are measured as in Fig. 2B—*i.e.*, between each terminal and the centre point of the star (or "Y-point")—the value of the volts per phase is obtained direct. With a Δ-connection for the winding, the amperes per phase are found by dividing the line amperes by $\sqrt{3}$, the volts per phase then being voltage across terminals. The reactance may also be determined by the application of single-phase current, the readings being taken with connections as in Figs. 2C and 2D; the former case giving readings for reactance per phase, while the latter gives the reactance of two phases in series, and hence reactance per phase will be one-half of that measured. Generally, the values obtained by this method of single-phase current lead to a slightly lower average value for the inductance than that obtained with three-phase current. In both these cases it is preferable to obtain readings with the armature and field in different relative positions.

The curve shown in Fig. 1 represents the inductance of the armature of a three-phase alternator of 850 kw. output, a few of the leading particulars being given in the following specification: rated output, 850 kw.; speed, 94 revolutions per minute; frequency, 25 ∼ per second; terminal voltage, 5,000 volts; connection of winding, Y; full-load current per phase, 98·5 amperes; armature slots per pole-piece, 6; slots per pole-piece per phase, 2; conductors per slot, 14. The machine is of the revolving-field type with 32 poles. The values for the reactance per phase, given in Fig. 1, were obtained from measurements made with three-phase current at 25 ∼, and the average value from the curve is 9·6 ohms per phase. Hence, since reactance = $2\pi n$ L (where n is the frequency and L the self-inducance in henrys), therefore

$$L = \frac{9{\cdot}6}{2 \times \pi \times 25} = {\cdot}061 \text{ henry.}$$

This is the average inductance of the armature per phase. But it is customary and more convenient when dealing with inductance calculations to express the inductance in terms of the number of lines per ampere-turns per inch length of

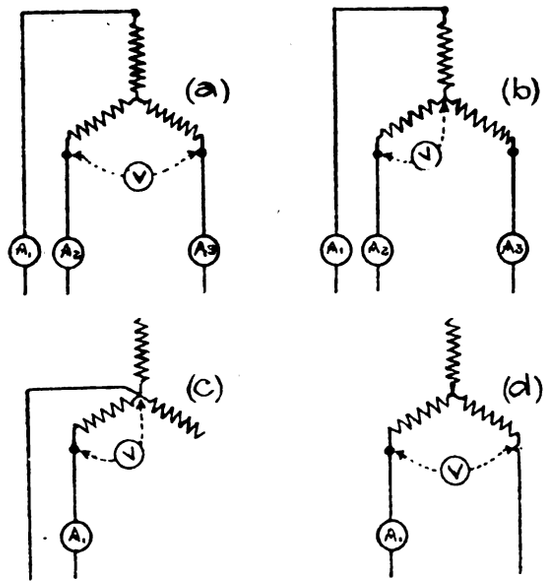

FIG. 2.

armature laminations. By this process all results are brought to a standard basis, and different designs can be easily compared. A coil is said to have an inductance of one henry when it is of such dimensions that a current of one ampere sets up a magnetic flux of such a magnitude that the product of the number of lines linked with the coil multiplied by the number of turns in the coil is equal to 100,000,000. If the coil has but one turn, then its inductance in henrys becomes 10^{-8} times the number of lines linked by the turn when one ampere is passing through it. Since one ampere passing round n turns sets up n times the flux that would be set up in passing round one turn, and as this flux is linked with each of the n turns, it follows that the product of the flux multiplied by the turns will be $(n)^2$ times as great as with one turn. In the machine under consideration there are 14 conductors per slot and two slots per pole per phase, and hence 28 turns in series per group of coils. The total groups of coils per phase will be 16. Hence the inductance per group of coils $= \frac{{\cdot}061}{16} = {\cdot}0038$ henry. The gross length of armature laminations is 14·5in., and therefore linkage of lines per inch length of armature laminations $= \frac{380{,}000}{14{\cdot}5} = 26{,}300$ lines. Hence lines per ampere-turn per inch length of armature laminations $= \frac{26{,}300}{(28)^2} = 33{\cdot}5$ lines for the average of all positions.

Method 2.—In applying this method the inductance is calculated from the observed saturation curves taken at no

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load and at full load with unity power factor. The no-load and full-load saturation curves for the 850-kw. alternator referred to above are given in Fig. 3, the scale of volts being reduced to correspond to the voltage *per phase*. We shall now proceed to analyse these curves, and deduce from them the reactance per phase. Independent calculations for the reactance will be made, taking three points on the no-load saturation curve—viz, 1,500, 2,000, and 2,880 volts per phase. The resistance per phase of the armature is ·315 ohm, and the C R drop at full load is $·315 \times 98·5 = 31$ volts. Therefore, the corresponding voltages on the full-load saturation curve are 1,469, 1,969, and 2,849 volts. From Fig. 3 we obtain the following data:

Voltage per phase	1,500	2,000	2,880
Excitation at no load (ampere-turns per spool)	3,100	4,300	7,650
Excitation at full load (98·5 amperes) and unity power factor (ampere-turns)	4,970	5,830	8,800

The difference between these two values of field excitation equals the ampere-turns required for overcoming armature demagnetisation.

Therefore ampere-turns required for overcoming armature demagnetisation	1,870	1,530	1,150

Assuming a sine wave distribution of the flux, the total armature strength by calculation is at full load equal to $14 \times 98·5 \times \sqrt{2} \times 2 = 3,900$ ampere-turns. The observed value is 3,700 ampere-turns, which will be used in the calculations below. It is convenient, and sufficiently accurate, to take the demagnetising effect of the armature as increasing proportionally to the sine of the angle of lag

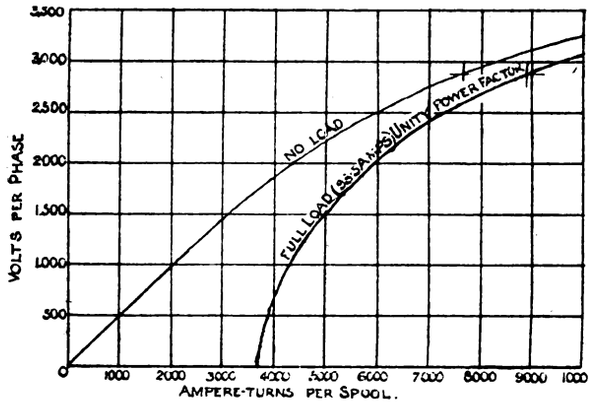

FIG. 3.

between the mid pole-face position and the position of the conductors when carrying maximum current. Hence, if θ be the angle of displacement of maximum current behind the mid pole-face position, we have for the three cases above:

3,700 sin θ equals	1,870	1,530	1,150
$\therefore$ sin θ equals	0·505	0·414	0·311
And tan θ equals	0·59	0·456	0·328

Now, tan θ is the ratio of the reactance voltage per phase to the impressed voltage per phase, and hence in the case under consideration we have

Tan θ equals	$\frac{R\,V}{1,500}$	$\frac{R\,V}{2,900}$	$\frac{R\,V}{2,880}$
Therefore reactance voltage at 98.5 amperes equals	885	912	945

The mean of these three values is 914, which value will be used for the reactance voltage per phase at full load.

Hence reactance per phase $= \frac{914}{98·5} = 9·3$ ohms, a value not materially different from that obtained by Method 1.

The value of the total armature strength (3,700 ampere-turns) is obtained by observing the field excitation required to send full-load current through the armature when short-circuited and run at normal speed. Under these conditions the maximum current is reached when the armature slot is 90deg. behind the mid pole-face position, and the full armature strength is in this case exerted in opposition to the field magnetomotive force. The field excitation, therefore, has to be in excess of this amount by the small percentage to overcome the small C R drop in the conductors. The curve obtained by plotting field excitation as abscissæ and short-circuit armature current as ordinates is a straight line passing through zero, and is designated the "short-circuit" characteristic.—MONOPHASE.

Answer to No. 731 (*awarded* 7*s.* 6*d.*).—An alternator armature cannot be said to have a definite single coefficient of self-induction, for the number of magnetic lines self-induced through the armature coils per ampere varies (1) with the relative position of the armature coils and the magnet poles (the inductive effect being, of course a maximum when the coil centres are directly opposite the poles); (2) with the power factor of the armature load (for with unity power factor the maximum value of the armature current occurs when the centres of the armature coils

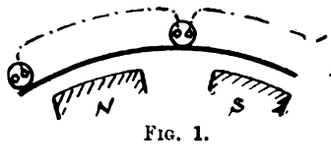

FIG. 1.

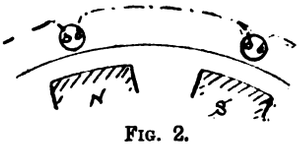

FIG. 2.

are midway between two poles, Fig. 2, and in their least effective position, whilst with a 90deg. phase displacement this maximum current value occurs when the coils are in their most effective position—*i.e.*, directly opposite the poles, Fig. 1); (3) with the actual value of the current (slightly more lines being induced per ampere of a low current than of a high one owing to the effect of iron saturation); (4) with the state of saturation of the field magnets—*e.g.*, whether they are excited or unexcited. On this account it is only possible to obtain a value which may for convenience be called the "coefficient of self-induction," but which really only represents the inductance of the armature under one particular set of conditions.

One of the simplest ways of doing this is to make a short-circuit test on the alternator. The armature is short-circuited through an ammeter, and the field is only just sufficiently excited to cause the normal full-load current to circulate in the armature when it is driven at about normal speed. The exciting current to produce this state is noted, and a reading is next taken of the terminal volts on open circuit with this same excitation. This open-circuit voltage is equal to the total drop in the armature during the short-circuit reading. This drop is made up of the volts lost in the resistance of the armature winding, the inductive drop due to magnetic lines set up around the armature wires, and the drop due to reduction in the main flux looped with the armature coils, brought about by the armature back ampere-turns. The last two quantities need not strictly be distinguished from one another, for a reduction in the main flux or the setting up of a new flux in the opposite direction, both due to the armature current, give practically identical results. The C R or ohmic drop is easily obtained by measuring the resistance of the armature winding, and since the C R drop is in phase with the armature current, whilst the inductive drop is in quadrature with the current,

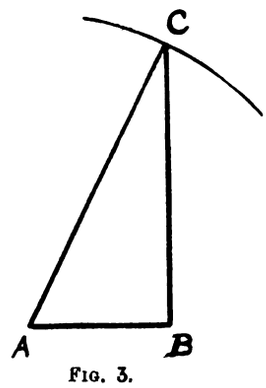

FIG. 3.

the resultant drop on the short-circuit test (equal to the open-circuit volts in this case) will form the hypotenuse of a right-angle triangle, of which the C R and the inductive drops respectively are the sides. Draw a line, A B (Fig. 3), to represent the C R drop to any scale. With A as centre and a radius equal, on the same scale, to the open-circuit volts measured as above, draw an arc of a circle. From B draw B C at right angles to A B and to meet the arc. Then B C represents the total inductive drop, and the correspond-

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ing value of the coefficient of self-induction, L, in henrys, may be obtained from the fact that inductive drop = B C $= \pi \frown\!\!\smile$ L C volts, assuming a sine wave of E.M.F., where $\frown\!\!\smile$ = the periodicity at which the test was made, C = the armature current on the short-circuit test. The value of L so obtained is the effective self-induction of the armature at normal current, with a phase displacement of the current of nearly 90deg. (the power factor on a short-circuit test being nearly zero with most types of alternator owing to the great preponderance of the inductive drop over the resistance drop), and with a very weak field excitation. The result can therefore hardly be considered as the coefficient of self-induction under normal conditions, but it is sufficiently close to this to permit of fairly reliable results as regards the drop of the alternator being deduced from it.

Another method of obtaining the effective value of L consists in passing an alternating current about equal to the full-load current round the alternator armature whilst it is at rest, but with the field magnets excited to the normal extent. The volts required to pass the current round the armature winding are again equal to the resultant of the C R drop and the inductive drop, and the value of the latter and of L can be obtained by means of a right-angle triangle, exactly as in Fig. 3. The test must be repeated with the armature coils in two or three different positions, relatively to the pole-faces, varying from right opposite the poles to midway between the poles. The average of these three or four results for L will be the effective value under normal current and excitation conditions, but with only an approximation to the real relative positions of armature coils and magnet poles, which correspond to the various instantaneous current values when the alternator is running under normal conditions. The effect of this discrepancy on the effective value of L under working conditions is, however, only very slight.—Q.

Answer to No. 731 (*awarded* 5*s*.).—Before answering this question, it would be as well to examine what is here meant by the term "self-induction." Obviously, the self-induction of the armature will depend on its position relative to the field magnets; its maximum value will correspond to the position of zero E.M.F., and its minimum value to the position of maximum E.M.F., so that it is seen the self-induction of the armature will fluctuate with a frequency double that of the induced E.M.F. For all practical purposes we may consider the armature as possessed of a constant self-induction or inductance (we will use the latter term), and this we will call its "equivalent inductance." This, then, is what is required to be determined, and it can be done in the following manner. First run the alternator at normal speed, and take a set of readings connecting exciting current and E M.F. These can be plotted in the form of a curve, which may be called the "open-circuit characteristic." Secondly, short-circuit the alternator through an ammeter (this should be of negligible inductance: a hot-wire instrument would do very well), and then take another set of readings connecting the short-circuit armature current with the exciting current. From these readings another curve is plotted, which may be called the "short-circuit characteristic." Now suppose that, corresponding to any value of the exciting current, the E.M.F. obtained from the first curve is represented by E, and that the short-circuit current corresponding to the same exciting current, obtained from the second curve, is represented by C; if the resistance of the armature = R, which can easily be ascertained by measuring the drop across the armature with a known continuous current passing, then we have

$$C = \frac{E}{\sqrt{R^2 + L^2 p^2}}$$

where $p = 2 \pi \times$ frequency.

$$\therefore L p = \frac{\sqrt{E^2 - C^2 R^2}}{C}$$

$$L = \frac{\sqrt{E^2 - C^2 R^2}}{C p}$$

where L = equivalent inductance of armature. As L p is appreciably large compared with R, the current, C, will lag by nearly 90deg. behind E, so that the value obtained for L will be greater than what it would be if C was in phase with E, for obviously in the first case the current reaches its maximum for a position of the armature corresponding to its maximum inductance. In the above it has been assumed that the current and E.M.F. waves have been true sine waves, which, of course, is never absolutely attained in practice.

From the above it will be seen that the equivalent inductance of the armature will vary with the displacement of the main current with respect to the E.M.F.—*i.e.*, the power factor of the load—so that it is a very uncertain quantity. This variation in the equivalent inductance could be shown by inserting a non-inductive resistance in series with the armature, and then again obtaining the short-circuit characteristic. This will have the effect of increasing R with respect to L p, and thus decreasing the lag of the current, C, behind E, and if the value of the non-inductive resistance is known, the equivalent inductance, L, can be again determined. The fluctuation of the inductance of the armature with varying positions could be shown by measuring the inductance corresponding to different positions taken over half a period. To do this for any given position, pass a known alternating current, C, through the armature and measure the drop, E, on a voltmeter. Then, as before,

$$L = \frac{\sqrt{E^2 - C^2 R^2}}{C p}.$$

Repeated for different positions, a curve showing the fluctuation could be plotted.—A. P. YOUNG.

Answer to No. 731 (*awarded* 5*s*.).—The best, and certainly the simplest, method of measuring the self-induction of a circuit is to use the well-known formula

$$\tan \theta = \frac{\text{reactance}}{\text{resistance}},$$

$$\text{reactance} = 2 \pi n L,$$

where n = frequency and L = self-induction in henrys. Simplying the above equation, we get

$$L = \frac{\tan \theta \times \text{resistance}}{2 \pi \text{ frequency}}.$$

Tan θ can be found from tables, as $\tan \theta = \frac{\sin \theta}{\cos \theta}$. There are two methods of arriving at the power factor (cos θ) of a circuit which are commonly used in shop practice—viz.:

1. Apply an alternating current to the armature winding, then by means of a voltmeter, ammeter, and wattmeter the power factor (cos θ) can be readily obtained.

$$\cos \theta = \frac{\text{watts}}{\text{amperes} \times \text{volts}}.$$

2. Apply an alternate current of known voltage, E, and measure the watts with wattmeter, then

$$\cos \theta = \frac{\text{watts with alternating current}}{\text{watts with direct current}}.$$

The watts with direct current of voltage $E = C^2 R$, current being found by Ohm's law.

Example.

Armature resistance = 2 ohms.
Frequency = 100 cycles per second.
Voltage applied = 100.
Wattmeter reading, 40.
$C^2 R = 50^2 \times 2 = 5{,}000$.

$$\text{Cos } \theta = \frac{40}{5{,}000} = \cdot 008.$$

$$\text{Tan } \theta = \frac{\cdot 999}{\cdot 008} = 125 \text{ (approximate)}.$$

$$L = \frac{\tan \theta \times \text{resistance}}{2 \pi \times \text{frequency}} = \frac{125 \times 2}{2 \pi \times 100} = \cdot 4 \text{ henry}.$$

A. J. MARTIN.

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NOVEMBER 25, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

ANSWERS.

Question No. 732.—What is the best method of predetermining the voltage drop due to magnetic leakage in a transformer at, say, full load and any given power factor?

Best Answer to No. 732 (*awarded* 10*s.*).—The drop in the terminal volts between no load and full load on a transformer is due to the combined effect of the C R volts lost in the resistance of the primary and secondary windings, and the back voltage due to magnetic leakage between the primary and the secondary. The C R voltage is in phase with the current, whilst the leakage drop is in quadrature with the current, so that in order to determine the actual

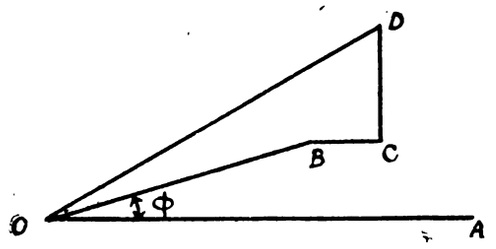

Fig 1.

drop these two quantities must be combined vectorially with the terminal voltage, as shown in Fig. 1. O A represents the phase of the secondary current; O B, the value of the full-load secondary terminal voltage required, drawn at an angle ϕ to O A equal to the angle of phase displacement between the secondary current and voltage for the particular load for which the drop is to be determined—*i.e.*, cos ϕ is the power factor of the load. When the load consists of condensers, so that the current is a *leading* one, the angle ϕ will be set out below the line O A instead of above it. From B draw B C parallel to O A and equal to the C R drop in primary and secondary windings reduced to the secondary side—*i e*, B C = secondary resistance × secondary current + (primary resistance × primary current $\times \frac{\text{secondary turns}}{\text{primary turns}}$). From C draw C D at right angles to O A and equal to the drop due to magnetic leakage calculated, as explained below. Then O D will be the no-load terminal voltage required in order to obtain the full-load voltage O B, and O D − O B will equal the voltage drop. Stated as a percentage of the no-load voltage, the drop $= \frac{O D - O B}{O D} \times 100$.

The approximate value of the leakage drop may be arrived at by the following considerations (see Kapp, *Elektrotechnische Zeitschrift*, April 14, 1898, and Kapp's "Transformers"): When a transformer, such as is shown diagrammatically in Fig. 2, is on open secondary circuit, a definite alternating flux passes through both primary and secondary windings, and its maximum instantaneous value is given by

$$\text{Flux} = \frac{\text{primary volts} \times 10^8}{4{\cdot}44 \times \text{total primary turns in series} \times \sim}.$$

This total flux, as far as the primary winding is concerned, is practically constant at all loads (at full load the internal primary volts fall from ½ to 1 per cent. owing to loss in the primary resistance, and this causes a corresponding drop in the flux, but this small difference may be neglected). As regards the secondary, however, the flux actually looped with its turns changes with the load owing to the fact that as the load on the transformer and the total ampere-turns in the primary and secondary windings increase, more and more of the primary flux, instead of being practically all confined to the iron circuit of the transformer, leaks back through the air (somewhat as shown by the dotted arrows in Fig. 2), and so, though the total flux linked with the primary turns remains unchanged, some of it returns through the space occupied by the primary winding, the insulation between primary and secondary and the secondary winding, and so is entirely or partially ineffective as far as the secondary winding is concerned. The amount of this leakage flux depends on (1) the ampere-turns of primary or secondary (which are practically equal at anything approaching full load) on each limb; (2) the average length of the leakage path in air, as shown by the dotted arrows, *d*, in Fig. 2; (3) the effective area of the leakage paths in air—*i.e.*, some function of the width of a primary coil + a secondary coil + the insulation between them multiplied by the mean periphery of the coils—*i.e.*, the mean length of one turn of wire in the primary and the secondary.

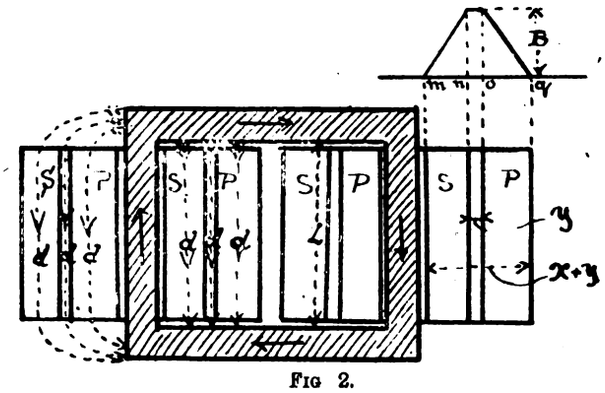

Fig 2.

The density of the leakage flux varies from zero close to the iron core within both the primary and secondary windings (as there are no effective ampere-turns there) to a maximum in the space occupied by the insulation between primary and secondary (where the full ampere-turns of the primary, or secondary, coil are effective in producing leakage) and then down again to zero at the extreme outside of the secondary coil (where the primary ampere-turns are practically neutralised by the equal and opposite secondary ampere-turns). The variations of the flux density from point to point of the winding are, in fact, somewhat as shown in the small figure in the right-hand corner of Fig. 2, assuming that the length of air-gap in the leakage path is constant for all points of the winding—an allowable assumption, considering that the depth of winding space is always fairly small as compared with the length of the winding space.

Now, the leakage flux which passes through the insulation between the primary and the secondary (*n* to *o*, Fig. 2) is fully effective on all the primary turns and wholly ineffective on the secondary turns. The flux in the space *m* to *n* varies in its effectiveness on the primary winding, the portions near the iron core being effective on fewer primary turns than those nearer the outside of the primary. None of this flux (*m* to *n*) is effective on the secondary winding. The flux in the space *o* to *q* is all fully effective on all the primary turns, but varies in its effectiveness on the secondary turns, the part nearer the primary winding being effective on fewer secondary turns than the part nearer the outside

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of the secondary coil. In order to decide the effective leakage flux actually producing a drop, the "equivalent amount" of leakage which is wholly effective on all the primary turns, and wholly ineffective on the secondary turns—*i.e*, the effective difference between the primary flux and the secondary flux at full load—must be arrived at. This can be easily found by a step-by-step process carried out on the small curve (*m* to *q*, in Fig. 2) at half a dozen or more equally spaced points, or by means of a simple integration.

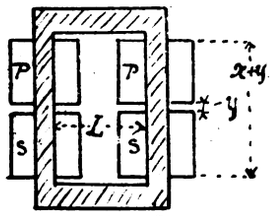

FIG. 3.

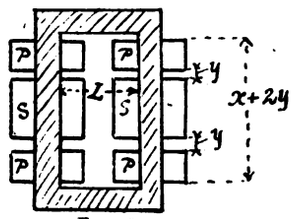

FIG. 4.

Calling the maximum flux density—*i.e.*, the flux density in the part *n* to *o*—B C.G.S. lines per square inch, it will be found that this "equivalent flux" density for the space *m* to *n* is $\frac{1}{3}$ B; from *n* to *o*, of course, the equivalent flux density will be equal to the actual flux density = B, whilst for the space from *o* to *q*, again, the equivalent density is $\frac{1}{3}$ B. Therefore, if *l* = mean length of a turn of primary or secondary winding—*i e.*, the periphery measured in the insulation between the primary and secondary in Fig. 2—in inches; *y* = thickness of insulation between the primary and the secondary coil (measured from copper to copper) in inches (see Figs. 2, 3, 4, and 5); *x* = width of winding space per limb—*i.e.*, combined depth of the primary and secondary windings per limb—in inches (see Figs. 2, 3, 5, and 5), we may say total equivalent leakage flux wholly effective on all the primary turns alone = B × *l* × $(y + \frac{1}{3}x)$ C.G.S. lines. This result remains the same whether the primary or the secondary is wound next the iron core.

The value of B can be obtained from the ampere-turns existing at the particular load in question and the ordinary air-gap flux formula

$$\text{Density C.G.S. lines per square inch in air} = \frac{\text{ampere-turns}}{\cdot 313 \times \text{length of air-gap}}.$$

Now, if A T = primary ampere-turns (or secondary ampere-turns) *per limb* = primary current × primary turns per limb at the load in question, the maximum instantaneous value of the ampere-turns will be 1·41 × A T, assuming a sine wave of current, and the maximum instantaneous value of the flux density in the insulation between the primary and the secondary will =

$$B = \frac{1{\cdot}41 \text{ A T}}{\cdot 313 \times \text{average length of leakage line such as } d\,d \text{ (Fig. 2)}}$$

$$= \frac{4{\cdot}5 \text{ A T}}{\text{average length of leakage line}}$$

∴ Total effective leakage flux

$$= \frac{4{\cdot}5 \times \text{A T}}{\text{average length of leakage line}} \times l \times (y + \tfrac{1}{3}x).$$

The drop in volts due to this leakage is

$$\text{No-load secondary volts} \times \frac{\text{effective leakage flux}}{\text{total no-load flux}},$$

and this is the number of volts to which C D in Fig. 1 is to be made equal.

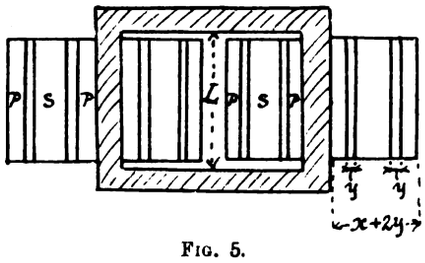

FIG. 5.

The average length of leakage path and the maximum number of ampere-turns effective in producing B vary with the arrangement of the coils. If the windings on each limb are split up into several primary coils and several secondary coils alternately interleaved, it is clear that (1) the maximum effective ampere-turns for producing leakage at any one point will fall, and (2) the area of the leakage path (corresponding to the length *m* to *q*) will also fall, so that a rapid falling-off in the leakage occurs—in fact, the drop in a transformer due to leakage falls almost as the square of the number of coils per limb.

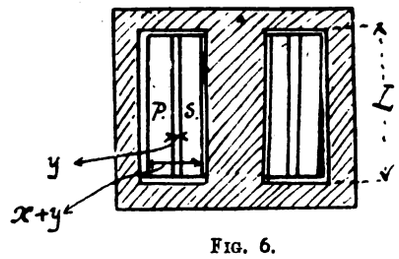

FIG. 6.

Applying the same method as described above to various other arrangements of coils, such as those shown in Figs. 3, 4, 5, and 6, and employing for simplicity the distance L inches from iron to iron inside the transformer, measured parallel to the insulation between primary and secondary (see Figs. 2 to 6) as the "average length of leakage line," it can be shown that the effective leakage flux is given with fair accuracy by the general formula:

Leakage flux effective on all primary turns and on no secondary turns in C.G.S. lines

$$= \frac{\text{A T} \times l}{\text{L} \times \text{K}^2} (3 \text{ K } y + x) \text{ C},$$

where A T, *l*, *y*, *x*, and L have the above-described values, and K = number of separate primary (*or* secondary) coils *per limb*. (When there are more coils in one winding than in the other, use the larger number for K—*e g.*, if there were two primary coils and one secondary coil per limb interleaved (as in Fig. 4 or Fig. 5). K would equal 2.) C = a constant which experiment has shown to equal about $2\frac{1}{2}$ to 3 for "core" type transformers (Figs. 2, 3, 4, and 5), and about $3\frac{1}{2}$ to 4 for "shell" type transformers (Fig. 6) with all the winding on one limb.—Q.

Answer to No. 732 (*awarded* 7*s.* 6*d.*).—By a transformer having magnetic leakage, we mean that a certain number of lines of force which thread the primary winding do not thread the secondary winding, and similarly a certain number of lines of force threading the secondary winding do not thread the primary winding. This means that each winding possesses a certain inductance of its own, and on this account a certain E.M.F. will be required to overcome the inductance voltage created in each winding when the transformer is working under load. Before answering this question it will, perhaps, be as well to investigate the working of a transformer possessing magnetic leakage and working under load. This can be best understood by aid of the vector diagram, shown in Fig. 1. For simplicity the assumption is made that the ratio of transformation of the transformer is unity, and that the load is non-inductive. Here we have O i_2 = secondary current; O E_2 = E.M.F. at the secondary terminals; E_2 e_2' = ohmic drop in secondary winding; O e_{s2} = E.M.F. required to overcome the inductance of secondary, drawn at right angles to O i_2. Then O e_2 = resultant of O e_2' and O e_{s2} is the E.M.F. induced in the secondary winding.

Again, O i_μ = wattless magnetising current, obviously at right angles to O e_2; O i_h = current required to compensate for the iron losses, drawn at right angles to O i_μ. Then O i_k = the resultant of O i_μ, and O i_h is the no-load current. This current must be the resultant of the primary and secondary currents, so that the secondary current, O i_1, is readily determined.

Further, O *b* = ohmic drop in the primary winding; O e_{s1} = E.M.F. required to overcome the inductance of the primary winding, at right angles to O i_1. Obviously, the E.M.F. applied to the primary terminals must be the resultant of O *b*, O e_{s1}, and a third component, O e_1, drawn equal and opposite to O e_2. The resultant O E_1 is then the E.M.F. across the primary terminals. This diagram

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can be greatly simplified in construction by assuming that the magnetising current, i_μ, is negligible, which is very nearly the case in practice, so that the primary and secondary currents are exactly opposite in phase to one another.

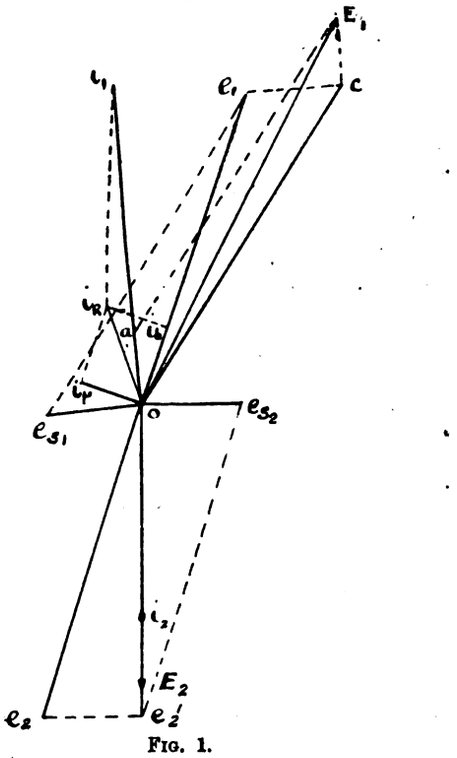

FIG. 1.

Fig. 2 shows the reconstructed diagram, it further being assumed that the load is now inductive, such that the angle of lag of the secondary current is ϕ. The same lettering is used as in Fig. 1; the ohmic drop in the primary winding (m E_1) being taken as equal to that in the secondary (E_2 e_1'), and similarly the inductance E.M.F.

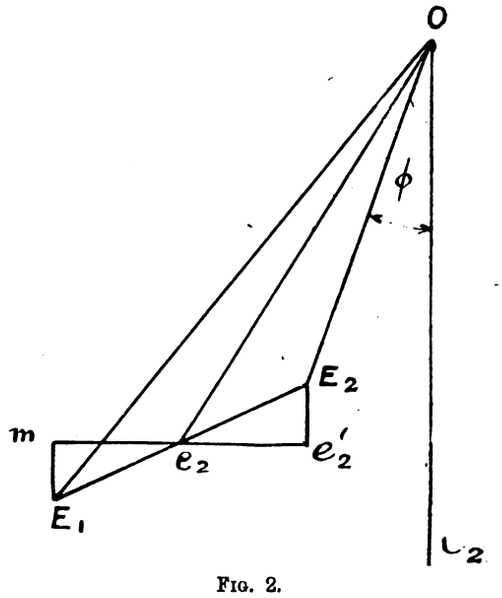

FIG. 2.

in the primary m e_2 equal to that in the secondary e_2 e_2'. O E_2 is then the secondary E.M.F. corresponding to a primary voltage, O E_1. This diagram can be still further simplified and brought into a form from which the primary and secondary voltages can be at once derived for any lag or lead of the secondary current with the transformer fully loaded.

Fig. 3 shows the practical form in which O A is equal to E_1 E_2 in Fig. 2, and A B represents the total ohmic drop in both windings, or twice that in either winding. About O as centre a circle is described of radius O E_1, where O E_1 is the constant E.M.F. applied to the primary terminals. With the same radius another circle is described with A as centre. Now consider the case where the vector representing the primary voltage has the position O E_1'. This corresponds to a non-inductive load on the secondary, there being neither lag nor lead of the secondary current. The secondary voltage is then represented by the length of the vector O E_2', E_1' E_2' representing the combined leakage and ohmic drop in the secondary. Suppose the load is inductive, and that the angle of lag is ϕ. Then, again, the primary voltage is represented by O E_1, and the secondary voltage by O E_2, and, similarly, the secondary voltage can be obtained for any value of the angle ϕ. In the case where the secondary current leads by an angle ϕ', the secondary voltage is here represented by O E_2'' and the primary voltage by O E_1'', and it is seen that the secondary voltage exceeds the primary voltage by an amount E_1'' E_2''.

The above has not truly answered the question, for before any practical use can be made of the diagram, it will be necessary to determine the value of O A. A B, of course, can be calculated from a knowledge of the full-load secondary current and the resistance of either winding. The value of O A is readily determined in the following manner. Short-circuit the secondary winding through an ammeter of negligible inductance (a hot-wire instrument for preference), and then apply current to the primary winding until the full-load secondary current is indicated on the ammeter. The voltage drop across the primary winding then represents the value of O A. This can be readily seen to be the case by a reference to Fig. 2. If this diagram was redrawn to suit the above case, O E_2

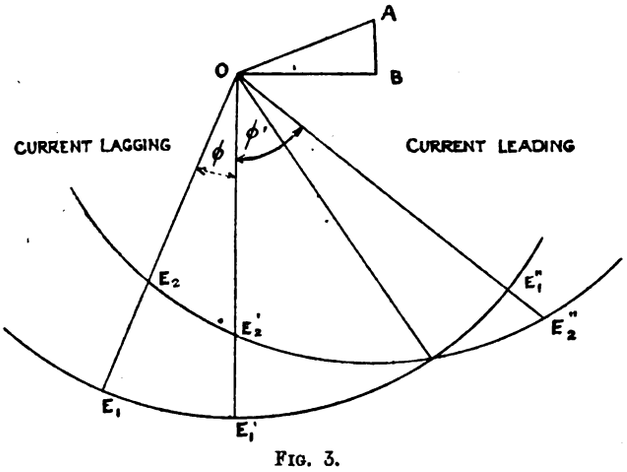

FIG. 3.

would obviously be zero, so that E_2 would coincide with O, and the primary voltage O E_1 would be equal to E_2 E_1, which latter corresponds to O A in Fig. 3.

In all the above cases it has been assumed that the ratio of transformation is unity, but Fig. 3 can be applied to a transformer with any known ratio simply by reducing the primary voltages to equivalent secondary voltages. To illustrate this, let us take the case of, say, a 60-kw. transformer, ratio 3,000 volts primary, 200 volts secondary.

Suppose resistance of primary = 1 ohm, then ohmic drop at full load = 1 × 20 = 20 volts.

Again, resistance of secondary = ·004 ohm, ohmic drop at full load = ·004 × 300 = 1·2 volts. Reducing the ohmic drop in the primary to correspond to a ratio of unity, we get a drop of $\left(20 \times \frac{200}{3{,}000}\right)$ = 1·33 volts. Therefore, total ohmic drop in both windings = 2·53 volts, corresponding to a ratio of unity.

Suppose that to maintain the full-load current of 300 amperes through the short-circuited secondary winding a voltage of 270 volts had to be applied to the primary terminals. This corresponds to a reduced voltage of $\left(\frac{270 \times 200}{300}\right)$ = 18 volts. Therefore, referring to Fig. 3, we have O A = 18, A B = 2·53, O E_1 = 200. If these be drawn to scale, the secondary voltage for any lag or lead of the secondary current can be at once scaled off.

I presume "R. S. L." requires to know the drop due to leakage alone. This for the case where the angle of lag is ϕ will be (E_1 E_2 − A B), and similarly for any other position.—A. P. YOUNG.

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Answer to No. 732 (*awarded* 5*s.*).—An easy method of determining the drop in secondary volts of a transformer at full load and at any power factor is the following First find the maximum impedance drop in the two windings. This can be found experimentally by short-circuiting the secondary coil and measuring the pressure across the primary terminals when full-load current flows through the windings at the working frequency. Fig. 1 is a sketch

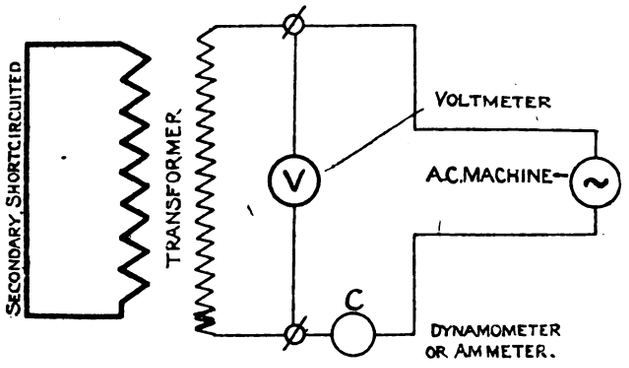

FIG. 1.

showing the connections necessary for this test. If C = the full-load current of the transformer, then V = the maximum impedance volts referred to the primary, and $\frac{V}{K}$ = the maximum impedance volts referred to the secondary, where K = ratio of transformation.

$$\frac{V}{K} = \sqrt{(\text{inductive drop})^2 + (\text{ohmic drop})^2}.$$

The drop in volts due to resistance of windings = $C_1 \times R_1 + \frac{C\ R}{K}$ = ohmic drop; C_1 = secondary full-load current; C = primary full-load current; R_1 = secondary resistance; R = primary resistance.

Knowing the full-load currents of the transformer, and finding the resistances of the windings, either by calculation or experiment, the ohmic drop at full load is easily determined. Construct a triangle A B C, making A B = impedance volts referred to secondary; B C = ohmic drop in secondary volts to a convenient scale; and the angle A C B a right angle. To the same scale, with radius equal to the

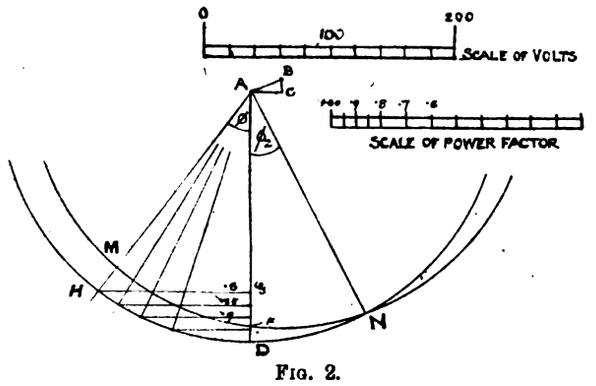

FIG. 2.

secondary voltage at no load, draw two circles with centres at A and B. Draw line D A at right angles to A C, then the length D F, to scale, cut off by the two circles is the total drop in secondary pressure at non-inductive full load. If the current lags by an angle ϕ—*i.e.*, if the power factor of the secondary load = cos ϕ—draw A H, making angle D A H = ϕ, then total drop in secondary volts at full load (power factor = cos ϕ) is the length H M, to scale. Now, $\cos \phi = \frac{A\ G}{A\ H} = \frac{A\ G}{A\ D}$. Therefore, if the line A D be divided into decimal parts, the position of the line A H for any power factor can easily be found by completing the triangle A H G, H being the point of intersection of the perpendicular H G drawn from G, and the circle centred at A. The angle ϕ_2 is drawn on the opposite side of line A D when the current leads by this amount. It is seen that the circles intersect at N. A N equals A D; therefore, when current leads by angle ϕ_2, there is no drop in secondary volts; if the angle of lead is greater than ϕ_2, then secondary volts rise.

For the sake of clearness, the triangle A B C in the diagram (Fig. 2) is shown larger in proportion to A D than in an ordinary transformer diagram—*i.e.*, constant-potential lighting transformer. In this diagram impedance volts = A B = 25 volts; ohmic drop = B C = 10 volts; total drop at power factor 1 = 12·5 volts, ·95 = 20 volts, ·9 = 22 volts, and ·85 = 23 volts. Working out a diagram for an actual transformer of which the following data are known: kilowatts = 50; primary volts, 2,000; secondary volts (no load), 204; primary resistance, ·5; secondary resistance = ·05; ~, 50; impedance volts (secondary), 10; total ohmic drop (secondary) = 2·5, the total drop at various power factors: 1 = 3; ·95 = 5·5; ·9 = 6·5; and ·85 = 8. The drop due to magnetic leakage alone = total drop − ohmic drop.—W. H.

THE AUSTRALIAN TELEGRAPH SYSTEM.

Hugh H. Lusk, in the November number of the *North American Review*, describes the Australian telegraph system. Before the Australian States were welded into one commonwealth, each of the States owned and controlled the telegraph lines within its borders, but when the union was effected the Federal Government took over all telegraph lines, and the Federal Parliament established the conditions under which they should be operated. Rates were fixed for town and suburban messages, for messages from one point to another point within the same State, and for messages from a place in one State to a place in any other State within the Commonwealth, and, taking these together, Mr. Lusk asserts that the cost of telegraphing in Australia is less than one-half, and would probably work out at one-third, the amount charged in America. The combined cheapness and efficiency of the telegraph system in Australia Mr. Lusk attributes to the fact that the telegraph lines are owned and operated by the public, and to the economies naturally attending the system. That the public utilise the facilities thus afforded them for telegraphic communication is evident from the fact that the number of messages *per capita* in Australia is apparently nearly three times what it is in America. The differences appear due, however, quite largely to methods of counting. He says:

"The circumstances of Australia, and the conditions of its settlement, have had the effect of making both its railroads and its telegraphs unusually extensive in comparison with the numbers of its population, and this is markedly the case with its mileage of telegraph lines. At present the great island is only settled on a strip of country bordering on the coast, and even that strip does not include the more northern shores either on the east or west, and takes in no part of the north side at all. The consequence is that a line of telegraph which connects the settlements of Queensland on the north-east of Australia with those of West Australia on the west coast—a distance, in a direct line, of about 2,500 miles—covers fully double that distance from the necessity of keeping in touch with the settled districts. There is, indeed, one line of telegraph which of necessity ignores this rule, and passes for nearly its whole length of about 1,700 miles from the south to the north-western corner of the island through an unsettled country. The purpose of this line is to connect settled Australia with the rest of the world by way of Java and India, and it passes through great districts of the interior which were first explored for the purpose of its construction. Under the circumstances, it was not possible that telegraph facilities could be supplied in Australia on a small scale or at a trifling cost."

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Supplement to "The Electrical Engineer,"
DECEMBER 2, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

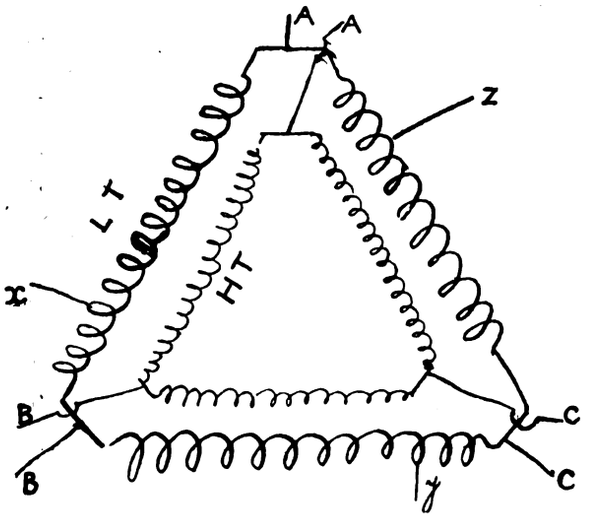
QUESTIONS.

741. A private telephone used in connection with a certain tramway system, to speak from the generating station to the different section boxes along the line, is found to work very unsatisfactorily when the cars are running, but works well when the cars have been stopped. The noise of cars can be heard quite distinctly, so much so that it is impossible to hear what is said. Length of track about seven miles; the telephone cables are laid beside the traction feeders, but in a separate trough, and parallel to the track. What is the best remedy to overcome this difficulty?—G. M.

742. It is common practice in continuous-current designing to take the permissible reactance voltage (per section of the armature winding) at a higher figure in the case of motors than in the case of dynamos. Is there any basis for this procedure in point of fact or of theory? Please discuss fully.—F. W. D.

ANSWERS.

733. In a three-phase sub-station for rotary converters, the three single-phase transformers are connected in mesh. From each of these transformers an extra lead is taken on the low-tension side



to provide a lower voltage for starting the starting motors of the rotaries. In what phase are these extra leads—x, y, and z?—POLYPHASE.

Answer to No. 733 (*awarded* 7*s.* 6*d.*).—If the leads x, y, and z are taken off the secondary windings at exactly symmetrical positions—*i.e.* the number of turns between the points B x, A z, and C y are equal—then the voltages between the lines x, y, and z will be equal and exactly 120deg. apart in phase to one another. This can be easily seen by reference to Fig. 1. In this diagram 0 1 represents the voltage across the secondary winding, C B, 0 2 that across B A, and 0 3 that across the third winding, A C. Now, the voltage between the lines x and y is made up of two components, one component proportional to the winding between the points B and y and in phase with 0 1, the other component proportional to the winding between the points B and x and in phase with 0 2. The resultant of these two components represents the voltage between the lines x and y, and is represented in magnitude and phase by the vector $0\,y\,x$ in the diagram. Similarly the voltage between the lines x and z is represented by $0\,x\,z$, and that between the lines y and z by $0\,z\,y$ From the symmetry of the diagram it is easily seen that if the winding between the points B x, A z, and C y are equal, then the three vectors $0\,y\,x$, $0\,x\,z$, and $0\,z\,y$ will be equal and exactly 120deg. apart in phase.

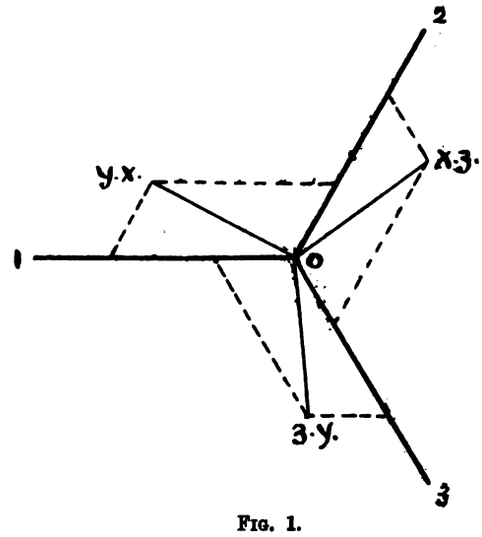


FIG. 1.

The state of affairs can be more readily seen by a reference to Fig. 2. Here the triangle A B C represents the voltages across the three secondary windings. The triangle $x\,y\,z$ then represents the voltages between the lines x, y, and z, and obviously this triangle is an equilateral triangle. From this diagram it is readily seen that the minimum voltage that can be obtained between the lines x, y, and z still maintaining 120deg. phase displacement between the three voltages is one half the

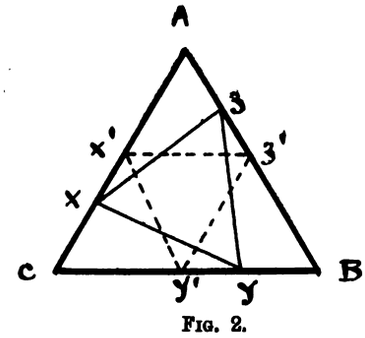


FIG. 2.

voltage across the secondary of either transformer, corresponding to the dotted triangle, $x^1\,z^1\,y^1$, and it is seen that this result is obtained by tapping off the secondary windings at the points $x^1\,z^1\,y^1$—*i.e.*, at the middle point of each.—A. P. Y.

Answer to No. 733 (*awarded* 7*s.* 6*d.*).—To find the phases of the voltages between the points X, Y, and Z, the easiest way is to use the graphical method. The diagram to be drawn is similar to that given by "Polyphase" in his question, except that the lines now represent E.M.F.'s instead of actual transformer windings. We need not consider the primaries of the transformers. The secondaries being connected in mesh, their E.M.F.'s will be represented by an equilateral triangle, A B C (Fig. 1). If the triangle revolve about its centre point, O, in, say, a clockwise direction, the projections of A B, B C, and C A at any instant on the horizontal, P Q, will give their respective instantaneous values at the instant in question. Similarly, the projections of O A, O B, and O C give the instantaneous values of the E.M.F.'s between A B C and the neutral.

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Now, take points X, Y, and Z in A B, B C, and C A respectively such that these points divide the three lines in the same proportion that the secondary windings are divided by the tappings. Then the triangle X Y Z obviously must represent the E.M.F.'s between these points, and their instantaneous values will be given by the projections of X Y, Y Z, and Z X upon P Q. Also the phases of the voltages between these extra leads relatively to the phases of the main voltages, A B C, will be given by the angle θ.

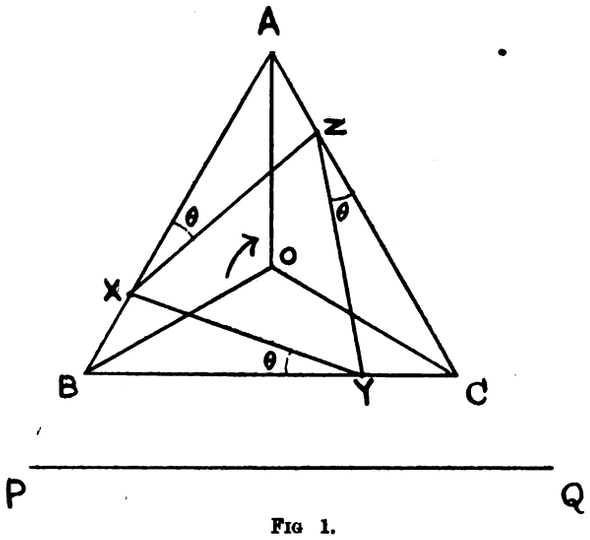

FIG 1.

This is clearly so, because X Z reaches its maximum—*i.e.*, is parallel to P Q—before A B by an interval equal to the time taken to turn through an angle θ. The question does not give the positions of X, Y, and Z in the windings, but if we assume A X = two-thirds of A B, and the other windings to be similarly divided, it is easy to show that the starting voltage on the motor is 58 per cent. of the full voltage, and differs in phase from the latter by an angle of 30deg. If X, Y, and Z are taken at the middle points of A B, B C, and C A respectively, then the starting voltage is obviously one-half, and differs in phase from the main voltage by 60deg.

An easier method of connection for accomplishing the same result is shown in Fig. 2. Two of the secondary windings only, A B and A C, are tapped at X and Y, and

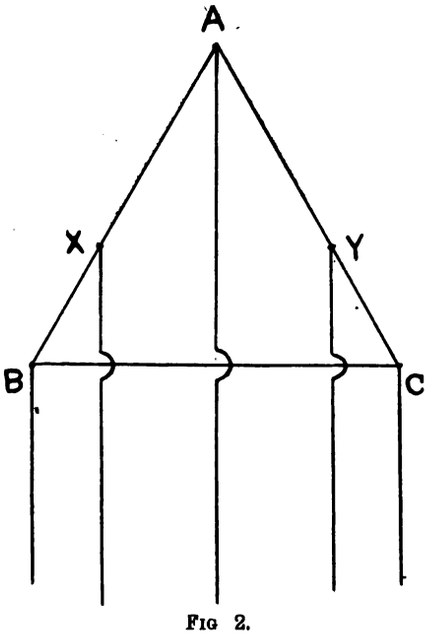

FIG 2.

extra leads taken from these points. The starting voltage is given by the leads from A, X, and Y, and the running or normal voltage by the leads from A, B, and C. This allows of running only two extra leads for starting. The secondary, B C, is idle, and the voltage regulation not quite so good as if all three were used, though quite good enough for starting purposes.—R. C.

Answer to No. 733 (*awarded* 5*s.*).—In order to determine precisely the phase angle between the E M.F. wave at x, y, and z and the E.M.F. wave in the high-tension lines connected to B, C, and A respectively, we must investigate the various reactions taking place in the transformer itself. Since the transformers are separate in each phase, the phase of the volts across B x and B A will be identical. Hence, if we find the phase of this latter E.M.F., we shall arrive at the determination required.

Let us consider the initial case of an unloaded transformer. Let E_{11} (Fig. 1) represent the phase of the secondary E M.F., B A. Since no current is flowing in the

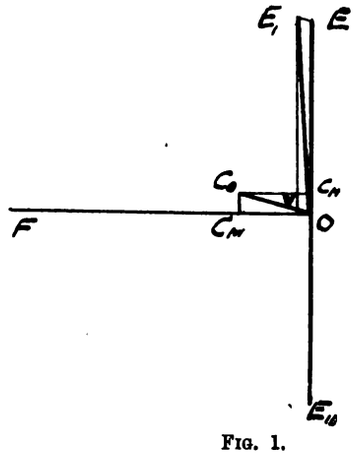

FIG. 1.

secondary windings, we have no losses, and hence E_{11} represents the induced secondary volts. The alternating flux producing this leads by 90deg., and may be represented by F. A back E.M.F. in the primary is also induced by this flux, and is shown as E (leading again by 90deg.).

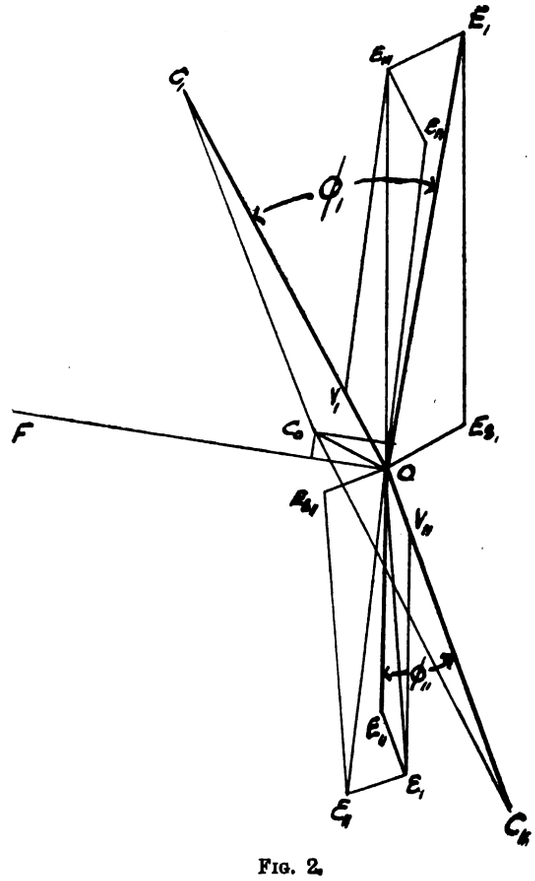

FIG. 2.

A small current flows in the primary of the transformer supplying the iron losses and magnetising the transformer. The magnetising component, C_M, is in phase with the flux, and the hysteresis, etc., losses are made good by C_H in phase with the E M.F. (power component). C_0 then is the no-load current. V is a vector equal to the volts lost in the primary due to C R drop. Hence, E_1—the resultant of E and

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V—gives the phase of the line volts—at least the high-tension potential difference across the primary. The angle E_1 O E_{11} is a measure of the phase displacement of the volts B A (or B x) and the primary terminal potential difference.

When a load comes on the transformer, the conditions are not so simple. For the sake of discussion we will assume a load current, C_{11}, lagging behind the E.M.F., E_2, by the angle ϕ_{11}. Now the resistance of the secondary caused a voltage loss equal, say, to V_{11}. Further, owing to a small amount of magnetic leakage between the secondary wires, we have a self-induction E.M.F. lagging 90deg. behind the current wave. This effect is dependent on the frequency and the number of turns on the secondary coil and the leakage coefficient, which varies with different types of transformer. This must be allowed for by a vector, E_{s11}, in opposition, and so shown leading by 90deg. Now, compounding these three E.M.F. vectors, E_{11}, V_{11}, and E_{s11}—we get first E_1, then E_{11}—which is the total induced secondary volts necessary to give the current C_{11} at a terminal voltage of E_{11}, lagging by ϕ_{11} degrees. As before, we need a flux F, 90deg. in advance, giving in its turn a back E.M.F., E_{1V}. C_o is the current necessary for magnetisation and iron losses. To get, C_1 the primary load current, we proceed as follows: C_{11}, in addition to producing the small self-inductive field, would also produce another field in phase with this latter, were it not prevented by the tendency of the primary current to produce a field equal to it but in opposition of phase. Hence the phase of the primary load

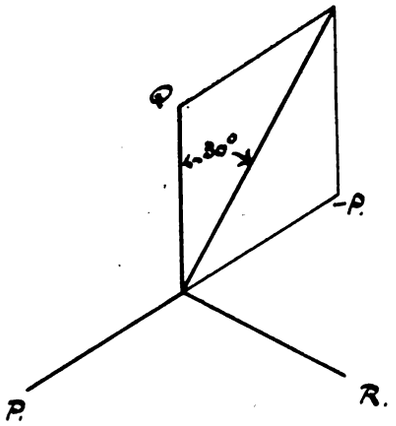
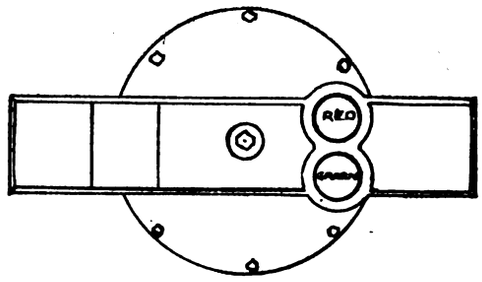


FIG. 3.

current—that is to say, that component which neutralises the effect of the secondary load current—is in opposition of phase to C_{11}, whence by compounding we obtain C_1, the primary current. The component parts of the total primary volts are: (1) the back E.M.F., E_{1V}; (2) the self-induction neutralising E.M.F., E_{s1}; (3) and the primary copper drop, V_1. These when compounded give E_1, the terminal primary volts. The angle between E_1 and E_{11} is a measure of the phase angle between volts B A primary and B A secondary. If the vectors P Q R in Fig. 3 represent the phase of the volts generated in each coil or winding of the star-wound alternator (usual tramway, etc., practice), then if P and Q represent the waves at A and B respectively, evidently the phase of the potential difference on A B (primary) will be 30deg. in advance of the alternator wave. Therefore, the phase of the voltage across B x (or A x for that matter) will be E_1 O E_{11}—30deg. This angle, as will be seen from a study of the diagram, changes with the load current and the power factor, and also with the frequency.—W. E. O.

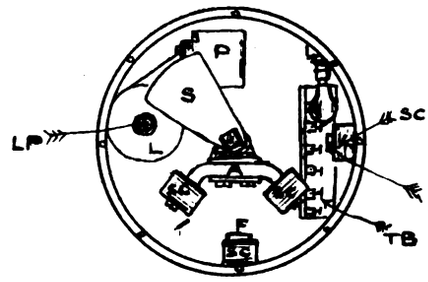
Question No. 734.—Describe the Harison system of electric signalling for single-line working on tramways.

Answer to No. 734 (*awarded* 7*s.* 6*d.*).—The Harison system is automatic and simple. It is arranged on the lock and block principle; only one car is allowed on the protected section at the same time. It also provides for the contingency of two cars entering the protected section simultaneously from opposite ends. The signals consist of miniature railway semaphores, with red and green spectacles, illuminated at night by incandescent lamps. The semaphore arm is weighted so as to return from the "line clear" position to "danger" entirely by gravity, thus complying with the Board of Trade regulations. On a current being passed through the signal coils, S C, the armature, A, carrying the semaphore arm is attracted by the fixed pole-pieces, F, thereby lowering the arm to the "safety" or "line clear" position. The arrangement for locking the arm at the "danger" position and unlocking the same is accomplished by two solenoids provided with a common plunger, L P. When current is passed through the front (or locking) solenoid, L, the plunger is drawn into it, and engages with the "shield," S, on the shaft carrying the arm,



View of Signal with Arm and Lid in Position.

thereby preventing it from lowering. When a current is allowed to pass through the rear (or unlocking) solenoid, the plunger is drawn back into it, and disengages from the shield, and the arm is left free to lower. The preference solenoid, P, is provided in one only of the two signals protecting a section. This is a device for preventing the preference signal from being locked, and comes into action



View of Signal with Arm and Lid removed, showing position of Mechanism when Signal is at Danger. S C Signal coils, A Armature, F Fixed pole-pieces, L P Locking plunger, S Shield, L Locking solenoid, P Preference solenoid, T B Terminal board.

when two cars are trying to enter the protected section at opposite ends at the same instant. It has no effect if the preference signal is already locked. The mechanism of the signal proper is, therefore, extremely simple, there being no electrical contacts to wear, spark, or get out of order, so that the maintenance is practically nil. The whole of the working parts are enclosed in a cast-iron watertight case, with a small door in the lid for inspection purposes. The installation can be carried either on the shunt or series system, both being applicable to single trolley lines.

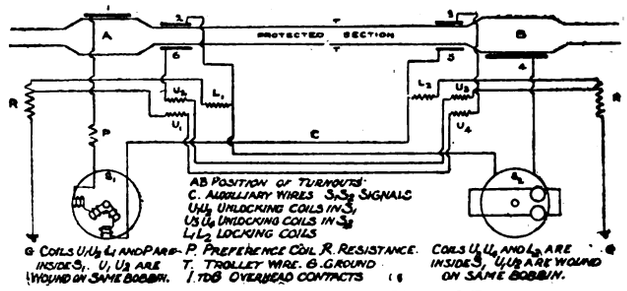


Diagram of Shunt System—Single Line and Turnout.

Diagrams of connections are shown for the shunt system arranged for a single line and turn-outs. For this six overhead contacts are erected, shown at 1, 2, 3, 4, 5, and 6. Contacts 1 and 4 are arranged so that a car always stops underneath them while waiting on the turnout, the remaining contacts being placed so that there is no possibility of a car stopping underneath them. Suppose a car arrives at A and makes contact with 1, the P, S_1, and L_2 to earth is completed. If this line is clear, S_1 is lowered and

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S_2 is locked. The car then proceeds to 2, where the circuit made is L_1 to earth, thereby locking S_1 behind it, the line being now blocked. When the car arrives at 3 the circuit U_4 U_1 to earth is made, and both signals are unlocked. The operations of 4, 5, and 6 contacts are identical with 1, 2, and 3 respectively. It will be noted that 3 and 6 are provided with separate unlocking circuits, which can never be alive at the same time. The windings of the solenoids are so arranged that (1) if U_1 and L_1 are both energised, S_1 remains unlocked; (2) if U_2 and L_1 are both energised, S_1 is unlocked; (3) if U_3 and L_2 are both energised, S_2 remains unlocked; (4) if U_4 and L_2 are both energised, S_2 is unlocked. Also, if L_1 and L_2 are dead, U_1, U_2, U_3, and U_4 are each of themselves capable of unlocking their respective signals.

Bearing these facts in mind, the following cases are taken to show the action of the signal: (1) if car A reaches 1 before car B reaches 4, S_1 is lowered and S_2 locked, or *vice versâ*; (2) if cars A and B arrive at 1 and 4 simultaneously, S_2 is locked, but not S_1, since the preference coil prevents it, car A thereby having the preference; (3) if cars A and B are waiting at 1 and 4 respectively, and a third car, C, is on the protected section, the signal at which it arrives will be unlocked, but not the one behind it.

It is unnecessary to describe the series systems in equal detail here. Suffice it to say that it is so termed on account of the signal windings being in series with the overhead trolley wires, an arrangement which involves the erection of a few section insulators and the use of two auxiliary wires. The chief advantage claimed for the Harison system of automatic signalling over other systems of its kind is that it provides for the contingency of two cars on a single-line system trying to enter the protected section from opposite ends simultaneously. The system is being used at Portsmouth, Batley, Wallasey, etc.—C. H. L.

Answer to No. 734 (*awarded* 7*s.* 6*d.*).—The Harison patent system of automatic signalling for single-line working of tramways is so arranged that a shunt or series system may be used, but as the series system has not so far been used, I propose to confine my remarks to the shunt system. The signal, as shown in Fig 1, is arranged with a semaphore

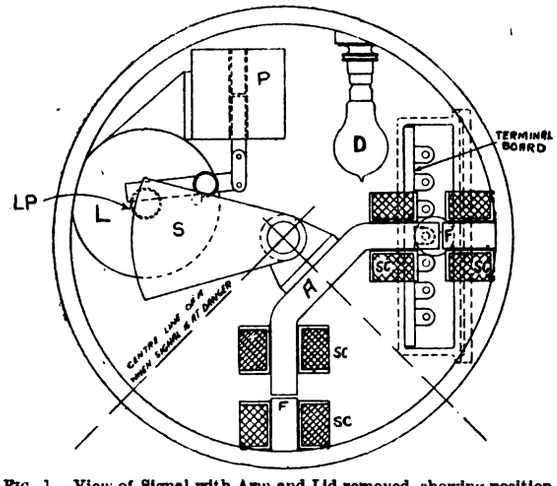

FIG. 1.—View of Signal with Arm and Lid removed, showing position of Mechanism when Arm is at "Line Clear" Position.

fitted with red and green spectacles, which are illuminated at night by incandescent lamps, marked D. This semaphore arm is weighted so as to return from the "line clear" position to "danger" entirely by gravity. On a current being passed through the signal coils, S C, the armature, A, carrying the semaphore arm, is attracted by the fixed pole-pieces, F, thereby lowering the arm to the "safety" or "line clear" position. The arrangement for locking the arm at the "danger" position, and unlocking the same, is accomplished by two solenoids provided with a common plunger, L P. When current is passed through the front or locking solenoid, L, the plunger is drawn into it, and engages with the shield, S, on the shaft carrying the arm, thereby preventing it from lowering. When a current is allowed to pass through the rear or unlocking solenoid, the plunger is drawn back into it and disengages from the shield, and the arm is left free to lower. The preference solenoid, P, is provided in one only of the two signals protecting a section. It is a device for preventing the preference signal from being locked, and comes into action when two cars are trying to enter the protected section at opposite ends at the same instant. It has no effect if the preference signal is already locked, nor till it is unlocked. The whole of the working parts are enclosed in a cast-iron watertight case, which is arranged to bolt on to the traction poles.

When the shunt system is used, the diagram of connections for which is shown in Fig. 2, it is necessary to have

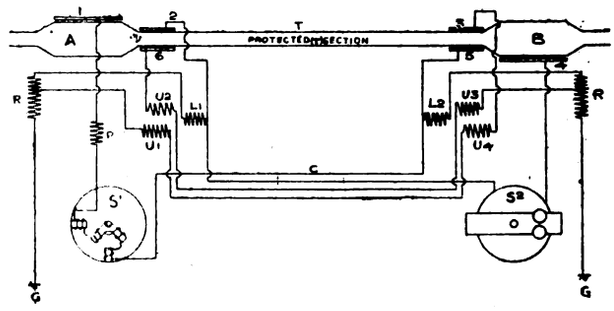

FIG. 2.—A B Turnouts, C Auxiliary wires, S_1 S_2 Signals, U_1 U_2 Unlocking coils in S_1, U_3 U_4 Unlocking coils in S_2, L_1 L_2 Locking coils, G Ground, P Preference coils, R Resistance, T Trolley wire, 1 to 6 Overhead contacts.

erected special contacts (overhead), which are operated by the trolley wheel or trolley head. Connection is made between the trolley wire and the overhead contact, and the shunt circuit is established through the signals to earth during the time that the car is under the contacts. Four auxiliary leads are also required between the signals, these being of small cross-section, the amount of current used being about 2½ amperes. Fig. 2 shows the special overhead contacts, which are marked 1, 2, 3, 4, 5, and 6. Contacts 1 and 4 are arranged so that a car always stops underneath them whilst waiting on the turnout. Contacts 2, 3, 5, and 6 are placed so that there is no possibility of a car stopping underneath them. Suppose a car arrives at A and makes contact with 1, the circuit completed is P, S_1, and L_2 to earth. If the line is clear, S_1 is lowered and S_2 is locked. The car then proceeds to 2, where the circuit made is L_1 to earth, thereby locking S_1 behind it. The line is now blocked. When it arrives at 3 the circuit made is U_4, U_1 to earth, and thus both signals are unlocked. The operations of numbers 4, 5, and 6 contacts are identical with numbers 1, 2, and 3 respectively. Now, it will be noticed that 3 and 6 are provided with separate unlocking circuits, which can never be alive at the same time. The windings of the locking and unlocking solenoids are so arranged that if U_1 and L_1 are both energised, S_1 remains locked; if U_2 and L_1 are both energised, S_1 is unlocked; if U_3 and L_2 are both energised, S_2 remains locked; and if U_4 and L_2 are both energised, S_2 is unlocked; also if L_1 and L_2 be not energised, U_1, U_2, U_3, and U_4 are each capable of unlocking their respective signals by themselves.

Bearing these facts in mind, the following cases are taken to show thoroughly the action of the signal: (1) Suppose car A reaches 1 before car B reaches 4, S_1 is lowered, S_2 is locked. (2) If car B reaches 4 before car A reaches 1, S_2 is lowered and S_1 is locked. (3) If cars A and B arrive at 1 and 4 simultaneously, S_2 is locked but S_1 is not, since the preference coil prevents it, car A thereby having the preference over car B. (4) If car A and car B are waiting at 1 and 4, and a third car, C, is on the protected section, then if car C arrives at 3, S_2 is unlocked but not S_1. If, however, car C is going in the other direction and arrives at 6, S_1 is unlocked and not S_2.—B. C. S.

[Other replies to Question No. 734 will be given in our next issue.—ED. *E. E.*]

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DECEMBER 9, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

743. I use five tons of zinc annually in the production of hydrogen for plumbers' use. When the solution is saturated with sulphate of zinc it is thrown away. Describe best method of recovering the zinc in metallic form by electrolysis.—G. W.

744. Will anyone who has had experience with the Cruse controllable superheater give an account of its general working as regards efficiency, cost of upkeep, and the liability of the copper water-tubes to become scaled or corroded?—S. T.

ANSWERS.

Question No. 734.—Describe the Harison system of electric signalling for single-line working on tramways.

Answer to No. 734 (*awarded* 5*s.*).—The Harison signal for single-line tramways with turnouts is constructed in two forms—viz., shunt and series—but a description of the shunt will serve for both, as it will give a general idea of the system. The apparatus consists of a number of overhead contacts (1-6, Fig. 3) placed in close proximity to the trolley wire, signals constructed as shown in Figs. 1 and 2, with semaphore arm and red and green glasses for night use (an incandescent lamp being used to illuminate the glasses), and four auxiliary wires between each turnout. The semaphore arm is weighted so that it will return to "danger" by gravity alone, thus complying with the Board of Trade regulations. The current for working the apparatus is obtained from the trolley wire by means of an attachment on the trolley head, which makes a connection between the trolley wire and fixed contact pieces. The connections are shown in Fig. 3. On a current being passed through the signal coils, D_1 D_2, the movable coils, D_1, mounted on the armature, E, are attracted towards the fixed pole-pieces, D_2, thus lowering

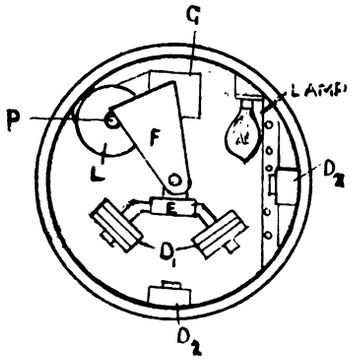

Fig. 1.

the arm to "clear." The semaphore arm is locked by the aid of three coils—L (the locking coil) and two unlocking coils, U_1 U_2—mounted side by side with one common plunger, P. When current is passed through the front coil, L, the plunger is drawn into it, the front end projecting and preventing the arm, F, from lowering, thus locking the semaphore arm at "danger." On current being passed through unlocking coils the plunger is withdrawn, thereby unlocking the arm. The preference coil, G, is provided in one of the two signals controlling a section, which gives preference to the signal in which it is placed, when two cars try to enter the section at the same time in opposite directions, the preference coil preventing its signal being locked. Suppose a car arrives at A, if the signal S_1 is not locked, current passes through G, S_1, L_2,

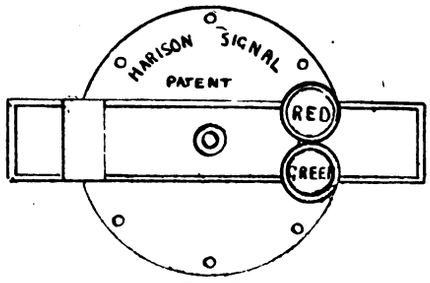

Fig. 2.

and r_2 to earth, thus lowering S_1 and locking S_2. When car leaves 1 the signal S_1 returns to "danger," and is locked by current from 2 through L_1 and r_1 to earth. On arriving at 3, S_1 and S_2 are both unlocked, thus leaving line clear. The windings are so arranged that if U_1 and L_1 are both energised, S_1 is locked; if U_2 and L_1, S_1 is unlocked; if U_3 and L_2, S_2 is locked; and if U_4 and L_2, S_2 is unlocked.

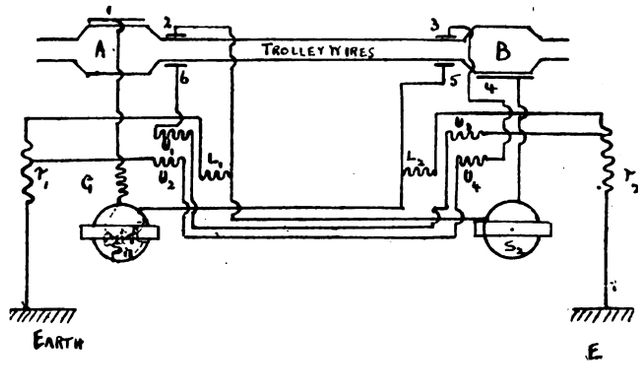

Fig. 3.

The current required to work the signal is from two to three amperes, so that small cross-section wires only are required. The signals are fixed on the poles which support the trolley wire. In the series system a few section insulators are required in the trolley wire, the current being passed through the signals to the cars and two auxiliary wires.—H. S.

Question No. 735.—What is the most practical (not text-book) method of quickly locating faults in underground three-core lead-covered distributors (laid solid) or concentric feeders (in conduits) on a three-wire continuous-current system? Consider the following faults: (1) two cores short-circuited; (2) two cores short-circuited with "earth"; (3) earth on one core (unusual). It is required—first to quickly locate between disconnecting boxes, and then locate closely. The writer (for the latter) favours a simple system with comparatively large testing currents, such as taking drop of potential from each end of faulty main to earth, with heavy constant current passing along whole main, but fails to see how this method can be applied in the cases of (1) and (2). Accurate bridge tests, in the writer's opinion, are almost impossible for street work. Give particulars of most suitable instruments and apparatus that can be quickly arranged for tests.

Answer to No. 735 (*awarded* 7*s.* 6*d.*).—First, to locate between disconnecting boxes. It may be assumed that in (1) and (2) considerable current is flowing through the fault, and we may test in each disconnecting box, without disconnecting, by placing a small compass on the connecting links and noting the direction of the current. We can thus trace up to the nearest disconnecting box to the fault, since in the core which is positive to the fault the current must be flowing towards the fault; and in the negative core, away from the fault. If the leakage current be small compared with the load, or in case (3), the only satisfactory method is to "disconnect and try." Trying or testing is most quickly done by using a lamp as detector, and poten-

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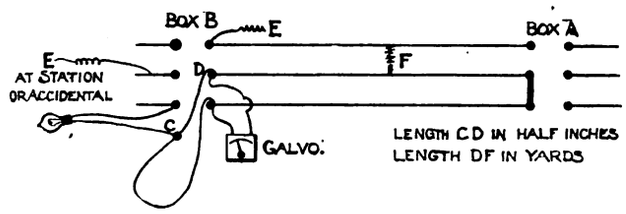
tial to earth from the mains. With 200 volts to earth, a 200-volt 8-c.p. lamp will show a red filament when in series with a fault of 5,000 ohms resistance. In cases (2) and (3) the cable to be tested is disconnected at both ends, one lamp lead connected to a terminal in the box at, say, 200 volts to earth; the other lamp lead is touched to "earth," and the lamp lights up, then touched on the terminal of the core to be tested, and if the filament of the lamp shows no colour, the insulation resistance of that core is over 5,000 ohms to earth. A similar test for "circuit" instead of for "earth" is made in case (1). If all three cores are not dead while one is being tested, care must be taken that any colour shown on the lamp filament is not due to consumers' lamps connecting the "dead" core under test with the "live" one.

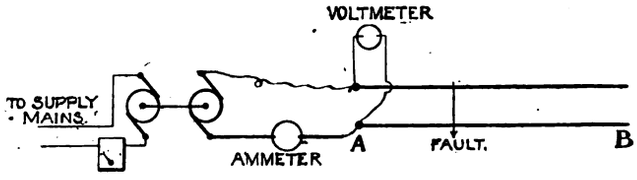
Secondly, to localise on a continuous length. I beg to disagree with "R. V. M." I have found the "loop test" most accurate, and the three cases he gives lend themselves particularly to that method of localisation. The only instrument required is a low-resistance moving-coil galvanometer giving a visible deflection with ·0001 volt applied to its terminals. Such an instrument can be obtained for about £7. My method of testing may be best shown by an example. Suppose the fault to be between two disconnecting boxes, A and B, the length of cable between terminals being exactly 100 yards, and the section of each core ·25 square inch. Throw dead all three cores. In box A make a good short-circuit connection between the good core and a faulty one. For this connection I use tin fuse strip 1in. by $\frac{1}{16}$in., which, if cleaned and clamped on to a clean terminal is bound to "bed" well and make good connection. The resistance of this must be calculated or measured, and is found to be equal to that of, say, 30ft. of ·25 square inch cable. This gives the total equivalent length of loop (box B to box A) connector (box A to box B), 100 + 10 + 100 = 210 yards. For the balance wire, take a scale of $\frac{1}{2}$in. of balance wire to a yard of cable loop; 210 half-inches = 8ft. 9in., a convenient length for working. The resistance of this should be comparable with that of the cable loop; No. 16 or No. 18 copper binding wire will do very well, but it must be free from bad kinks, which are apt to alter the resistance. Take about 10ft. of the binding wire and connect it, in box B, across the terminals of the cores which are short-circuited in box A, so that there is exactly 8ft. 9in. of wire between the terminals, connect the short ends to the galvanometer leads, and in case (1) earth the other core.



Connect one lead from a 16-c.p. or 32-c.p. lamp to a "live" terminal, and touch the other lamp lead on the balance wire; the lamp will light and the galvanometer will give a deflection. Arrange two men standing on carpet or other insulation to hold the wire loop clear and slide the lamp lead along the wire till the galvanometer points to zero. Then, if, necessary, a closer balance can be made by holding the lamp lead in that position and using a key in the galvanometer circuit, and again sliding the lamp lead about the wire $\frac{1}{16}$in. at a time, and noting the direction in which the galvanometer tends to swing when switched in. Having found the exact zero position, mark or cut the wire there and measure shorter piece from mark to terminal; if this is found to be 27$\frac{1}{8}$in., the position of the fault will be $27\frac{1}{8} \times 2 = 54\frac{1}{4}$ yards from box B, at which the test was carried out. It is generally more satisfactory to afterwards repeat the test from box A, short-circuiting at B and taking midway between the two points indicated as the exact position of the fault, as this practically cancels any small error in measuring the length of the cores or of the short-circuiting links. The accompanying diagram readily shows the connections.—A. P. McD.

Answer to No. 735 (*awarded* 7*s.* 6*d.*).—The writer has had great success in locating faults on a given length of triple-concentric or concentric lead-covered cable by means of the method described later. To localise a fault on a large network to a length of main between two disconnecting boxes is often no easy matter, and it is impossible to say what is the best thing to be done without a knowledge of the particular circumstances of the case. Where the distributors are fused the blowing of fuses should indicate the section on which the fault exists. Supposing, however, that the fuses do not blow, or that the fault is an earth, the writer advises splitting up the network into two or more portions, as may be convenient, each portion to be fed by a separate feeder, with, of course, a middle-wire feeder if the main feeders are not triple-concentric or three-core. Then the fault will show on one or other portion by the current passing through the feeder ammeter connected to the faulty section. Transfer a portion of the network on which the fault is indicated on to one of the sound sections, and see if the fault goes with it. By continuing this process the trouble can be brought down to one length of distributor. To find the position of a fault on a length of main between two disconnecting boxes the writer uses a small motor-generator, such as is used for charging individual cells of a battery. The motor side is wound for the supply voltage, and the generator is made to give, say, 50 amperes at from two to ten volts. Such a machine can easily be taken about in a hand-cart and handled by a couple of men.

Having disconnected the faulty length of main, the little generator is put down alongside one of the disconnecting boxes, and the motor is coupled, through its starting switch, to one of the live mains in the box. The generator is coupled by a pair of short leads (with a portable ammeter in one) to the terminals of the cable to be tested. If the fault is a short between two cores, then the generator is coupled to these two cores and run up to such a speed as to give a convenient reading on the ammeter. The volts across the two cores must then be measured at each end of the main by means of low-reading voltmeters (cell testers are very suitable). If the fault is of very low resistance, no reading will be obtainable on the far end of the main. It will be seen that the pressure between the cores at the end remote from the generator will be due to the drop across the fault, so that this reading divided by the current passing at the time will give the resistance of the fault, which we require to know before we can determine the position of it. Having noted the current, C, and the volts, E, at the generator end of the cable, and also obtained the resistance of the fault, make the same test from the other end, calling the current C_1 and the volts E_1. Now, the



distance of the fault from each end must be proportionate to the resistance of the cable from each end to the fault. Referring to the figure, the resistance of the cable (lead and return) from A to the fault is $\frac{E}{C}$ – resistance of fault, and from B resistance is $\frac{E_1}{C_1}$ – resistance of fault.

To take as an example a test the writer made, which proved to be correct within a foot in a total length of 285ft.

On testing at A, current = 20·5 amperes at 2·5 volts, and volts at B at same time = 0·3. Therefore, resistance of fault = $\frac{\cdot 3}{20 \cdot 5}$ = ·0146 ohm. Resistance of two cores from A to fault = $\frac{2 \cdot 5}{20 \cdot 5}$ – ·0146 = ·1219 – ·0146 = ·1073 ohm

On testing at B, current = 25 amperes at ·55 volt. Resistance of two cores from B to fault = $\frac{\cdot 55}{25}$ – ·0146 = ·022 – ·0146 = ·0074 ohm. Therefore, distance of fault from A = $\frac{0074 \times 285}{\cdot 1073}$ = 19ft.

There seems to be no reason why this test should not be

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applied to case No. 2 supposed by "R. V. M." The test current should be put through one of the short-circuited cores and back by way of the lead sheathing.

Case No. 3 should be dealt with in the same way. The writer has used this method of testing to find an earth on the outer of a triple-concentric lead-covered cable, and it should be just as applicable to the third case mentioned by "R. V. M." Of course, in these tests for earths it is supposed that the lead is either continuous or is well bonded at the service and other boxes, if any. Also, of course, before making the test, all consumers on this length must be disconnected at their fuse boxes.—S. A. C.

[N.B.—Will "S. A. C." kindly forward his name and address.—Ed. *E. E.*]

Answer to No. 735 (*awarded* 7*s.* 6*d.*).—The various resistance methods are, in the opinion of many engineers, impracticable and unsatisfactory. Conditions rarely favour the transportation of a testing laboratory. As hinted at in the question, many testing methods that look well on paper fail lamentably in practice. In order to locate the position of a fault, it is a very common procedure to burn it out, and by noting smoke at the manholes to determine more or less approximately the source of the trouble. This is rather a drastic method, and may lead to more burning than is desirable. Although it has been said that the best instruments which can be employed to find an earth are the pick and shovel, the "cut and try" method, unless used

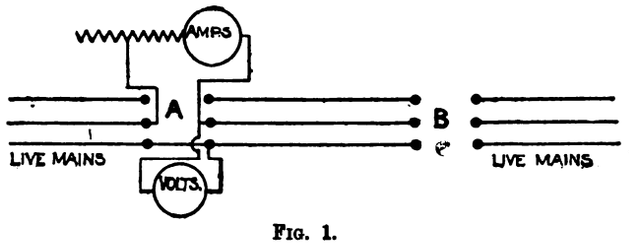

Fig. 1.

with great caution, is apt to be expensive. Very good results are often obtained by means of noting the deflections of a small compass carried over the surface of the ground under which lies the conductor. If a current of eight to twelve amperes is sent through the cable, and this current is reversed in direction every few seconds, the compass will show by its deflections ceasing where the

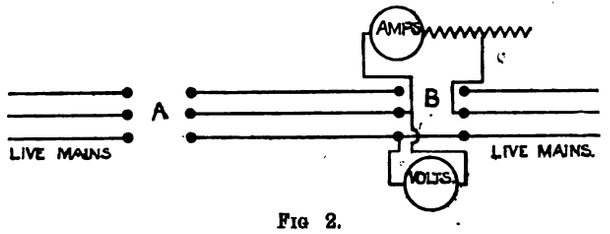

Fig 2.

fault is located. The induction method is also much used in connection with a telephone. A coil having about 500 turns of small wire, of such a shape that a long base is presented to the ground, is wheeled or carried over the top of the cable. A telephone being inserted in the coil, any alteration in the induced current in the coil is evidenced by the clicking or humming of the receiver. Thus one is able to more or less closely fix on a fault in a hidden conductor.

A very suitable method for finding faults as mentioned in the query would be by taking fall of potential when a current flows through the faulty cable. Take Case 1—two cores short-circuited. Figs. 1 and 2 show the connections. A and B are the manholes, or junction boxes, between which lies the fault. By means of the adjustable resistance the current is kept the same at each end. Let the distance between A and B = l; distance between A and fault = x; then distance between B and fault = $l - x$. In each case the drop in volts will vary as the resistance through which the testing current is flowing. Therefore, if d_1 and d_2 be the readings at A and B respectively,

$$\frac{x}{l-x} = \frac{d_1}{d_2}$$

$$x\,d_2 = d_1\,l - d_1\,x$$

$$x\,d_2 + d_1\,x = d_1\,l$$

$$\therefore\ x = \frac{d_1\,l}{d_1 + d_2}.$$

Case 2.—If it is a "dead earth," the same method will be obviously applicable, and it is very unlikely that the earth will be distributed far along the cable. At any rate, it is most improbable that the leakage between copper and earth will be so spread along the cable as to interfere practically with the test.

Case 3.—Send a measured current from each end, using an artificial earth for the return. Thus the two readings may be obtained.

Notes made while the mains are being laid, such as positions or joints, crossings, etc., are invaluable to a mains superintendent. Also, after mains are laid, a watchful eye should be kept on all road operations, and any abnormal readings of feeder ampere-meters noted. A competent mains man will often be able to almost fix on the faulty spot before testing operations.—M. M.

Question No. 736.—A shunt-wound generator is running at 440-500 volts. It is found, upon the shunt field circuit, which is separately excited, being made to the 'bus bars, a series of flashes occur midway between the commutator bars, where the conductors are joined, and the bearing surface of commutator—in other words, between the insulating varnish and air-space of the bars. This takes place immediately the shunt field or magnet coils are excited, and periodically while running on load; also, again, on breaking the shunt circuit. The armature in question was thoroughly cleaned and repainted, so it is no question of carbon or copper dust, neither is it due to oil, etc. Note that the sparking takes place between adjacent coils. Yet the generator is able to run without any undue heating, and a good insulation resistance to earth is obtained. Give what you consider the probable cause of this.

Best Answer to No. 736 (*awarded* 10*s.*).—Such intermittent sparking or flashing between neighbouring commutator plates is a fairly common occurrence on high-voltage machines, and is generally quite harmless. In spite of the careful cleaning of the commutator, carbon and copper dust does lodge temporarily on the mica between the commutator bars, and forms a more or less complete momentary short-circuit between them. In low-voltage machines the voltage from bar to bar is too small to pass any appreciable current across these temporary bridges, but in higher-voltage machines sufficient current is sent through them to burn them out, and this burning out is the cause of the flashes noticed (each spark being lengthened out into a streak of light by the persistence of vision, as the commutator rotates).

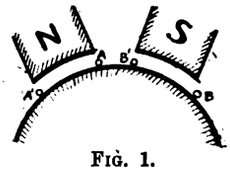

Fig. 1.

The fact that the flashing occurs more especially on switching the shunt in or out is due to an additional voltage set up in the armature sections by a transformer action between the shunt coils, acting as primary, and the armature coils, acting as secondary. This transformer action alone is unable to induce a voltage in the armature section anything like as great as that due to rotation, for the time taken for the flux to rise from zero to its full value after switching on (or to fall from its full value to zero after switching off), is usually a matter of many seconds, whilst the time taken to insert the whole flux per pole into an armature coil, by means of its rotation, is, at normal speeds, a mere fraction of a second. The fact that the flux changes whilst the coil rotates has the effect, however, of increasing the induced voltage above the normal during part of the time and reducing it during the rest of the time, whilst leaving the average induced voltage unchanged. This can be made clearer by the following numerical consideration. Let A B (Fig. 1) represent the two sides of an armature section. Between the times when the coil occupies the positions A B and A′ B′ respectively, the full flux (neglecting fringing) of the N pole becomes inserted into the coil and the full flux of the S pole is withdrawn from the coil. If the flux density is uniform

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over the polar arc, the rate of change of the flux looped with the coil will be uniform, and will induce a constant voltage in the section equal to

$$\frac{\text{Flux per pole in C.G.S. lines} \times 2 \times \text{turns per armature section}}{\text{Time taken to pass from A B to A' B', in seconds} \times 10^8} \text{ volts.}$$

Call this voltage V. Next suppose that the shunt has only recently been switched on, and that the flux has only attained 90 per cent. of its full value at the instant when the coil is at A B, and reaches its full normal value by a uniform increase by the time that the coil arrives at A' B'. Then at the position A B the flux looped with the coil will equal ·9 F from the S pole, where F is the full normal flux per pole. When the coil has moved on past one-tenth of the polar arc the flux per pole will have to ·91 F, and the flux looped with the coil will be ·91 F × ·1 = ·091 F from the N pole and ·91 F × ·9 = ·819 F from the S pole. Or the change of flux looped with the coil during this interval is ·091 F + (·9 − ·819) F = ·172 F. If the full steady flux, F, had been attained, the change in flux in the same interval would have been ·2 F; ∴ the average volts induced in the position A B may be taken as $\frac{·172}{·2}$ V = ·86 V.

Next consider the other extreme point—viz., the instant when the coil is approaching A' B'. When the coil is one-tenth of the polar arc from A' B', the flux per pole will have attained the value of ·99 F, and the flux looped with the coil will be ·99 F × ·9 = ·891 F from the N pole and ·99 F × ·1 = ·099 F from the S pole. When the coil has actually reached the position A' B' the flux has reached its full value of F, and the flux looped with the coil is F for the N pole and O from the S pole, or the change in flux looped with the coil in this small interval is (F − ·891 F) + ·099 F = ·208 F—*i.e.*, the average voltage induced in the section whilst passing the last one-tenth of the pole will be approximately $\frac{·208}{·2}$ V = 1·04 V, or 4 per cent. above the normal. Though this voltage increase is small, the example will serve to show that a rise does occur if the flux is changing in value, and more especially just previously to the flux attaining its full value after switching on, or just after the flux commences to fall after switching off.

The actual value of the rise is determined by the relation of the time taken by a coil to pass a pole (depending on the speed of the machine) to the time taken by the flux in reaching its maximum value on switching on or in falling to zero on switching off (depending on the self-induction and resistance of the shunt winding, and on the value of the eddy currents set up in the solid iron of the magnets by changes of flux). It is, therefore, quite possible that in certain machines a considerable voltage rise might occur between neighbouring commutator bars, and this would tend to make the flashing across more frequent and more noticeable.—Q.

Answer to No. 736 (*awarded* 5*s*).—The flashing may be due either to an effect similar to that in induction machines, or to reflections from sparks at the brushes. On many dynamos, any alteration to the field or variation in load gives rise to a certain amount of sparking. This sparking being reflected by the varnished commutator lugs, might easily lead an observer to be under the impression that sparking was actually taking place between the lugs. Suppose, however, that the flashing is due to the first suggested cause. The brush-holders are at a considerable difference of potential, and these brush-holders, which are probably very close to the commutator lugs, act by induction on the varnished lugs Occasionally sparking may take place between brush-holders and the lugs of the commutator, persistence of vision making it appear as if the flashing actually took place between the lugs. It is quite to be expected that this phenomenon would have no appreciable effect on the working of the dynamo, nor on its insulation. The cause being due to the dynamo acting as a sort of influence machine, that which would be a good conductor for a static charge would give a good insulation test for a dynamo.—M. M.

Answer to No. 736 (*awarded* 5*s*.).—I assume that the sparking is caused by the following: (1) the armature of the generator has evidently a great number of turns per coil; (2) the magnetic field is very strong. If a circuit containing an electromagnet is suddenly broken, a spark appears at the points of rupture; this is caused by the collapsing of the magnetic lines upon the winding, which generates a sufficiently high E.M.F. to cause a spark. We have here a strong magnetic field cutting through a great number of turns of wire in a very short time. In the case of the generator, when the magnetic field is switched on, a large number of magnetic lines suddenly cut through the armature coils, which causes a sufficiently high E.M.F. to spark across the ends of the coils—*i e*, the commutator segments. When the shunt circuit is broken these lines are withdrawn, and again a high E.M.F. caused in the armature coils. This sparking will not take place when the field is steady.—W. DARLING.

SOCIETY OF ENGINEERS.

At a meeting of the Society of Engineers on Monday, the 5th inst., a paper on "Condensing Machinery" was read by Mr. William Edward Storey. After briefly mentioning a few of the condensing engines constructed in the seventeenth and early eighteenth centuries, the author showed how the desire to economise steam resulted in Watt's comprehensive invention, which introduced the separate condenser in a form very little varied to this day. He observed that the jet condenser, from its simplicity, was almost exclusively used until the demand for pure feed water became imperative and the surface condenser was introduced into steamships. The originating cause of the independent condenser was the high speed of modern reciprocating engines. A comparison of the relative advantages of different types of jet condensers shows the counter-current condenser to be more efficient than the parallel-current type, producing a better vacuum with reduced expenditure of power and smaller outlay for pumps. The barometric condenser, he observed, dispensed entirely with the air-pump, and he gave particulars of a large installation of such condensers in Manchester. A similar condenser, invented by Weiss, uses the barometric principle in conjunction with a dry air-pump. The design of water-pump best suited for use with counter-current condensers was stated to be the horizontal, in which type particular care has to be observed to prevent accumulation of air in the valve boxes. The question of pure feed water was the genesis of the surface condenser, the oil separator or filter freeing the water of condensation from the only impurity likely to have ill-effects upon the boiler. Jet condensers are more efficient, but cannot be applied in all cases. The author observed that the evaporative condenser enabled the advantages of surface condensation to be experienced where there was only sufficient water available for boiler feed purposes. Its chief drawback is the fouling of the cooling surface by sedimentary deposit. For tubular condensers the best arrangement for the tubes was stated to be the vertical, which gives better drainage for the water condensed on the surface and leaves the latter more efficient. Central condensing plants are used where many different units of steam-engines are installed, and are generally operated by their own steam-engines or by electric motors. At Deptford condensing plant for 10,000 h.p. of engines is erected on the roof. It consists of cooling towers, surface condensers, air and circulating pumps with their own high-speed engines. In conclusion, the author observed that the difficulties met with in dealing with condensers for winding and similar intermittently working engines had still largely to be solved, but were now receiving much attention.

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Supplement to "The Electrical Engineer,"
DECEMBER 16, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

745. A direct-current generator of 500 volts, for use on a three-wire system, is fitted with an automatic balancing arrangement, consisting of a choking coil fed, *via* slip rings, from two points on the armature windings, the middle point of the choking coil being connected to the neutral 'bus bar. Can you give the theory of its action in balancing the pressure of the two sides of the network?—DELCEF.

746. A 300-kw. Ferranti alternator (2,100 volts, 50 cycles, single-phase) is excited by a shunt-wound Elwell-Parker machine rated at 100 volts and 60 amperes, rope-driven from the main shaft. The exciting current varies from 40 to 60 amperes. Several times during the last 18 months this machine has dropped her exciting current under various load conditions, picking it up again after a short interval on one or two occasions. Careful examination for loose connections, slipping of the ropes, earths, or shorts on the exciter connections has failed to reveal any fault which would account for this behaviour. Moreover, the machine has invariably run satisfactorily on the next shift. The writer would be glad of an explanation of this phenomenon.—W. H. H.

747. How is it possible to predetermine, with anything like accuracy, the point at which a "synchronous" motor will drop out of step?—A. C.

ANSWERS.

Question No. 737.—Describe what you consider the best method of locating a middle-wire earth in any section of a network, giving sketches of same.

Answer to No. 737 (awarded 7s. 6d.).—Suppose the station battery is working in parallel with the generators, and both feeding into the network, a very easy method for testing the insulation resistance of the neutral or outer conductors without interfering with the supply is to make connections as shown in Fig. 1, where G is the generators, E the station

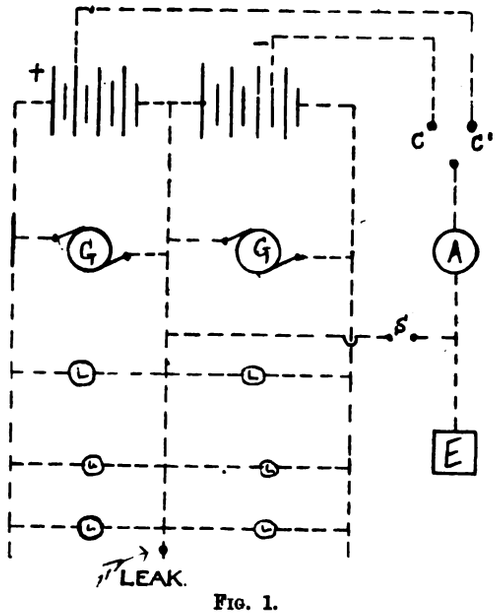

FIG. 1.

earth-plate to which the neutral wire is connected through the switch S, A is an ammeter which is connected through a two-way switch. The two contacts, C and C^1, are each connected to the third cell from the neutral connections of each side of the system. If the permanent earth is broken by the switch, S, and the two-way switch placed on contact C^1, and there is a leak on the neutral main, a current will flow from the three cells to E, back to the battery through the neutral wire defect. If the two-way switch is placed on contact C, you would get the same result, only the current would be in the opposite direction. This test will immediately show up any serious defect on the outer of the triple-concentric system. When you have found that there is a fault, you can then proceed to find it to a certain area. This can be effected very easily where there is a shunt central-zero ammeter, with a shunt between each neutral feeder, and the station neutral 'bus bar, to measure the current flowing through each neutral feeder. Of course, this test will have to be taken when there is no likelihood of the supply to alter for an hour. The permanent neutral earth at the station need not be interfered with during this test. Take readings, by means of the ammeter and neutral feeder shunts, of any current that is flowing between the neutral feeders and the station 'bus bar, and make a note of the direction of current by central zero ammeter, then earth the negative side of the system through an ammeter and resistance, commencing with a few ohms. Fig. 2 shows the arrange-

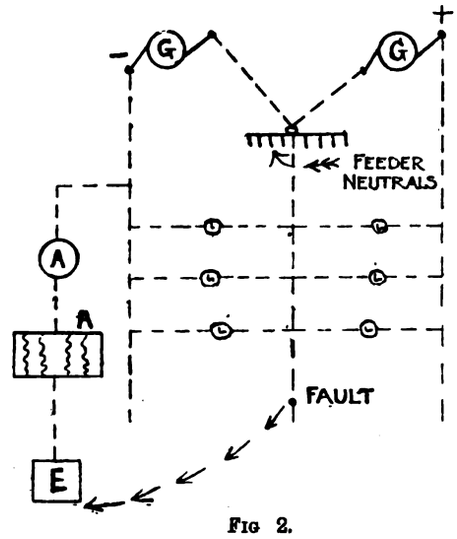

FIG. 2.

ment. The negative side is perferably earthed, for the reason that if for the purpose of testing it is necessary to put an extra strain on the insulation of either of the outer conductors, the positive should always be in a better condition to sustain it, because the insulation resistance of a negative conductor from earth is generally lower than positive. Having earthed the negative outer through the resistance, R, take the reading of the ammeter, A, and as quickly as possible take another set of readings of the feeder neutral-wire currents. These will no doubt be found to have increased over the previous readings, in proportion to the ratio of distance between each feeder and the defective main. If the system is a large one, with a number of feeders in parallel on the network, it may be necessary to increase the current permitted to pass to E through the resistance R, but it should be kept as low as possible to prevent the conditions of pressure on the main altering, so that the positive conductor of the system is put to a dangerous potential from earth, the Board of Trade limit being 250 volts, and to also prevent the possibility for seriously disturbing the defective main. After obtaining the second readings of the feeder neutral wire, it then remains to judge the locality of the fault. Having localised the fault to a certain district, you can then split that portion of the network into sections, making tests of each section until the faulty one is discovered. It may be possible to trace the defective main without disconnecting the sections in the defective area by means of a compass placed over the undivided neutral wire connections in the section boxes, and intermittently earthing one of the outers through a resistance, but where the current is available from the network the best test is Murray's loop test, which connections are shown in Fig. 3. V is a milli-voltmeter of the lowest possible resistance, containing a central zero and about 15deg. marked off on each side of the scale. R is the resistance frame, which consists of a porcelain insulated board, containing the resistance wire (about 20ft. 18 gauge copper wire), which is wound on insulators and constitutes the bridge. The wire should be stretched so that the exact length of wire at any point between its terminals could be easily calculated. The terminals should be of large dimensions, so that good contacts are got between the ends of the loop to be tested and the bridge wire. A bayonet lamp-holder socket is attached to one end of the

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board, with suitable terminals, one for the supply wire, the other for the test wire. B is the faulty conductor. A is another, but without a fault, conductor of the three-wire main, of the same sectional area as B. H is a connecting piece of the same section as A and B, which should have a good metallic contact. First see that the pointer on the milli-voltmeter dial is directly over the zero point. Take wire G, make a contact with any part of the bridge wire, and watch voltmeter. Move the wire, G, along the bridge in one direction or the other until a point, say J, is reached, at which the voltmeter needle stands exactly at zero, and in the position in which it rested before the test wire, G, was used. When the needle is in its normal position, take notice of the exact point at which contact is made with the bridge, and measure the lengths between this point and each end of the bridge respectively. The position of the fault on the loop will be in a direct ratio with the different lengths obtained between the test contact and the two ends of the bridge, the fault on the loop, A B, being nearest to that end of the bridge which gives the greatest length between its end and the test contact.

Suppose test contact came 5in. from A and 15in. from B. Measure the total length of loop A B, and if the total length is 200 yards the fault will be $\frac{5}{20} \times 200$ from one end and $\frac{15}{20} \times 200$ from the other end, 20, of course, being the length of the test wire. The fault will, therefore, be 50 yards from one end and 150 yards from the other, and

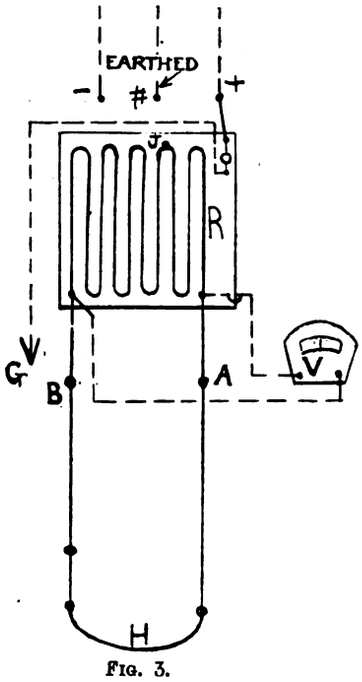

Fig. 3.

the fault will be nearest to that end of the loop which is connected to the longest length of bridge, which is B H; therefore, the fault would be 50 yards from B. The feeder neutrals are not shown in Fig. 2, but they may be assumed to be connected to different points of the network, terminating through ammeter shunt connections at the station 'bus bar.—J. P. S. (Hetton-le-Hole).

Answer to No. 737 (*awarded* 7*s.* 6*d.*).—Fig. 1 shows the arrangement employed in some stations to test a three-wire system of mains. Under normal conditions, the switch B is closed, thus connecting the neutral 'bus bar to earth through the ammeter, A_1, and light fuse. Should an earth occur on the positive or the negative of the system, the fuse is blown and the bar is connected to earth through the lamp, which is connected to the terminals of the fuse. In some cases a variable resistance is inserted in the circuit. To test the mains, the positive, neutral, and negative 'bus bars are earthed in turn by closing switches C, B, and A respectively. If a fault exist on the neutral, a current will flow through the fault, and will be registered on A_1, when either of the switches A or C is closed. Assuming the pressure between positive and neutral, and neutral and negative, to be equal, the adjustable resistance remaining unaltered, a current of the same value will flow through the fault in each case. Should a fault exist on either of the outers as well, on the positive side, say, the ammeter will register the sum of the currents flowing through both faults when the negative is earthed; and when the positive

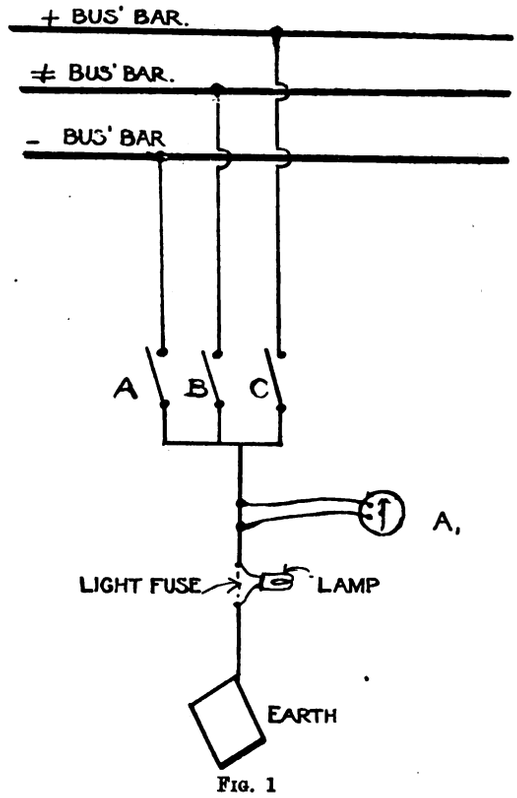

Fig. 1

itself is earthed, the current through the neutral fault only will be registered on A_1. If a fault exist on a consumer's premises, say between two arc lamps, run in series between positive and neutral, when the arcs are switched off, the fault may appear to be on the neutral—that is, the fuse may not be blown when the neutral is earthed, but when switched on the fuse will be blown, and the lamp will glow. If the positive and negative be successively earthed, the ammeter reading will be greater in the latter case.

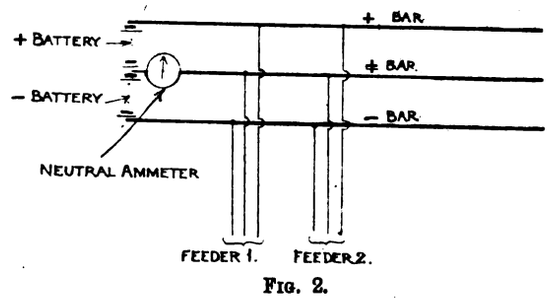

Fig. 2.

In Fig. 2 current is supplied to the 'bus bar from a battery, as is the case in some stations when the load is lightest. The neutral current, returning to or leaving the station, as the case may be, is registered on the neutral ammeter, and thus, when the switches A or C (Fig. 1) are closed, the reading of this meter, when the fault is a neutral one, will be altered by the amount flowing through the fault. To test for a neutral fault on the feeders, they may be successively disconnected at feeding points and 'bus-bar ends. If the fault exists on any of these, it will be removed when the faulty feeder is disconnected. In some stations it is possible to read the current in one or more of the neutral feeders at a time by connecting them through a special ammeter to the neutral 'bus bar. By thus connecting each neutral feeder in turn to the neutral 'bus bar, the other end of the feeder being disconnected from the network, the faulty feeder can be detected. Should the feeders be free of fault, the network may be divided into

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two sections, one section being connected through the special ammeter, and the section with the faulty distributor detected by noting the readings of the neutral ammeters when the positive or the negative is earthed. Then by continually transferring a distributor from the faulty to the sound section, the fault will be transferred to the sound section with the faulty distributor. In this way the fault can be traced to a length of distributor.

An alternative method, where the above is impracticable, is to disconnect either of the outers and the neutral of a distributor and connect the remaining live outer and the disconnected neutral through a lamp, the neutral being earthed at the station. When the neutral which is faulty is connected in this way the lamp will glow. This method means the cutting off of supply from consumers connected to the distributor under test. Another way of applying this test, when circumstances permit, is, instead of disconnecting one distributor at a time, to disconnect a section of the network. A lamp connected at one point of it, as above, will glow until the faulty neutral is disconnected from the section. To localise the fault in the cable, the following may be applied: In Fig. 3, K H is the faulty neutral, having a fault at F. M, N, O are live terminals. M is connected through a bank of lamps, R_1, and ammeter, A_2, to the neutral at H. Thus a current is passed through the fault to earth, the neutral bar at the station being earthed. Terminals, K G, at the other end of the cable are short-circuited and a voltmeter, V, connected to D and H, which will read the difference of potential between the fault and H. Let E_1 be the reading of V when a current, C_1, is passed through the fault. Let X be the resistance of

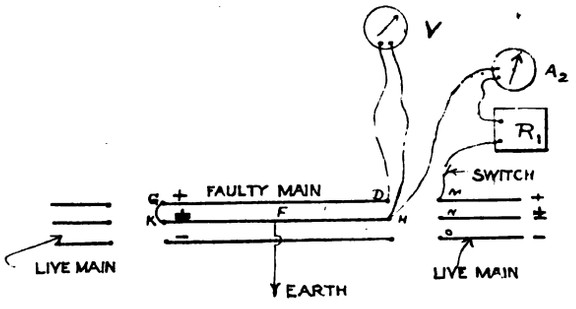

FIG. 3

F H; the resistance, R, of K H will be known. Then we have

$$\frac{E_1}{C_1} = X \quad \text{and} \quad H F = \frac{X}{R} \cdot H K.$$

Readings should be taken from the other end of the cables in the same way to check the value of X obtained as above. If E_2 and C_2 be the difference of potential and current in this case,

$$\frac{E_2}{C_2} = R - X.$$

Should two faults exist, the point F obtained as above would lie between them. Should the fault be on a house service connected to K H, the point F will be the position of the house service joint.—H. J. W.

Answer to No. 737 (*awarded* 5*s.*).—There are three general methods in use having for their purpose the localisation of faults. These are: the induction method, the fall of potential method, and one or other of the several forms of the "loop" arrangement. Provided the cables are unarmoured and not lead-covered, the induction method will, as a rule, be found most satisfactory. With this test an alternating or pulsating current is passed through the cable, and any alteration in the induced current in a portable coil noted by means of a telephone. The portable coil may conveniently consist of about 500 turns of No. 20, wound in the form of a triangle having a base of about 2ft. or 3ft. The coil should be provided with a laminated iron core. This coil is carried or wheeled as closely as possible to the ground immediately over the faulty cable, in order that the inducing effect may be a maximum. Fig. 1 is a diagrammatic sketch showing its application for locating a fault in the neutral of a three-wire system. At the station one of the outers is put to earth through an interrupting device and a resistance. The current is usually from eight to twelve amperes. Suppose, now, the exploring coil is carried over the faulty conductor, starting from the station. A clicking sound will be heard at the receiver until the coil comes over the fault. The sound will then cease, as the intermittent current does not flow in that part of the faulty cable which is beyond F.

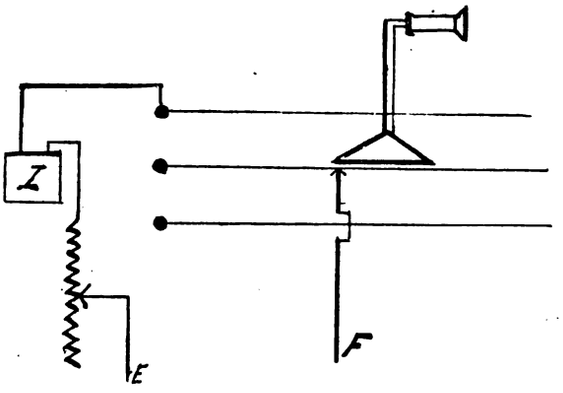

FIG. 1.

This test may also be made from any joint-box or manhole that may be convenient. In order to secure good results with this method, some practice is necessary; allowance must also be made for deviations in the path of the cable. The drop of potential method requires for its

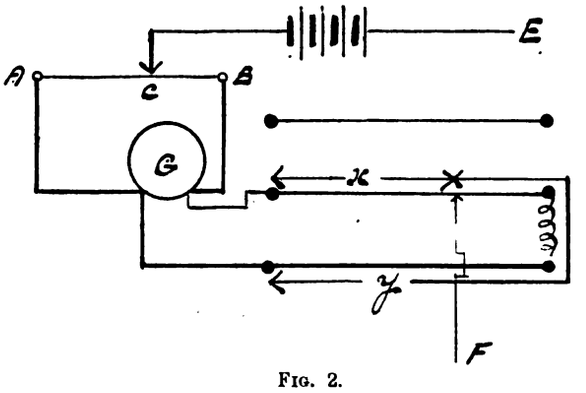

FIG. 2.

use delicate instruments, and rather troublesome calculations have often to be made owing to alterations in temperature. There are, however, many mains engineers who favour this particular method. When the cables are lead-covered or armoured, one of the loop tests will generally be found most reliable. With armoured or lead-covered cables, especially in dry situations, the leaking current does not necessarily leave at the fault and

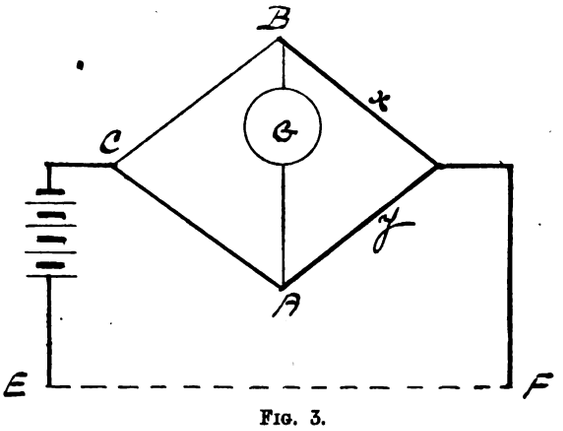

FIG. 3.

return by earth, but may first run some considerable distance along the metallic sheathing. In such cases the induction method often leads to erroneous calculations. Fig. 2 is a sketch of connections for localising fault on neutral. A B is a metre bridge (any piece of stretched wire of regular diameter and resistance will do equally well); C the adjustable contact of bridge; G, galvanometer—one of the outers is joined to the neutral at the distant

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end to provide a return; x is distance to fault in one direction; y the distance in other direction. We here have the advantage of a null method when on making contact at C no deflection is obtained, x is readily found. Fig. 3 is a diagram showing test in the familiar "lozenge." From which we have, when there is no deflection:

$$\frac{CB}{CA} \propto \frac{x}{y} \quad \therefore x = \frac{y \times CB}{CA}.$$

—M. M.

Answer to No. 737 (*awarded* 5*s.*).—It is assumed that the system in question is capable of considerable subdivision by means of disconnecting boxes at street corners or elsewhere, and that the neutral under normal conditions is earthed at the supply station only. First proceed to divide the network (or section on which the earth is known to be) into a few portions which can, for the time being, be fed from one central point only. Before doing so it must be remembered that it is unwise to take out the neutral links only, as this may result in putting a few large consumers in series with one or two small ones across the outers, with obvious results.

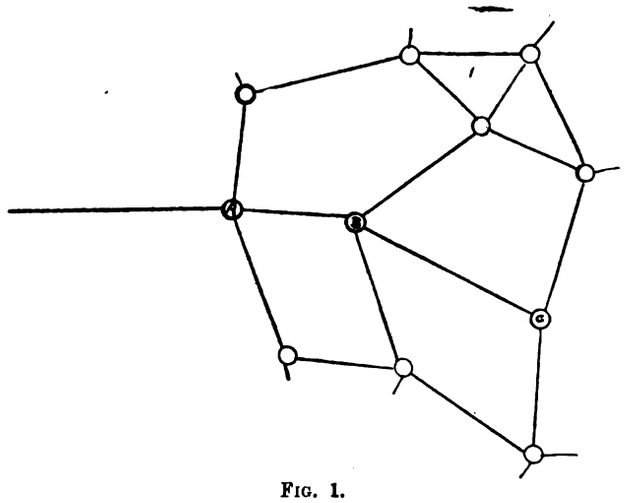

FIG. 1.

Suppose A (in Fig. 1) is the central point chosen, all other sources of supply to the section in the diagram being disconnected. Isolate one distributor, such as A B C, with its branch distributors, and test for an earthed neutral by making one outer alive and trying if a lamp will light from outer to neutral with the neutral link out. Repeat the test with each distributor radiating from A (each taken with its tributary sub-section of the network) until you find the one which gives a light with its neutral link out. Then take off one road at a time until you fail to get a light. This has now led you to the faulty main. Confirm this by testing the main as before, with a lamp from outer to neutral, making the outer alive from the remainder of the section which has now been coupled up again.

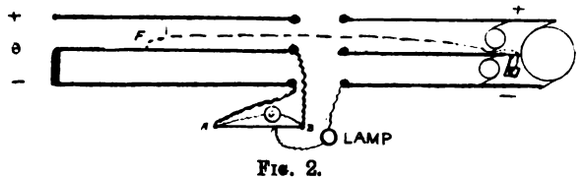

FIG. 2.

The next thing to do is to try the following loop test after having removed all consumers' fuses, or at least all those on one side of the system. Short-circuit one end of the main from neutral to one of the outers, and unless this be an absolute short-circuit it should be made by a piece of copper of definite length and section. Across the other end of the same pair place a length of 5ft. or 6ft. of platinoid wire (say No. 16, or thereabouts) stretched along a piece of casing (or a fault-localising bridge made for the purpose). At the two ends of this wire (A and B in Fig. 2) couple up a sensitive galvanometer. A wire is now connected through a 16-c.p. lamp to one of the live outers in the disconnecting box, and is slid along the platinoid wire until a balance is obtained. The sliding contact now divides the platinoid wire in the same proportion as the distance of the fault from the box bears to the total length of main (lead and return). In working out the result, account must be taken of the fact that the neutral is of different section to the outer, and allowance must also be made for the leads which connect the wire bridge to the main, and which should therefore be as thick and short as possible. Excellent results may be obtained by this method, the writer having frequently located faults by it within $\frac{1}{5}$th per cent.

Example.—The wire bridge is found to balance at a point 37·5 per cent. of its length from end B. The length of main, whose section is ·075, ·05, ·075, is 246 yards. The short-circuit is arranged so as to have negligible resistance. The size of leads used for coupling up is $^7/_{18}$, whose sectional area is ·0125 square inch. The two lengths used are each two yards long. We thus have the total length of main, reduced to a basis of ·05 square inch, made up as follows:

246 yards	·075	= 369 yards equivalent	·05
246 ,,	·05	= 246 ,, ,,	,,
4 ,,	·0125	= 16 ,, ,,	,,
	Total	= 631 ,, ,,	,,

37·5 per cent. of 631 = 236·5 yards. Deduct eight yards (the equivalent of two yards of $^7/_{18}$), and we find the fault to be 228½ yards from the box.—H. J.

Question No. 738.—Describe a practical way (other than by indicator card) of taking valve settings of Willans three-crank compound engine fitted with automatic expansion.

Best Answer to No 738 (*awarded* 10*s.*).—The Willans engines when supplied with variable expansion gear, whether operated by hand or automatically, are usually fitted with an indicator for the purpose of showing at what point the cut off is taking place. Possibly the indicator is not marked where the expansion is automatically varied. To do this entails exposing the trunk and variable expansion sleeve. Everything being made to jigs and gauges, and therefore all lines being alike, it will only be necessary to take the measurements from one line. The best way to do this is to disconnect the steam-top from the line nearest to the throttle valve. This involves breaking the joint between this and the steam-top of the next line, disconnecting the steam-pipe from the throttle valve, the throttle valve stem from the governor rod, and the link connecting the variable-expansion sleeves. When this has been done, take away the lower or cylindrical part of the steam-top, and replace the sleeve and cover, and reconnect the link. Cut some wooden distance pieces the exact length of the cylindrical portion taken away, with which to support the steam-top cover. Now place this line of pistons at the top of the stroke, and scratch a mark on the trunk against the top line of the port in the cut-off sleeve. Next move the line of pistons down until this scratch mark is lowered by an amount equal to one-tenth of the stroke. If the engine has been designed to cut off as early as one-tenth, you should now be able to cover the port in the trunk by the sloping edge of the port in the sleeve. This you will accomplish by twisting the cut-off sleeves by means of the hand lever at the flywheel end of the engine. This lever has a pointer attached to it, which slides in front of a segment, on which the position of cut-off can be marked. If at this one-tenth point the trunk port cannot be covered, then the engine has not been designed to cut off so early. Move the pistons down for another one-tenth of their stroke, and try again. When that tenth has been found at which the trunk port is covered by the sleeve, mark the position of the indicator for each tenth of the stroke for as many tenths as it will operate. Then mark further points of cut-off for the earliest and latest points, which will probably be at fractional parts of tenths. This completes the markings desired, and the steam-top can now be replaced. The measurements cannot be taken from the flywheel end line of pistons, as this steam-top is required for the support of the automatic link gear.—R. M. E.

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Supplement to "The Electrical Engineer,"
DECEMBER 23, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

QUESTIONS.

748. Where several boilers are working together, is it common practice to fit isolating non-return valves instead of ordinary stop valves? State the advantages of doing so. Is there an automatic valve on the market which shuts off the steam supply when a pipe bursts? If so, describe it.—D. R.

749. A 200-h.p. three-cylinder gas-engine direct coupled to a dynamo is supplied with producer gas from a holder which is alternately filled and emptied. The engine will run steadily for hours at a time, but sometimes it will suddenly back-fire and pull up. The dynamo is cut out and the speed of the engine brought up again, and the dynamo is then put in again. The engine will then run steadily again. It has been noticed that the engine usually back-fires when the holder is commencing to fill. Give reasons for this. R. A. H.

ANSWERS.

Question No. 739.—A 50-h.p. gas-engine and a 40-h.p. motor, shunt-wound, are connected by belts and clutches to the main shaft of a factory, so that in the event of the gas-engine breaking down the motor may take the load running on town current at 460 volts. It is desired to instal two electric cranes requiring 12 h.p. each, and to feed them by driving the motor as a dynamo when gas-engine is running, and direct from town mains if gas-engine is stopped and motor has to drive the factory. What voltage would we likely get, and what is the best arrangement of switch-gear, etc., for changing over

Best Answer to No. 739 (*awarded* 10*s.*).—From particulars given it is not quite clear whether the dynamo could be speeded up so as to compensate for the loss of voltage. It will be seen that if this could be done, the whole arrangement would be greatly simplified. If, as a dynamo, the speed remained the same as when running as a motor, there would be a drop of probably 60 volts, but this would depend somewhat upon the design of the machine. It would, however, be an easy matter to put a voltmeter across the terminals, put starting switch to full "on" position, run up as a dynamo on open circuit, and see exactly what the voltage was. Assuming that no alterations are to be made to the existing pulleys and belting, and that as a dynamo the machine only gives 400 volts, the voltage of the town

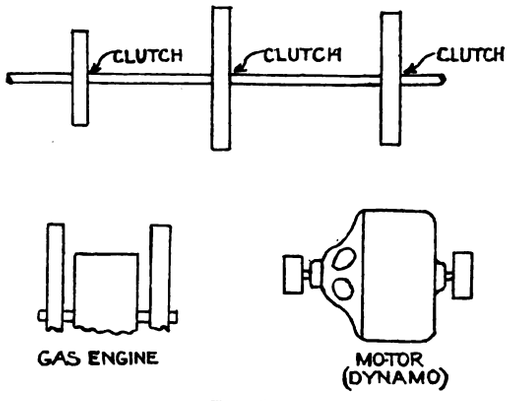

Fig. 1.

supply is 460; and if the electric cranes are to be run from that source for long periods, a considerable amount of current would be wasted if resistances were inserted in these circuits so as to enable the crane motors (wound for 400 volts) to be run off the 460-volt mains. There would also be the cost of the resistances. Four hundred and forty volt crane motors could be used, in which case they would run a little over speed when fed from town supply, and somewhat under speed when taking current from the factory dynamo. The latter method is the simpler of the two by far, and would be the more satisfactory, unless the disadvantage of the difference in speed of the cranes were sufficient to put it out of the question. On the other hand, it might be possible to fix a pulley on the opposite end of the motor (or dynamo) shaft, as well as an additional pulley and clutch on the shafting; also a second belt, and by suitably proportioning the diameters of these pulleys to so increase the speed of the machine when run as a dynamo as to obtain the required 460 volts. If this arrangement were adopted, 460-volt motors would be used on the cranes, and these would be working as efficiently when supplied from either source. This arrangement is shown diagrammatically in sketch No. 1.

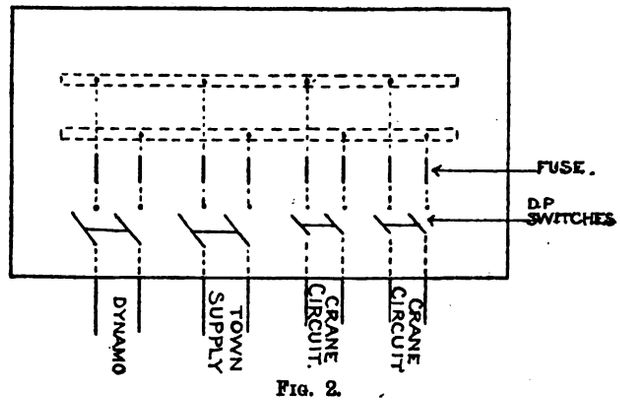

Fig. 2.

Sketch No. 2 shows a very simple switchboard arrangement, but one with which any of the following combinations for running can easily be made: (1) engine driving shafting and dynamo, the latter supplying current to the crane motors; (2) engine driving shafting, dynamo shut down, and crane motors running on town supply; (3) engine shut down, town supply driving crane motors and main motor, the latter driving the factory shafting. The existing motor-starting switch would, of course, have to be kept in the full "on" position when the machine was run as a dynamo, and if there is any likelihood of this being interfered with, it would be well to fix a switch which could be used to short-circuit the starter. The main switches would need to be handled with care, and to prevent careless attendants or unauthorised persons from putting the dynamo in parallel with the town supply it would be advisable to fix hinged pieces of fibre or vulcanite so as to project over the top contacts. These would require to be raised by hand before the switches could be closed.

With further reference to sketch No. 2, it will be noticed the main fuses are not placed on the live side of the switches. The 'bus bars could be either at the back of the board as shown or on the front, as preferred. Space is left on the upper part of the board for ammeter, voltmeter, etc., but for the sake of clearness these are not shown in the sketch. The idea of the arrangement is certainly a good one, as by its flexibility it would ensure the greatest possible immunity from stoppages of either the factory machinery or the cranes.—A.

Answer to No. 739 (*awarded* 7*s.* 6*d.*).—A shunt-wound machine will run as a dynamo or a motor in the same direction and with the same polarity, so it will not be necessary to worry about the polarity of the 40 h.p. motor, as the terminal which was connected to the positive main from the town supply will still be the positive terminal when the machine is driven in the same direction by the gas-engine. Having now settled this point about the polarity, it will perhaps be as well to consider what voltage we are likely to get across the brushes when the machine is run as a dynamo. This will depend on the design of the machine and on what point on the excitation curve we are working. If a curve be plotted for the magnetisation of a sample of iron plotting magnetic fluxes as ordinates and the values of the magnetising ampere-turns as abscissæ, we obtain a curve similar to Fig. 1. Now, a good modern machine is usually designed so that the poles are worked up to their saturation point—*i.e.*, so that the curve has

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just got over the bend a little bit—as after this, although we might obtain a slightly stronger field, still it would necessitate many more ampere-turns being put round the poles. At the point at which we are working on this curve it will, therefore, be seen that a small change in the magnetising ampere-turns will practically not affect the strength of the field. The formula for the voltage generated in an armature is

$$E = \frac{n Z N}{10^8}$$

where E = voltage generated;
Z = total number of armature conductors;
N = total flux, and
n = number of revolutions per second.

Now in the case of our dynamo running as a motor, and *vice versâ*, we have Z and n both constants if we assume the motor alone drives the factory shafting at the same speed as the engine does, so we see the voltage generated in the armature will vary only with the flux. Assume that running as a dynamo with field separately excited this E.M.F. be 460 volts, the same as the town pressure, then when the machine is self-exciting there will at no load be a small voltage drop in the armature itself due to the field current passing through it; hence it will be seen that the voltage we shall get when the machine is run as a dynamo will be something less than 460 volts. This drop will make N drop slightly also, but this will be very small if the machine be working well over the bend of the excitation curve, and altogether we may expect a voltage on our bus bars from this machine below 460 volts by a small percentage. As the current generated is to be used for motors on cranes this will be immaterial, as it will simply make them run a little slower. Of course, when taking any load

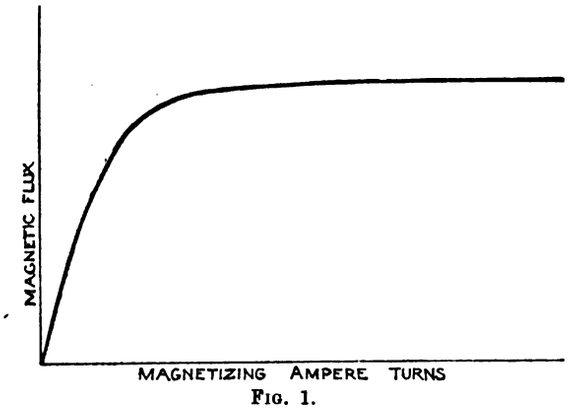

FIG. 1.

as a dynamo the voltage on this machine will still further drop. A way to overcome this total drop would be to increase the speed at which the machine is driven by driving it off a slightly larger diameter pulley on the main shaft, then when running as a motor the factory shafting will run slow, and it would be necessary to insert resistance in the shunt when it is running as a motor so as to speed it up, and then cut this out when it is running as a generator. This rheostat will be of no use when running as a dynamo as the voltage will be already low, and it will be impossible to increase the excitation by this means unless extra turns be wound on the field to be simply used when it is running as a dynamo.

The necessary connections I think suitable are very simple, and are indicated in Fig. 2, which speaks for itself. Suppose, first, all the shafting is being driven by the gas-engine and the cranes are not in use. To use the cranes it will be necessary to put in the clutch for the motor or dynamo and run this up to speed, and when voltmeter indicates 460 volts or as high as it will get, close the main switches for this machines, thus making the 'bus bars live and the mains to the two cranes. Now either or both of these can be run as desired. If it be now required to shut down the gas-engine, all that is required is to close the main switches for the town current on to the 'bus bars and then shut down the gas-engine. On closing these switches there will be rather a kick in the voltage, but as the current is simply to be used for motors this will not matter much, as it will only speed them up a little. To be able under these present circumstances to stop the mill shafting it will be necessary to open the motor switches; if one of these two be the present starter, it will be necessary to open this one, which, if a good make, will have a high resistance path to take the induced current on breaking the field. I think with this amount of explanation it will be clear how I should propose working this, and I may say this is about as cheap a method as any could be for running the machines in the way indicated in the question. Of course, the cranes themselves can be fitted with whatever style of controller it be desired, as that does not affect the question. In Fig. 2, W M is

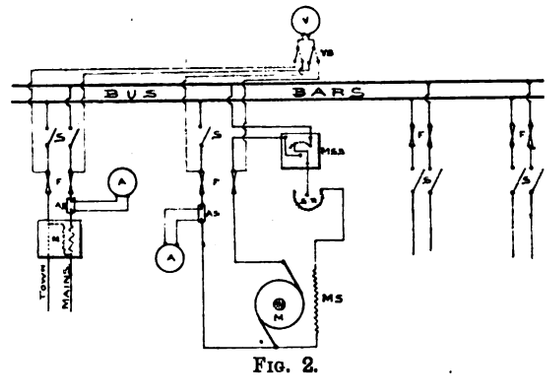

FIG. 2.

a wattmeter for the town supply, A S are ammeter shunts for the ammeters A, F are fuses, and S are switches. An extra switch can be put in the motor circuit on the same pole as the starter if it be desired, but I have left this out for the sake of economy. M is the motor which is to be run as a dynamo, and M S its shunt winding, S R the shunt rheostat for speeding it up which was mentioned before, M S S is the motor-starting switch, V is a voltmeter, and V S is a two-voltmeter switch for use with this, as it will save the price of a second voltmeter. If the kick in voltage and speed before mentioned in connection with parallelling the town supply on to the 'bus bars be objectionable, this might be done through some sort of resistance—*e.g.*, a water resistance—and then this be slowly cut out as the machine was being motored. Taken altogether, I think this method would prove to be satisfactory, and it would certainly not be costly.—E. R. ALEXANDER.

Answer to No. 739 (*awarded* 7*s.* 6*d.*).—Assuming the speed of the motor to be the same when driven as a generator, supplying current to the cranes, as when acting as a motor, the voltage at its terminals in the former case will be less than 460 volts, the voltage of the town supply. Taking the electrical efficiency of the motor as 97 per cent., the back E.M.F. generated in its armature will be about 446 volts. This would be the E.M.F. generated in the armature when driven as a generator, assuming the resultant magnetic field the same in each case. The voltage across the shunt winding, when acting as a motor, being 460 volts, will, when acting as a generator, be less. Consequently, the ampere-turns of the field system being less, the field will be somewhat reduced. For the

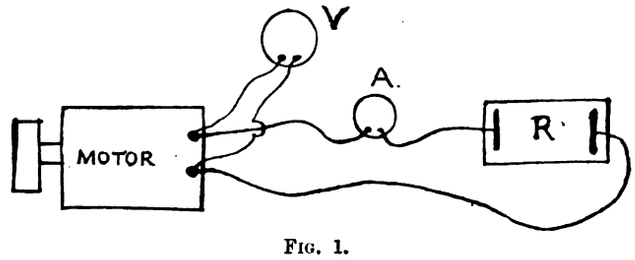

FIG. 1.

same armature current and equal excitation, the backward lead, if there be any, in the case of a motor needs be less than the forward lead in the case of a generator, owing to the effect of eddy currents and hysteresis. Therefore, the armature reaction will be greater in the generator. In this particular case, however, it may be less, as the armature current will be less than when acting as a motor.

Since the motor is already installed, and already coupled through the shafting to the gas-engine, why not run it as a generator, and note its behaviour while supplying

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current under the conditions intended to work it under. Fig. 1 shows the arrangement for carrying this out. R is a water resistance, consisting of two sheets of lead partially immersed in water. The part of each under water may be about a square foot. Each sheet is connected to a pole of the motor. A is an ammeter placed in one of the leads; V, a voltmeter giving the pressure across the motor terminals. While the motor is being run up (driven by the gas-engine), the lead sheets are kept well apart, and after the maximum reading on V is obtained, the leads are moved toward each other until the ammeter indicates the current required by the cranes. Let C denote this current in amperes, and V_1 the reading on the voltmeter (in volts), and allowing 800 watts per brake horse-power for the cranes, C will be given by the formula

$$\frac{24 \times 820}{V}.$$

It would be advantageous to have the voltage at the motor terminals, when driven as a generator, as nearly as possible the same as that of the town supply. This might be obtained by increasing the speed of the gas-engine. As regards the connections required, Fig. 2 represents this diagrammatically. B_1 and B_2 are two 'bus bars connected to the town mains through fuses, F_1 and F_2, and switches, S_1 and S_2, all of which are probably in position. The supply company's meters and fuses are not shown. The motor is connected to B_1 and B_2 through the switches S_3

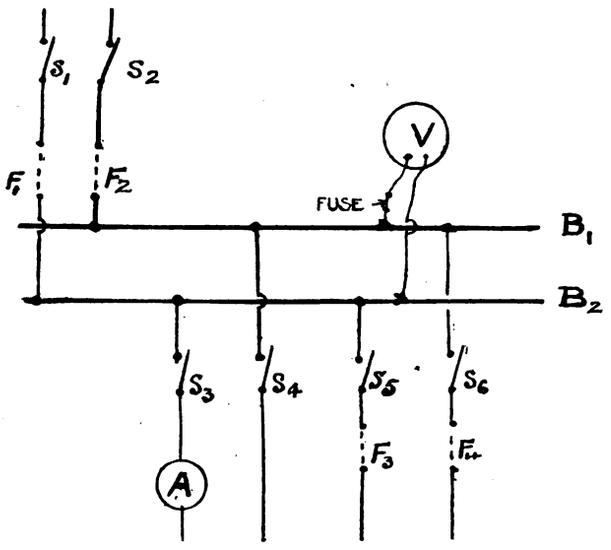
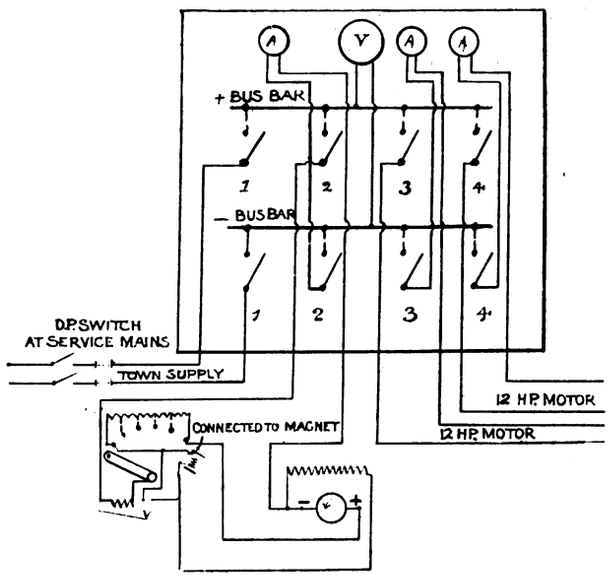


FIG 2.

and S_4. The lead through S_3 has an ammeter, A, on it, which is to have two scales, one on either side of zero, so that when the motor is supplied with current from the town mains, the current will be read on the scale on, say, the left of zero. When the motor is supplying current to the cranes, the current will be read on the scale to the right of zero. The crane's circuit is connected to B_1 and B_2 through the fuses F_3 and F_4 and switches S_5 and S_6. If necessary, two separate circuits may be run instead of one. V is a voltmeter connected across B_1 and B_2. When all the switches are closed, current will be supplied from the town mains to the motor and the cranes. When the motor supplies current to the cranes, S_1 and S_2 will be open and S_3, S_4, S_5, and S_6 closed.—H. J. W.

Answer to No. 739 (*awarded* 7*s.* 6*d.*).—A shunt-wound motor is the most perfect example of a reversible machine—*i.e.*, if it is supplied by electricity it will produce power, or if it is driven by power it will produce electricity—and this without any alteration other than to find the correct position of the brushes. In electric motors the brushes have to be shifted slightly backwards against the direction of rotation. The brush bracket should be shifted as far as it will go in this direction without sparking, when the motor is running lightly. It will then take its full load without sparking, and without further shifting. In the case of dynamos, the brushes are moved forward with the direction of rotation, and set in the same way. The machine will have to be driven at a little higher speed than it would run as a motor at 460 volts to generate the same voltage. To prevent a confusion of change-over switches, I would suggest that a switchboard be installed with suitably mounted switches and fuses to meet the requirements of the Board of Trade and the local supply company's regulations.

The accompanying sketch will make itself clear. No. 1 circuit, town supply through an additional double-pole switch and fuses (which could be kept locked when not in use), would supply the 'bus bars, 40-h.p. motor, and the two 12-h.p. motors. No. 2 circuit, 40-h.p motor, when working as a dynamo, would now supply 'bus bars with electricity. Nos. 3 and 4 circuits, each 12-h.p. motors. A voltmeter placed across the bars as shown would give the E.M.F. of town supply and dynamo. An ammeter could with advantage be placed in circuits Nos. 2, 3, and 4, or, if expense is a consideration, one large ammeter with suitable readings could be used with a two-way plug arrangement. When machine is working as a dynamo, starting switch could be closed against hold on coil, and it would remain in this position so long as dynamo was excited. Starting switch shunt connections should be as shown, closed across motor itself, so that when motor is stopped by switch-handle flying back, shunt circuit is not broken suddenly. The action of the shunt is very much like inertia in moving bodies, and its effect in starting and stopping is very much the same, in that it will not start quickly, and it is dangerous to try and stop it quickly, as



an attempt to try to stop a large flywheel suddenly would do some damage —C. W. H.

Question No. 741.—A private telephone used in connection with a certain tramway system, to speak from the generating station to the different section boxes along the line, is found to work very unsatisfactorily when the cars are running, but works well when the cars have been stopped. The noise of cars can be heard quite distinctly, so much so that it is impossible to hear what is said. Length of track about seven miles; the telephone cables are laid beside the traction feeders, but in a separate trough, and parallel to the track. What is the best remedy to overcome this difficulty?

Answer to No. 741 (*awarded* 7*s.* 6*d.*).—Telephone lines along tramway routes must comply with the following conditions to give satisfactory results: (1) they must form a metallic circuit clear of earth faults, a single line with earth return being quite unsuitable; (2) the telephone wires must be twisted after the manner of ordinary flex throughout their entire length, otherwise there will be induction from the tramway feeders, etc., near them; (3) if the telephone wires form part of a multiple-core cable, as is often the case, other portions being used as pilot wires for rail drop, etc., they must be twisted in pairs before being stranded with the cable, or there will be induction between the telephone wire and the pilot wire forming the strand next to it.

The querist must test his telephone circuits for earth faults, and examine the cables to see that wires are twisted as described above. If they are not, he will have to instal new ones to get good results. The writer has laid many miles of telephone cables in the same trench with tramway

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feeders without experiencing the least trouble from induction, it being quite impossible to hear the cars at all.—T. R.

Answer to No. 741 (*awarded 7s. 6d.*).—The noises heard in the telephone is perhaps due to leakage from the wires to the rails. If this is the case, it can easily be remedied. If no leakage exists, then the noises heard are caused by inductive disturbances—namely, electromagnetic induction, which is negligible where telephone circuits only are concerned; and electrostatic induction, which is very bad to get rid of. The theory of electromagnetic induction is, when a current is flowing in a wire, A, it is in the midst

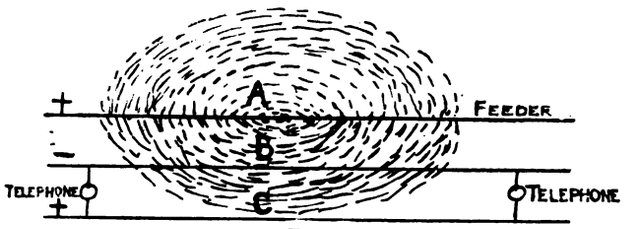


FIG. 1.

of a magnetic field. If this field cuts another wire, B, it will induce a current in B, only in an opposite direction to that in A. This is only a momentary current, but for any variation in the current in A there is an equal variation in B, but in an opposite direction. Fig. 1 shows the above, where A is a traction feeder, B and C the telephone lines. A current started in A may be detected in B, which would flow through each receiver (as indicated) and along C to complete the circuit. Therefore noises caused on the track rail may be heard on B line wire. The electrostatic induction theory is when a body, A, is charged with positive electricity, and another body, B, is brought near to it,

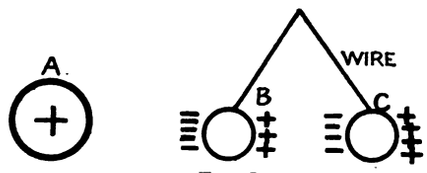


FIG. 2.

which is connected to a third body, C, further away by a wire, all the negative electricity in B and C is attracted to the side B nearest to A, and all the positive electricity passes to the side of B farthest from A, thence through the wire to C. This is shown in Fig. 2, which shows that by positively charging a body a current of momentary duration may be made to flow through a wire joining two other bodies entirely separate from it. The same thing is occurring in the telephone in question. If A is a traction feeder in which a current is flowing, and B the line wire of the telephone, C is the return wire, which also is connected

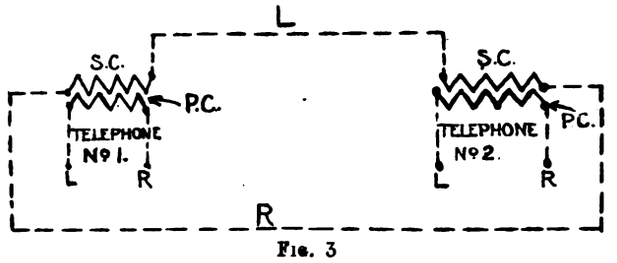
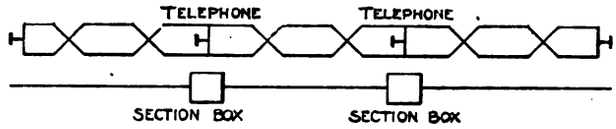


FIG. 3

to B, through the telephones. If the circuit is metallic, and the telephone cables could be twisted, this would neutralise any electrostatic effects. If the telephone cables cannot be twisted, a very good remedy is to instal a transformer to each telephone. This has the effect of reducing noises, so that the speech will not be interrupted. The transformer should be of the closed magnetic circuit type, with the primary and secondary coils wound to as near as possible the same resistance, from about 150 to 250 ohms. Fig. 3 shows the connections to each transformer, where L is the line wire, S C the secondary coils, P C the primary coils to which the line and return terminals on the telephone should be connected, thus making the telephone and primary coil on metallic circuit. This arrangement will be found to work very satisfactorily, as electrostatic charges produce small currents of high voltage, and as the effect on the transformer is equal to E C, lost energy due to dissipation in heat in primary and secondary coils, also eddy currents and hysteresis in the core, the loud noises are lost in the transformer coils. I may mention that the telephones used should be of the carbon granular transmitter type, as they are the most suitable for long distances and where transformers are used.—J. P. S. (Hetton-le-Hole).

Answer to No. 741 (*awarded 5s.*).—The only effective way of dealing with the difficulty in this case is to eliminate as far as possible the disturbing inductive influence of the neighbouring feeders. This may be done on the same principle as that employed by the Post Office to protect its telephone lines from the disturbances set up by neighbouring telegraph wires on the same poles—namely, by twisting the lines round each other, or by the introduction of crosses at certain points on the route. If in the system referred to in the question there are two conductors running the entire length of the track, the telephones should be introduced in "bridge" across the lines at the several section boxes, the lines between the sections being twisted or crossed as



is found practicable. This provides the only really satisfactory remedy for inductive disturbances from neighbouring conductors, the effect on one wire being exactly neutralised by an equal and opposite effect on the other, with the result that a "silent" circuit is obtained.—A. F.

Answer to No. 741 (*awarded 5s.*).—The best way to remedy this will be to put a return wire beside the existing lead. The telephone has now, I expect, an "earth" return, and if lead and return are placed together, all disagreeable sounds will cease. The reasons are:

1. If two wires are placed parallel to each other, and one of the wires has a telephone receiver in circuit, the other is connected to an alternator or in circuit with a battery and vibrating circuit breaker. If the machine is started or the battery switched on, a humming sound will be heard in the telephone, due to the rapid variations of the current in the other wire. The reason why the two circuits influence each other is this: the wires lie close together, and when the current is switched on, the lines of force spread out in concentric circles, which cut through the second wire, inducing an E.M.F. and causing a current if the circuit is complete. When the circuit is broken the lines collapse, and again cut through the wire, thus causing a second E.M.F. acting in the opposite direction; in fact, whenever the current varies in the exciting circuit a corresponding variation takes place in the second circuit, but, however, if the lead and return are placed together, the lines of force cut through both wires at once, causing two E.M.F.'s, one in each wire and each equal in strength, acting in the same direction; therefore, they oppose each other and the telephone is unaffected. The single telephone wire lying alongside the rails will, therefore, be influence by the variation of the current strength in the rails, which take the place of the return cable to the generating station. The rails are always more or less dirty, and so imperfect contact with the wheels of the car is made. This will cause great variation in the current strength, and the telephone circuit will be affected as described.

2. Another cause will be the difference of potential at the opposite ends of the track, the telephone being "earthed" near each end of the track. I think the real cause is the mutual induction between each circuit, which can only be remedied by placing the lead and return wires of the telephone circuit together.—W. DARLING.

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Supplement to "The Electrical Engineer,"
DECEMBER 30, 1904.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

750. Can anyone give results of a 12 months' working of an installation using Diesel oil-engines as prime movers, especially as regards the upkeep of this type of prime mover, and any trouble found in working the same?—W. T. W.

751. What is the cause of shrinkage of active material in Faure type negative plates with subsequent loss of capacity? Can capacity be recovered; if so, by what means —SHRINKAGE.

752. Describe what you consider the best method for cleaning the dust off boiler tubes of the Babcock and Wilcox type of boilers, especially where boilers are erected in a cramped position.—J. C.

ANSWERS.

Question No. 742.—It is common practice in continuous-current designing to take the permissible reactance voltage (per section of the armature winding) at a higher figure in the case of motors than in the case of dynamos. Is there any basis for this procedure in point of fact or of theory? Please discuss fully.

Answer to No. 742 (*awarded 7s. 6d.*).—The higher value is assigned to the reactance voltage per division of the *motor* armature winding, for reasons which can best be understood after a brief consideration of the factors determining the value in any case. As the reactance voltage is precisely of the nature of the back E.M.F. in a choking coil, produced, as it is, by the fluctuations of magnetic lines generated by the varying currents in the windings during the period of commutation, the value can be calculated by the formula

$$e_r = 2\pi n \mathrm{L C} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

obtaining the equivalent values of n and L as follows. To find n, divide brush breadth by the peripheral speed of commutator, so obtaining the time taken to reverse the current—or the equivalent value to half a period. The reciprocal of double this value will be n, the equivalent frequency. L is calculated by estimating the number of lines generated by one ampere in 1in. of the embedded conductors (in a slotted armature), and multiplying by the length of inches embedded and by the number of turns commuted together (if more than one). Dividing by 10^8 we have L in henrys.

Rothert gives the following formulæ:

$$e_r = 60 \times 10^{-8} \times \frac{\xi \times \mathrm{K}_w \times (l + 0{\cdot}1\ l_2)}{\mathrm{N} \times \mathrm{P}} \quad . \quad . \quad (2)$$

where ξ = number of turns per element of winding; K_w = output; l = length of embedded wires; l_2 = length of free portion; N = polar flux; P = number of pairs of poles; and

$$e_r = 105{\cdot}6 \times 10^{-8} \times \frac{\mathrm{Z}^2 \times \text{r.p.m.} \times \mathrm{C}_1 \times (l + l_2)}{\mathrm{K}} \quad . \quad (3)$$

where Z = total number of wires; C_1 = current in one conductor; K = number of commutator plates.

From these data we see that the value of e_r per section of winding varies directly as the number of turns per element, and inversely as the number of commutator plates (corresponding to the number of elements). An average value assigned in machines designed for carbon brushes is 1·2 times the voltage for commutator section for dynamos, and 1·8 for motors. This 50 per cent. increase is necessitated by the tendency of modern practice to make cheapness the governing consideration of motor construction, and to this end the number of armature slots and commutator sections are reduced as far as possible. This, of course, means an increase of the wires per section, or ξ in (2), and decrease of K in (3), the result being an increase of e_r, the value of the reactance voltage. The increase in the volts per commutator section is the prohibitive feature in applying this principle to dynamo construction.—A. M. L.

Answer to No. 742 (*awarded 7s. 6d.*).—The statement made in the question that it is common practice to take the permissible reactance voltage higher in the case of a motor than in the case of a dynamo, seems to be far from true unless more detail is given as to the rating of the respective machines. As a matter of fact, in a line of standard machines rated for continuous working with the same temperature rise, the reverse is the case, as will be readily seen from the following. With machines of small and moderate size, of recent design, say up to 150 b.h.p., or equivalent in kilowatts, it is the temperature rise which limits the output of a given armature. Now, in a standard line of machines, the flux used in a given armature would be taken the same, whether for use as a dynamo or motor, in order to use the most economical densities in the iron. Also, for the same terminal voltage, it is well known that the speed required when working as a dynamo is higher than the speed of the same machine as a motor. In fact, if V is the terminal voltage, R the resistance of the armature, C the current in the armature, the ratio of the speed as a dynamo to the speed as a motor will be for the same flux $\frac{\mathrm{V}+\mathrm{C R}}{\mathrm{V}-\mathrm{C R}}$, whilst for the same heating the armature current must be the same, so that the reactance voltages must also bear the same ratio, which shows that, with the conditions pointed out above, the reactance voltage is usually taken at a higher value in the case of the dynamo. Even in the case of large machines, in which the tendency to spark limits the output, there is no reason why a higher reactance voltage should be allowed when working as a motor.

Looking at the question from a practical point of view, we might argue that in the case of the dynamo there is an attendant who could rock the brushes, assuming that the position was not fixed, which is not the case with motors, which usually have to run quite unattended, so that again the statement in the question must be opposed. If a stronger field is used in one case, the armature current may be much higher without fear of sparking owing to the stronger field, as is the case with motors rated for intermittent working. For instance, motors rated for a temperature rise of 130deg. F. after one hour's full-load run will be found to have a reactance voltage from 30 to 40 per cent. higher than in motors rated for continuous working, at the same time having equally good working properties. But in this case we have altered the conditions in such a way as to make the comparison unfair. What "F. W. D." has probably done is to compare dynamos with a temperature rise of 70deg. F. with motors rated with 80deg. F. rise, both after a six hours' run, in which case his statement would be quite correct.—W. J. P.

Answer to No. 742 (*awarded 7s. 6d.*).—It is not quite correct to state that more armature reaction is allowed in a motor than in a dynamo, as it is only in shunt motors that any benefit can be obtained from the armature reaction, consequently it is only in the shunt motor that a greater armature reaction is permitted. The reason for this procedure is fairly simple. In a dynamo or motor the armature reaction is greatest when the armature current is greatest;

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in the case of a dynamo the effect of the armature reaction in weakening the field is most acute at full load, and results in lowering the voltage of the machine, a thing which cannot be tolerated, especially when the output of the machine is required to be as great and efficient as possible. In the case of a shunt-wound motor, however, the weakening of the field due to armature reaction is beneficial, in that it assists to keep the speed of the motor constant, as follows: A heavy load is thrown on the motor; for a moment the motor slows down, this reduces the back E.M.F. and allows the impressed E.M.F. to urge more current through the armature, resulting in the increased armature reaction weakening the field, and allowing the motor to run faster again. The speed does not come exactly up to its former value, but very nearly so, as long as the load thrown on the motor is within its legitimate limits; the effect, of course, of load being indiscriminately piled on to the motor would be to pull it up. A little consideration will show that in the case of a series motor the same effect cannot be produced by the armature reaction as in a shunt motor, due to the fact that in a series motor the field and armature current either decrease or increase together, whilst in a shunt motor the field is entirely independent of the armature, and the effect of weakening the field current is not to weaken the armature current, but to increase it, and *vice versâ*. In the case of a compound-wound motor the armature reaction is treated in the same way as in a dynamo—that is, is kept as low as possible and the speed regulation obtained by correct design of the series turns, the shunt winding always controlling the polarity of the field. The reason, then, for allowing greater armature reaction in a shunt motor than in a dynamo is that in the case of a dynamo, a series, or a compound-wound motor the armature reaction is productive of nothing but evil, whilst in a shunt motor, if properly controlled, this reaction will prove of great benefit.—W. T. W.

Answer to No. 742 (*awarded* 7*s.* 6*d.*).—Although considerable difference of opinion has always existed among engineers with regard to commutation, it has long been recognised that one of the most certain ways of securing sparkless collection at the brushes is to make the number of sections in the commutator as great as possible. Specifications have been issued stating that for a given voltage the machine must not have less than a certain number of commutator sections. Hobart, in his excellent paper read at Glasgow in 1901, pointed out that although a large number of sections tended to make good commutation possible, the prime factor in the matter was the product of the reactance of the section under commutation multiplied by the current flowing through that section. To this product he gave the name of "reactance voltage." It will be seen that in any machine, dynamo, or motor, increase of load means also an increase in reactance voltage. It is common knowledge that many machines which run satisfactorily at normal loads, spark badly when overloaded. Practice points to a figure of about three for the reactance voltage in order to secure good commutation. If this amount be much exceeded, the brushes are likely to work badly. It is not that a motor possesses any inherent property enabling it to run satisfactorily with a high reactance voltage; the answer to the question propounded by "F. W. D." turns rather on the question of rating.

Motors are often rated at considerably below their maximum output; in such cases, therefore, the reactance voltage, which appears to be excessive when calculated for maximum current, is but normal under the usual running conditions. Another point also to be considered is that many motors under full load fall off in speed. Thus, although there is an increase in current, there is a decrease in the periodicity. Therefore, the lower periodicity tends to reduce the effect due to a rise in current. This is seen from the formula: reactance voltage $= 2\pi \sim l\,C$, where l = length of conductor in the short-circuited section, and $\sim$ = periodicity (while the coil is short-circuited the current in it has to pass through half a period). Variation in speed is most pronounced in the case of series motors; this type of motor rarely runs long at its maximum output. With an equal ratio of rating and load there does not appear any reason why the reactance voltage may be less in a motor than in a dynamo. The great advantage claimed by Messrs. Parshall and Hobart in designing a machine on the lines that reactance voltage is to be considered of paramount importance, is that by so doing commutation is independent of the fluctations in field strength. Armature action, or varying potential on the magnets, may so weaken the fields of a machine, that its power to effect commutation by a so-called "magnetic fringe" is nullified, and sparking ensues. The whole question of reactance voltage is one well worth serious study by the electrical engineer.—M. M.

Question No. 743.—I use five tons of zinc annually in the production of hydrogen for plumbers' use. When the solution is saturated with sulphate of zinc it is thrown away. Describe best method of recovering the zinc in metallic form by electrolysis.

Best Answer to No. 743 (*awarded* 10*s.*).—The electrolysis of zinc sulphate solutions is attended with considerable difficulty, and requires skilled supervision and special knowledge. Zinc is a metal so electro-positive, and needing so much energy for its reduction, that when aqueous solutions of its salts are electrolysed there is a tendency to produce hydrogen instead of zinc at the cathode. Beside this, from most solutions, including the sulphate, the metal is liable to be deposited in a spongy condition, unless special precautions are taken as to the acidity of the electrolyte, and as to the current density at the cathode, and so on. The working conditions have been investigated by Mylius and Fromm, and the results of their investigations have been published (*Zeitschrift für anorganische Chemie*, 1895, p. 144. In order to avoid as far as possible the evolution of hydrogen at the cathode, the electrolyte should not be weak; it should contain at least 10 per cent. of crystallised salt, $ZnSO_4 7H_2O$. Next, it should be neutral or only slightly acid. The solution mentioned in the question will require to be diluted if the zinc has been properly used in the first instance, and the solution will, under the same circumstances, also be near the neutral point. Thirdly, the solution must not be basic, and it must not contain any oxidising impurity.

The next point to consider is, will it pay to instal plant to treat, and incur expenses to recover, so small a quantity as five tons annually? The cost of the necessary electric energy can be computed within a reasonable margin of accuracy. The decomposition of zinc sulphate, represented by the equation $ZnSO_4 Aq = Zn + H_2SO_4 + O$, involves an expenditure of 106 kilogramme-centigrade-calories for each 65 grm. of zinc deposited, which corresponds with 2,564 horse-power hours per ton, or 12,820 horse-power hours for five tons, equal to 3,749 horse-power hours for deposition of five tons per annum, working 24 hours per day. But in practice the current efficiency will not exceed 80 per cent., owing to the unavoidable expenditure of energy in producing hydrogen at the cathode, nor will the voltage efficiency exceed 50 per cent., so that the practical combined voltage and current efficiency will not exceed 40 per cent. The commercial energy required will therefore be $\frac{3,749 \times 100}{40} = 9,372$ horse-power hours continuous working for 12 months. If the current for electro-deposition is supplied from a motor-generator at, say, 80 per cent. efficiency, the power consumed will be $\frac{9,372}{0{\cdot}8} = 11,715$ horse-power hours, or $11,715 \times 0{\cdot}746 = 8,739$ Board of Trade units. If this could be obtained from a public supply source at 2d. per unit, the cost of energy would be £39. 10s. per annum, or £8 per ton of recovered zinc. As the value of zinc is, on an average, about £22 per ton, one-third of the value of the recovered metal is gone in the cost of power alone if taken from public source and at the price named per Board of Trade unit. To this must be added incidental expenses to provide for wear and tear of the plant, depreciation, renewal of anodes (which must be of carbon, which is attacked in solutions from which oxygen is generated, as in this case), and also expenses of skilled supervision. For all this there is a margin of, say, £14 per ton, or £70 per annum. It is doubtful, therefore, whether the zinc recovery plant would be a profitable one. However, if it should be thought advisable to undertake the

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work, the following additional information will, it is hoped, be of service.

It will not be found possible to deposit the whole of the zinc in the bath, because the electrolyte will be constantly increasing in acidity as the zinc is deposited. At the same time, it is not necessary that all the zinc in the bath should be deposited at one time, as the liquor, partly depleted of the metal, may be used for hydrogen generation again. The amount of zinc to be deposited will be 32lb. per day, and for this at 80 per cent. current efficiency, and working eight hours per day, the current necessary will be 240 amperes. The current density will be about 15 amperes per square foot. Consequently the cathode surface will be $\frac{240}{15} = 16$ square feet. A tank to hold nine cathodes and eight anodes, each 1ft. by 1ft., will give the necessary surface and density. Placing the electrodes 2in. apart, a vat 48in. long, 14in. wide, and 16in. deep will be about right. The voltage will be between four and six. The parallel system must necessarily, with insoluble anodes, be employed—that is to say, all the anodes joined in parallel to the positive pole of dynamo and all the cathodes in parallel joined to the negative pole. The electrolyte must be kept constantly stirred.—ELECTROLYSIS.

[Will the author of this answer kindly forward his name and address.—ED., *E. E.*]

Answer to No. 743 (*awarded* 7*s.* 6*d.*).—The figures given in this question show that 2cwt. of zinc are used in a week. Two hundredweight of zinc dissolved in dilute sulphuric acid would amount to about 6,000lb. of saturated solution of sulphate of zinc, supposing that the solution is fairly saturated and at normal temperature, when 1lb. of the crystallised salt would be dissolved by 2½lb. of water. To deposit 2cwt. of metallic zinc from this solution would require 85,000 ampere-hours, or a current of 1,420 amperes 60 hours a week. The E.M.F. of the current would be best at about three or four volts. The solution would be normally acid, and is a good conductor of electricity. According to Gore, the solution should be diluted with about an equal bulk of pure water to give a good reguline deposit. Having thoroughly mixed the solution and water, the temperature should be allowed, if necessary, to fall to 60deg. F., and then the specific gravity should be noted by means of a hydrometer, as there will be some little practical difficulty in maintaining the bath at the proper density or strength for giving a good reguline deposit. The anode should be a sheet of platinum foil. The kathode may be a sheet of zinc or any metal, or even carbon if preferred. I need hardly mention that sulphate of zinc is composed of zinc and sulphuric acid, and that the effect of the electrolytic action is to separate these two. There will, of course, be no difficulty in lifting the zinc out of the bath when it is deposited, but if provision is not made for also removing the sulphuric acid, obviously the solution of the bath will gradually become more and more acid, and then the sulphuric acid will dissolve the zinc as soon as it is deposited, and so none could be removed. This acid, when free, can be estimated by the usual methods given in chemical text-books, if desirable, but in the process of electrolysis there is little or no need for this, because we know that every 65oz. of zinc removed from the bath would represent 98oz. of sulphuric acid set free in the bath. Therefore, careful note should be made of the quantity of zinc deposited every hour, and quicklime in proportion should be added to neutralise the acid set free by the electrolysis. The proportion of pure dry quicklime would be 56oz. for every 65oz. of zinc deposited. The lime would unite with the sulphuric acid to form sulphate of lime, which being only sparingly soluble in water would soon settle on the bottom and could easily be removed when necessary. A little care and practice will enable the bath to be kept in good working order. Fresh sulphate of zinc solution must be added to supply zinc for deposition, but this need not be diluted with water as the first lot was, because the bath having been made up in the first place, all that is necessary is to maintain the standard as shown by the hydrometer. The quicklime, if dry, will take up water as well as acid, and so all three will be removed together, and if the bath is fairly shallow and has a good surface exposed to the air, evaporation will help to get rid of the water added with the saturated solution of sulphate of zinc from time to time. The powdered dry quicklime must be laid on the surface of the liquid in the bath, and must be stirred in so as to give it an opportunity to find and mix with the acid before it settles to the bottom. Sulphate of lime is a white powder, whereas quicklime is generally slightly coloured brown. Care must also be taken that too much lime is not added, because it would deposit the zinc as hydrated oxide. A piece of litmus paper dipped into the liquid should turn distinctly red to show that the bath is acid. If the above directions are carefully followed, there will be no serious difficulty in obtaining a good deposit of metallic zinc, but great care must be used in maintaining the condition of the bath, or trouble will certainly follow. The platinum sheet mentioned above is very expensive, but if carefully handled it lasts for ever. However, to save expense, and considering that sulphuric acid is present in considerable extent in the bath, I see no reason why lead should not be substituted. It would be cheaper, and should give good commercial results. There is no difficulty in obtaining zinc electrolytically. The difficulty is in maintaining the proper conditions of the bath.—F. G. A.

Answer to No. 743 (*awarded* 5*s.*).—The most satisfactory process for recovering the zinc from a solution of zinc sulphate is by electrolysis. The following method is economical and gives good results. The saturated solution of zinc sulphate is placed in the ordinary depositing trough, using as anodes either plates of carbon or sheets of lead. The cathodes should be made of sheets of zinc. In the electrolysis of zinc sulphate, zinc is deposited at the cathode and sulphuric acid is liberated at the anode; it is therefore essential that a conductor be used as anode that will not be affected by the acid, as neither carbon nor lead are affected by sulphuric acid. These are most commonly used, and, if pure lead is used, the zinc would be deposited at a slightly lower voltage than if carbon be employed. The reason of this is that the back E.M.F. between zinc and lead is not so great as that between zinc and carbon when they are immersed in a solution of zinc sulphate. The sulphuric acid set free at the anodes by electrolysis rises and floats in a diluted state upon the surface of the zinc solution. This may be collected by allowing it to overflow into a trough, and used again to produce hydrogen gas and zinc sulphate. In this way a complete cycle of operations is obtained. Thus (1) the sulphuric acid dissolves the zinc, forming hydrogen gas and zinc sulphate; (2) the zinc sulphate is run into the bottom of the depositing trough, where it is split up by electrolysis into zinc and sulphuric acid; (3) the sulphuric acid rises to the top of the liquid and overflows into a vessel, from which it is pumped into the first trough, together with the deposited zinc, thus completing the cycle of operations. As the acid and zinc used in producing hydrogen and zinc sulphate is continually being reproduced by electrolysis, there is no loss except in electrical energy. By the method described above, one kilowatt-hour or Board of Trade unit will produce, roughly, about 10oz. of zinc.—A. J. MARTIN.

Answer to No. 743 (*awarded* 5*s.*).—It is doubtful if there is any known satisfactory electrolytic method of recovering the zinc. There are, in the electroplating industry, processes and manipulations with regard to zinc which are more or less trade secrets, but the writer is not aware of any that would be suitable for the purpose of "G. W." To obtain zinc by electrolytic methods has been an attractive object, and has engaged the attention of numerous metallurgists, but so far as is generally known with but little result. One promising patent (German) consists of the following arrangement: The cathode comprises a series of zinc plates suspended in a long vat; these plates are parallel to each other and to the ends of the vat. Between these plates, boxes, or holders are placed, which carry the residues intermixed with a quantity of carbon or crushed zinc ore. These boxes are provided with perforated sides to allow free circulation to the electrolyte. Cloths are stretched below the plates in order to catch any particles that may fall from the zinc

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plates. In order to obtain a connection for the positive pole, anodes are made by inserting metal rods into the mixture of residues and carbon contained by the boxes. "G. W." would be better advised to try and find a market for the residue than to attempt the recovery of the zinc. Failing this, he would more likely find it more satisfactory to filter the residue and crystallise out the sulphate of zinc. He should find little difficulty in disposing of these crystals to advantage.—M. M.

Question No. 745.—A direct-current generator of 500 volts, for use on a three-wire system, is fitted with an automatic balancing arrangement, consisting of a choking coil fed, *via* slip-rings, from two points on the armature windings, the middle point of the choking coil being connected to the neutral 'bus bar. Can you give the theory of its action in balancing the pressure of the two sides of the network?

Answer to No. 745 (*awarded* 7*s.* 6*d.*).—The voltage obtained from the slip-rings is, of course, an alternating one, and when connections are made to the choking coil a small lagging current will flow, just sufficient to magnetise it and choke back the applied alternating E.M.F. Fig. 1

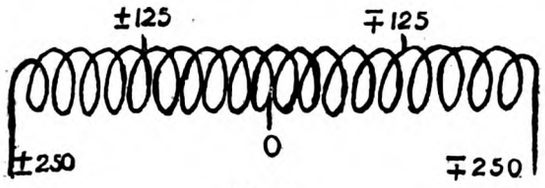


Fig 1.

represents the choking coil, and shows what voltages are obtained from different parts of the windings, the ends being marked ±250 and ∓250, meaning that while A is alternating between plus 250 and minus 250, B is at any instant at the same voltage, but with the sign changed. Similarly, at points one-quarter along the coil from either end the voltages may be represented as ±125 and ∓125. Following the argument further, we see that the middle point of the choker is zero at any and every instant—that is, it is always at a voltage midway between that applied to the ends of the coil; and, therefore, if the middle wire of the continuous-current system be connected to this point, it will be kept at a potential exactly half-way between the *generated* voltage of the machine, and the out-of-balance current will flow back to the machine *vid* the choker. It must be noted that the arrangement is not perfect, in that it provides a fixed zero point, and cannot be arranged to compensate for the extra drop in the mains of that side of the system carrying most current. The out-of-balance current returning to one side of the armature, as indicated in Fig. 2, even causes a larger internal ohmic drop on that

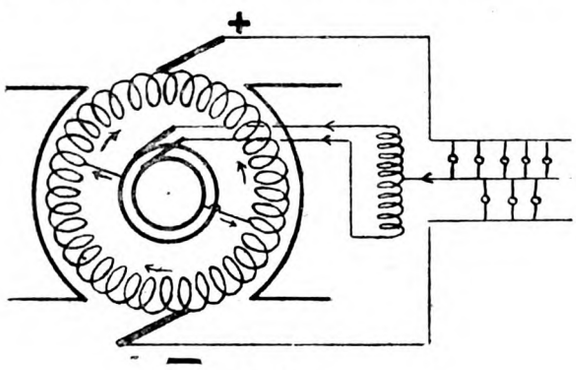
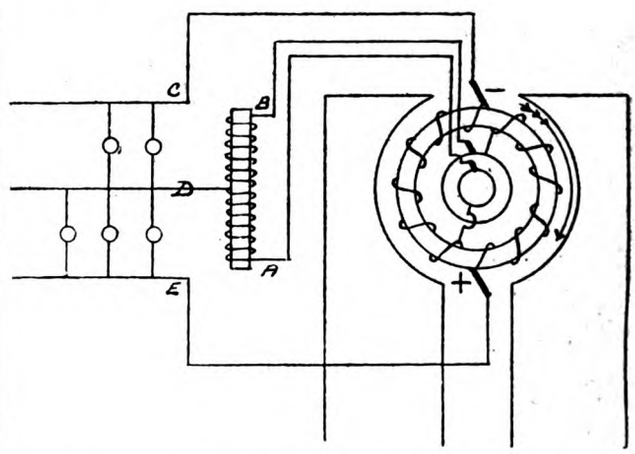


Fig. 2.

side of the machine, with the result that even the values of the terminal volts above and below the neutral point of the choker are slightly different. In designing the choker, a fairly high flux density may be used, say 60,000 or more, because of the low periodicity of continuous-current machines, generally less than 20, and as few windings should be put on as possible. The windings themselves should be provided to carry half the out-of-balance current, for the current divides equally on entering the choker. At first sight this would not appear so, for inasmuch as the points at which the current re-enters the armature are sometimes near to one brush and sometimes near to the other, it would appear that more current would travel by that path which brings it near to the brush taking the greater current (the positive brush in Fig. 2). But if more current flowed from the middle of the choker in one direction than flowed from the middle in the other direction, then the magnetism of the core would be disturbed and a back E.M.F. would be induced, which did not correspond to the applied E.M.F., with the result that an alternating current would flow in such a way as to restore the previous condition of things when the continuous current was dividing equally in the choker.—X. Z. Y.

Answer to No. 745 (*awarded* 7*s.* 6*d.*).—The idea of the arrangement is to provide a return for the out-of-balance current without trouble through sparking at the brushes. One method of supplying a three-wire system from one machine is to have a second pair of brushes on a diameter at right angles to the ordinary pair. These two extra brushes are joined together; it is evident they are at equal potential, and provide a return for the out-of-balance current by means of the neutral wire to which they are connected. Unless, however, the pole-pieces are specially shaped, this method is practically worthless on account of violent sparking. By employing a choking coil as described in the query, a path is provided for any out-of-balance current without this destructive sparking.



The accompanying figure is a diagrammatic sketch of the connections. The E.M.F. generated by the armature is a minimum at the negative, and rises to a maximum at the positive brush. In the position shown in the figure it will be seen that the inner slip-ring is at a higher potential than the outer. Suppose now that the side D E is more heavily loaded than the side C D, there is then a greater difference of potential between C and D than between D and E The out-of-balance current then flows from D to B, then to outer slip-ring, and by armature winding to the positive brush. As rotation proceeds and the connections from armature to slip-rings reach the horizontal position, A and B will be at equal potential, and the out-of-balance current divides equally. When the connections are vertical, A and B will be at maximum and minimum, the middle of choking coil being at mean potential. Any out-of-balance current will then flow to B, outer slip-ring, negative brush, and then down each side of armature to the positive brush. That A B must be a choking coil is obvious, as the reactance is necessary to prevent a large alternating current flowing through it from the brushes. The resistance of the winding on the coil must be low, in order to freely carry any out-of-balance that may be flowing in the middle or neutral wire of the system.—M. M.

[Other replies to Question No. 745 will be given in our next issue.—Ed. *E. E.*]

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